Pregnancy testing in Britain, *c.*1900-67: laboratories, animals and demand from doctors, patients and consumers

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Contents

Summary

This thesis explores a lost world of pregnancy testing in Britain from around 1900 to 1967. The overall argument is that a mixed public-private market for pregnancy testing was sustained less by the medicalisation of women's bodies or the managerial state than by the entrepreneurial testers and diagnostic consumers who helped create and maintain the demand for this now ubiquitous reproductive technology. It also places the diagnostic laboratory, a surprisingly little studied institution, more centrally in our historical understanding of twentieth-century medicine and motherhood. By the early 1900s, amenorrhoea, morning sickness and quickening were well established as important signs of pregnancy. The fetal heartbeat was highly valued as the most reliable sign of all, but it could only be detected in the third trimester and so was not useful for early diagnosis. In the years around 1914, Emil Abderhalden's serodiagnostic test for early pregnancy raised expectations that laboratory science was on the verge of a major breakthrough. But it was not until the late 1920s that the Aschheim-Zondek (mouse) test, a product of reproductive endocrinology, was adopted and implemented on a large scale. In Britain, it was first tested, scaled up and made routine in Edinburgh in the 1930s. Crucially, the 'pregnancy diagnosis station' there and hospital laboratories in London and other cities restricted their services to medical practitioners; only by becoming a patient could a woman have her urine tested. Physicians predominantly used these services for differential diagnosis and maternity experts dismissed laboratory testing as unnecessary and expensive. Healthy women were generally advised to rely on self-diagnosis and it was not until the 1950s that demand began to shift from doctors to patients. After World War II, the National Health Service (NHS) and Family Planning Association (FPA) established pregnancy diagnostic services using the new test animal, *Xenopus laevis*. Whereas the NHS accepted 'pathological' cases, but rejected 'curiosity' cases, the FPA agreed to test any woman regardless of her motivation, but would communicate the result only to her doctor. In the years leading up to the 1967 Abortion Act, *Xenopus* was supplanted by immunological test kits and private commercial laboratories in London began serving women directly, not as 'patients', but as 'clients'.

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Author's Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration; it does not exceed 80,000 words.

Jesse Olszynko-Gryn:

Date:

Introduction: Quickening, technology and the market

Pregnancy testing has never been easier. Waiting three minutes for the iconic 'thin blue line' has become a rite of passage of maternity. For countless women, the home pregnancy test, a cheap and ubiquitous over-the-counter retail product, mediates between the uncertainty of a missed period and the potentially life-changing decision either to prepare for motherhood or to terminate an unwanted pregnancy. As artist Tracey Emin put it in her installation *Feeling pregnant*, 'I go to the bathroom, knowing that within three minutes my life might never be the same again' (Emin, 2005, 164). Technologies of fetal testing and imaging have become embroiled in public debates over abortion and designer babies and so attracted much scholarly attention (Rothman, 1986, Rapp, 1999, Franklin & Roberts, 2006, Nicolson & Fleming, 2013, Löwy, 2014). Yet, although home tests have transformed women's experience of pregnancy as much as ultrasound or amniocentesis, very little is known about their history.[1]

Sarah Leavitt's study of the home pregnancy test in American culture remains the only historical account of pregnancy testing for any period or country (Leavitt, 2006). Building on Leavitt's empirical work, especially the dataset of 'consumers' stories' she collected in the online exhibit 'A Thin Blue Line', other scholars have discussed the home pregnancy test as a non-feminist technology that disempowers women by 'deskilling' them (Layne, 2009, 2010), as a technology that simultaneously demedicalises and remedicalises pregnancy (Tone, 2012), and as a domesticated tool of health consumption (Childerhose & MacDonald, 2013). Thus, the key issues that have so far emerged around pregnancy testing are medicalisation, feminism and consumerism.

For Leavitt, the home pregnancy test was a significant outcome of the women's health movement that returned the moment of realisation to the privacy of women's homes. But it is difficult to fully appreciate what was new about home pregnancy tests without a clear picture of how women determined whether or not they were pregnant before home test kits became commercially available in the late 1970s.

[1] On the 'embodied' and 'textually mediated' experience of pregnancy: Young, 1984, Lee & Jackson, 2002, Papen, 2008.

Crucially, we would need to know a great deal more about the extent to which access to pregnancy testing was already medicalised, demedicalised, commercialised, or framed as a woman's right in the decades before they were first sold directly to consumers. To better grasp the contemporary issues and ambiguities of the home pregnancy test as well as reproductive and diagnostic technologies more generally, we need to recover the markets and infrastructures that went before. This thesis is the first academic study to do so. A case study in use-based history of technology (Edgerton, 2006), my account will focus less on dramatic moments of obvious innovation than on the creation and maintenance of demand, markets, infrastructures and routines over the longer term.

Ever since Barbara Duden's groundbreaking *The woman beneath the skin*, first published in German in 1987, scholars, including Duden, have portrayed quickening as 'an experience that has lost its status' (Duden, 1992, 335). Modern medical technology in (male) doctors' hands often appears to be the culprit. The seventeenth century, in Duden's words, 'was a time when women quickened; it was taken for granted that women have this experience, make it public, and thereby establish the fact of a pregnancy […] Today, consciousness of pregnancy starts in a very different way […] A scientific, technological test rather than a kick urges the woman to change her self-image' (Duden, 1993, 79-80). As Clare Hanson puts it in her 'cultural history of pregnancy': 'The "technologisation" of pregnancy can be said to have begun with the development of the first reliable pregnancy test in the 1920s' (Hanson, 2004, 136). And in her account of 'America's growing public interest in pregnancy', Laura Tropp writes:

> As pregnancy testing transformed from an observational activity in the home to a technology-laden scientific enterprise, the discovery of pregnancy became a privilege of medical professionals. A woman might suspect she was pregnant, but her doctor was the first to know. Thus began the deterioration of pregnancy as the exclusive domain of the mother, for she was no longer the most reliable source for this discovery (Tropp, 2013, 15).

In *Pregnancy, risk and biopolitics*, Lorna Weir goes even farther, ascribing the 'moment of truth' to childbirth: 'With the invention of hormonal tests for the

diagnosis of pregnancy, birth no longer formed the moment of truth as to whether or not a woman was with child' (Weir, 2006, 74). And in her 'history of the fetus in modern America', Sara Dubow writes:

> In the late nineteenth century, fetal life was recognized and acknowledged only at the moment of "quickening" in the fourth or fifth month of pregnancy; by the late twentieth century, ultrasound exams could detect fetal life from the earliest days of conception (Dubow, 2011, 3).

Though perhaps usefully schematic, the one-dimensional contrast between quickening or childbirth, on the one hand, and pregnancy tests or ultrasound, on the other, hardly tells the whole story. Early-modernists know this. In her examination of pregnancy in early-modern Europe, Cathy McClive notes that 'Detecting pregnancy was not easy; the most common signs, a swelling belly, cessation of menstruation, and quickening, were ambivalent and open to interpretation. It was often hard to differentiate between a "true" and a "false" pregnancy' (McClive, 2002, 212). As Ian Burney puts it in relation to courts in eighteenth-century England, determining 'the basic fact of pregnancy was a problematic interpretive task, contestable both between suspects and their accusers, between suspects and experts enrolled to determine bodily truths, and between medical men themselves' (Burney, 1997, 500).

For the twentieth century, however, we do not yet have a historical account of pregnancy detection that examines the status of quickening in relation to the other signs of pregnancy, the fetal heartbeat, or laboratory pregnancy tests. Although the Aschheim-Zondek (mouse) test, the first modern hormonal pregnancy test, is typically presented as a radical turning point,[2] we know very little about practices of pregnancy detection before or after its invention in the late 1920s. We do not really know what impact, if any, the diagnostic laboratory had on women's experiences of the earliest stages of pregnancy or to what extent women even knew about the test.

[2] Wikipedia exemplifies the tendency to skip from Ancient Egyptian 'pregnancy testing' and 'nonscientific' medieval uroscopy to the Aschheim-Zondek test: http://en.wikipedia.org/wiki/Pregnancy_test#History.

Whereas feminist scholars have lamented the diminished status of quickening and critiqued the technological mediation of pregnancy testing, physicians and scientists have celebrated the scientific progress of successive regimes of new and improved pregnancy tests. Timelines stretch from Ancient Egypt to the present and construct the demand for a reliable pregnancy test as timeless and ahistorical. The following three statements spanning the past eight decades are typical:

> 'There has been a constant demand in the minds of the medical profession, and in the lay mind, also, for signs and tests that would diagnose early pregnancy' (Mathieu, 1929, 1).

> 'Man's natural curiosity concerning proof of early pregnancy probably extends to the beginning of time; evidence of this interest can be found in the Egyptian medical papyri dating back nearly 4,000 years' (Bruehl, 1952, 591).

> 'Methods for diagnosing pregnancy have evolved over the past 4,000 years, from primitive urinary bioassays to mass-produced precision products. But at their core, these tests still answer a very personal and private question—Am I pregnant?' (Marcus, 2011, 43)

Such statements are radically incomplete and misleading because they portray technological progress in a social and cultural vacuum. Though seemingly asking about a biological constant,[3] the question 'Am I pregnant?' does not mean what it did 4,000 years ago or even 100 years ago. Our cultures of pregnancy, antenatal care, abortion, and maternity have changed too much. Narratives of linear progress also conceal the palimpsest of coextensive diagnostic resources that persist alongside the uncertainties and ambivalent feelings of a missed period and early pregnancy. In the twenty-first century it remains conventional to delay disclosure of a confirmed pregnancy to extended family, friends and colleagues until after the first trimester, when miscarriage is most likely (Layne, 2003, 70).

[3] In Rachel Bowlby's words: 'pregnancy has arguably remained the stubbornly intractable element in the sequence of biological occurrences that lead to the arrival of a baby […] No human baby has yet come into the world that did not emerge from a female (or partly female) human body' (Bowlby, 2013, 23).

In her recent feminist critique of the home pregnancy test, anthropologist Linda Layne noted that this 'seemingly simple little technology has changed the way women experience infertility, pregnancy, abortion, and pregnancy loss' (Layne, 2009, 75-76). However, we do not yet know how pregnancy testing structured these experiences, if at all, before the home test. Histories of inventors and inventions in the research laboratory have left broader questions about the social relations and public cultures of pregnancy testing unanswered. We know very little about the historical specificity of the demand for pregnancy testing or the meaning of a positive or negative result at any given time. How did doctors, women and laboratory workers relate to one another when it came to a diagnosis of pregnancy? What if the patient was an unmarried girl or suspected of wanting an illegal abortion?

A central aim of this thesis is to recover to what extent and how these experiences were mediated by laboratory pregnancy tests in the decades before the first home tests. It will examine the practices of pregnancy detection from around 1900, before the first laboratory tests were invented, to 1967, when abortion was effectively legalised in Britain. Rather than focus on scientific research and a series of landmark innovations, I will recover how pregnancy diagnostic services were established and maintained for routine use. Rather than assume that before pregnancy testing women relied on their own senses to determine whether they were pregnant, I will investigate the diagnostic resources available to women before and after the Aschheim-Zondek test. As analytic resources, I will draw on historical approaches to entrepreneurship, innovation, technological change, the medical marketplace and the laboratory.

Joseph Alois Schumpeter is known as 'one of the few economists' to have made science and technological change central to his theories of economic development (Walsh, 1984, 212). Following Schumpeter, historical economists and social scientists have tended to write about entrepreneurs and technology in terms of invention, innovation and diffusion (Schot & de la Bruheze, 2003, 231, Edgerton, 2010, 689). Schumpeter's entrepreneurs are the ambivalent 'agents of innovation and creative destruction'; their activities produce new markets and economic prosperity even as they destroy the 'dreams' and 'fortunes' of the older entrepreneurs they shoved aside (McCraw, 2007, 7). There was no escaping from what Schumpeter called the 'perennial gale of creative destruction'. His most famous concept, creative

destruction was, as he put it in 1943, 'the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live with' (Schumpeter, 2003, 83). Creative destruction evocatively captures the dynamics of the supply side of pregnancy testing with its periods of apparent stability punctuated by dramatic regime changes when new entrepreneurs with their new technologies, infrastructures and supply lines sweep away the old.

On the demand side of the story, I want to briefly look back on the past three decades of historical writing about the 'medical marketplace'. Historians of early-modern England have been writing about the 'medical marketplace' since the mid 1980s (Porter, 1985, 1988, Cook, 1986). Inspired by E. P. Thompson, feminist 'herstories' and the History Workshop, Roy Porter exuberantly reconstructed an eighteenth-century bustling with medical entrepreneurs and consumers. In *Health for sale*, his 'people's history' of 'commercial medicine', Porter extended the arguments made some years earlier in *The birth of a consumer society* by Neil McKendrick, John Brewer and his own teacher John H. Plumb. The business of health and 'medical entrepreneurship', Porter wrote in 1989, had been 'neglected' and he urged historians of medicine to draw on 'histories of consumer behavior and material culture' in order to 'obtain a better understanding of market capitalism' (Porter, 1989, 239).

Historians writing in the early 1990s extended Porter's project forward into the nineteenth and early-twentieth century and back to ancient Rome (Nutton, 1992, Digby, 1994). A decade later Margaret Pelling complained that the medical marketplace concept had become a 'purely nominal, if not meaningless' anachronism that was 'now overdue for revision' (Pelling, 2003, 342-343). In 2007, although the concept had been 'a commonplace' for two decades, Mark Jenner and Patrick Wallis could still write that historians knew 'very little about the scale, scope, boundaries or internal dynamics of the market for medicine' (Jenner & Wallis, 2007, 2). Reflecting on the 'diversity of the social and economic networks' revealed by the studies collected in *Medicine and the market in England and its colonies,* c.*1450*- c.*1850*, they prompted historians to 'think of the *markets* for medical goods and services rather than a generalised image of the medical market or marketplace' (Jenner & Wallis, 2007, 16).

As Jenner and Wallis have pointed out, medical historians began writing about consumer society in the decades when market terminology became 'ubiquitous' in public discussions of health policy.[4] They suggest that the prevalence of marketplace language may have 'made it easier to avoid engaging in fuller studies of the market or the medical economy' (Jenner & Wallis, 2007, 2). They further speculate that the nineteenth century may have been a 'heyday' of practitioners discussing British medicine in 'starkly commercial and market-oriented language', which may only have seemed 'inappropriate' 'between the late 1940s and late 1970s' when the [NHS] was […] agreed to be a national *service*' (Jenner & Wallis, 2007, 10). The core of this thesis spans the thirty-five years from 1929 to 1964 and one of its central aims is to interrogate the financial relations and medical economy of pregnancy testing, a special case of diagnostic laboratory services, before and after the creation of the NHS.

As Robert Kohler has recently observed, 'laboratory history is now surprisingly neglected' (Kohler, 2008, 761). Steve Sturdy and Roger Cooter's account of statist efforts to rationalise health care remains an influential explanation of the rise of the laboratory in modern medicine (Sturdy & Cooter, 1998, Kohler, 2008). Their analysis explains well the role of the diagnostic laboratory in public health campaigns, for example, in mass screening programmes for syphilis or cervical cancer.[5] But they missed an important piece of the puzzle: the medical market for commercial diagnostic testing, which was established by the 1920s (Worboys, 2004). Laboratories sink or swim depending on 'how effectively they [deal] with the rest of the world', so it is important to look outside the laboratory and, in the case of diagnostic testing, beyond the managerial state as well, for the crucial 'debates about what a laboratory should be, whether it is needed, by whom, and for what purposes—and about how it should be funded' (Gooday, 2008, 786). As I will argue, the success or failure of pregnancy testing hinged on whether the testers managed to cultivate a viable commercial market beyond the lab.[6]

[4] Jenner & Wallis, 2007, 2. Roger Cooter and Claudia Stein make similar observations: Cooter & Stein, 2013, 22, 238.
[5] Although the Pap smear was first announced as a test of the estrous cycle in guinea pigs in 1917 and then as a test for cancer cells in women in the 1920s, it was not implemented in mass screening programmes until the 1940s: Singleton & Michael, 1993, Clarke & Casper, 1996, Casper & Clarke, 1998, Löwy, 2010.
[6] For a recent review of the 'market turn' in science and technology studies: Simakova, 2013, 1-15.

An inviting model for historicising the diagnostic laboratory is Ludwik Fleck's belated classic, *Genesis and development of a scientific fact*, first published in German in 1935. Fleck's titular 'fact', which provided the empirical material for his general sociology of knowledge, was the relation between the Wassermann reaction and syphilis (Fleck, 1979). Fleck argued that the reaction became a clinically useful test only many years after the initial 'discovery' paper of 1906. Rather than attempt to identify a single discoverer or turning point, Fleck instead emphasised the tedious labour of many anonymous laboratory workers in the 'drawn-out process starting from false assumptions and irreproducible initial experiments along several dead ends and detours' that made Wassermann's reaction into a practical and reliable diagnostic tool (van den Belt, 2011, 332). At a more general level Fleck turned from what he perceived as the unreliably idealised and rationalised accounts of historical actors and eyewitnesses, including August von Wassermann, to a social view of collective discovery or invention. Though Fleck only mentioned the Aschheim-Zondek test in passing (to distance laboratory diagnosis from medieval uroscopy), in this thesis I want to take up his central sociological concerns with the significance of routine laboratory work and the sustained process of collective invention in the making of modern medicine and, in this case, modern pregnancy.[7]

The story of pregnancy testing in mid-twentieth-century Britain is one of steadily increasing demand and public visibility.[8] The number of tests performed by the Edinburgh pregnancy diagnosis station, an institution central to my thesis, increased from 840 in 1929, the year it was set up, to over 20,000 in 1964, the year it stopped using animals (see Figure 4.10 for the most complete presentation of the quantitative data used in this thesis). The meticulously kept records of a rural Gloucestershire GP interviewed by sociologist Ann Oakley in the early 1980s show that he ordered pregnancy tests for just over 1% of his female patients in the late 1940s and nearly 40% in the late 1970s, a thirty-fold increase in three decades (**figure 0.1**).[9] Whereas in 1931 the socialist feminist Stella Browne could claim that information about

[7] Fleck, 1979, 24. See also Löwy, 1993, 2004.
[8] Throughout this thesis I use 'Britain' to refer to England, Wales, and Scotland. Aside from a few passing remarks, Northern Ireland is excluded from my analysis.
[9] For comparison, in the same period his home deliveries declined from 71.3% to 1.3%: Oakley, 1984a, 230.

pregnancy testing was being 'kept from women who needed it' (Hall, 2000, 290), market research conducted in 1971 found that 66% of women 'had heard of' laboratory pregnancy tests.[10] Around the same time, the Edinburgh geneticist Hugh Donald recalled in an interview with historian Margaret Deacon that pregnancy testing, which 'everyone's gotten used to now', had been 'a thoroughly unmentionable subject' in the 1930s.[11] This thesis sets out to explain these increases – in demand and supply, public visibility and acceptability – in terms of the social and cultural history of pregnancy and medicine in twentieth-century Britain.

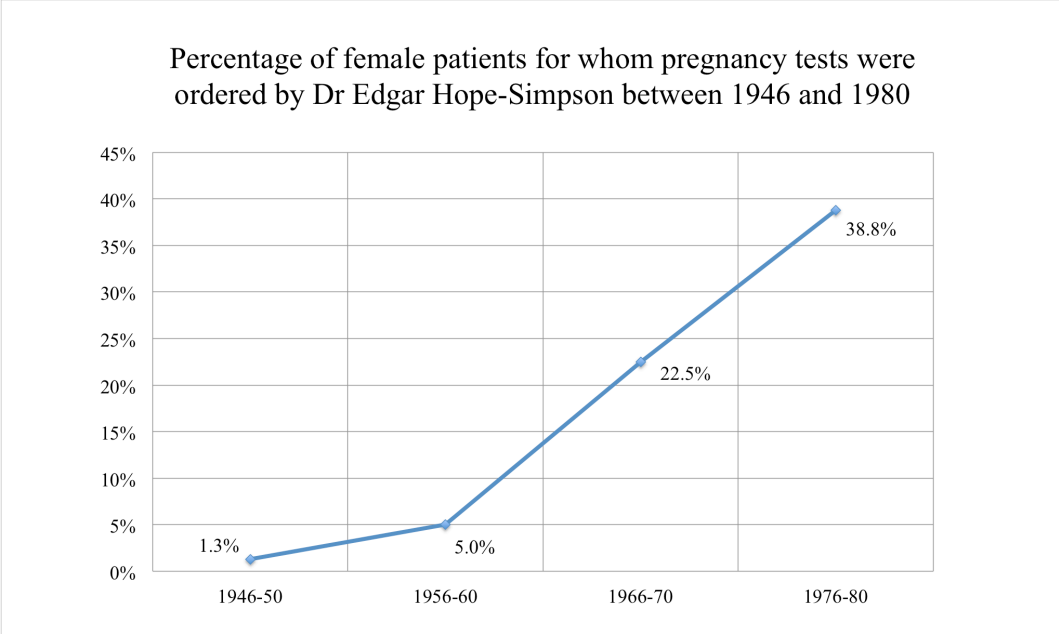


Figure 0.1. Chart based on samples of 80 female patients extracted by Ann Oakley from the case notes of Dr Hope-Simpson of Gloucestershire (Oakley, 1984a, 230).

Yet, this story of entrepreneurialism, innovation and creative destruction is not all about inexorable technological progress sweeping away the traditional. On the demand side, I want to complicate the schematic model that starkly contrasts a woman's experience of amenorrhoea before and after the availability of laboratory

[10] A. B. Giles to Helen Graham, 9 November 1971, Home Pregnancy Test'. PPGRA/B/4, Wellcome Library.
[11] Interview by Margaret Deacon with Prof Hugh Paterson Donald, 1908-1989 (geneticist and director Animal Breeding Research Organisation, The University of Edinburgh), Edinburgh University Science Studies Unit, 1969-1971, Institute of Animal Genetics, C1271/04/01. As will become clear, throughout the period covered by this thesis, pregnancy testing was often linked, as with contraception, to loose sexual mores, unplanned pregnancy, unwed mothers, and illegal abortion.

tests. I do not dispute that anxiously or expectantly waiting for the result of a home test is a meaningful experience shared by countless women that would not have been possible in the 1930s or even in the 1960s. I do want to recover the continuity of amenorrhoea as an ambiguous experience to this day mediated not only by new technologies, but also by older and resilient diagnostic resources and social relations.

Beyond quickening, we know very little about how women experienced the earliest days, weeks and moths of pregnancy.[12] As Mary Fissell reminds us, early-modern 'vernacular medical works as well as women's domestic practices employed a range of methods, from urine tests to a panoply of subtle physical signs, to establish pregnancy' (Fissell, 2003, 64-65). Victorian ladies 'wrote endless letters to mothers and married sisters about their hopes and fears if menstruation was a few days late' (Jalland, 1988, 139). And oral-history interviews suggest that some women 'took abortifacients when it was clear that they were actually pregnant and they did not ignore the realities of what they were doing' (Fisher, 1998, 35). So it seems likely that even as many women avoided pregnancy by taking 'female pills' or other remedies (Brookes, 1988, 4; Fisher, 1999, 221-222; Jones, 2007, 134), they also recognised a missed period and morning sickness as early, though uncertain, indications of pregnancy.

What about today? Take Marika Seigel's first-hand account of her own pregnancy realisation experience, which she uses to open her recently published study of pregnancy advice manuals:

> My pregnant body didn't come on slowly, a result of the accumulated evidence of missed periods, cravings, quickening. It came on suddenly, in the minutes between peeing on a stick and seeing a pink cross materialize. (I have to admit, though, that I had had to see two more of those crosses before I really believed.) One of the first things that I did after receiving this positive result was to call the University Health Clinic, tell the receptionist that I was 'pretty sure' I was pregnant, and to make an appointment with a doctor. Barely a week later, I paid a visit to that

[12] Otherwise invaluable documentary sources such as *Maternity: letters from working-women collected by the Women's Co-operative Guild* contain rich narratives of advanced pregnancy, childbirth and motherhood, but take pregnancy realisation for granted (Davies, 1978).

> doctor, who further confirmed my pregnancy with a blood test and ultrasound (Seigel, 2014, 1).

The relevant point of this interestingly contradictory passage is Seigel's parenthetic admission that the positive result of a home pregnancy test was only partially convincing; she was 'pretty sure' but did not 'really' believe she was pregnant until further tests confirmed the first one. Today home pregnancy tests are tellingly sold in two-for-one packs and most will be purchased by women who have some cause for suspicion in the first place. An important demand-side aim of this thesis will be to recover and analyse the persistence of the older experience of protracted ambiguity and gradual realisation, often mixed with fear or hope, alongside the coextensive newer experience of the technologically mediated diagnostic moment, which is not always as definitive as we might expect.

Structurally, this thesis will attempt a synthetic account of invention, adoption, and routine use, key aspects of social and technological change that are often studied separately.[13] Andrea Tone's *Devices and desires: a history of contraceptives in America* (2001) is exemplary social history that foregrounds the agency of individual entrepreneurs and consumers, but it leaves out much of the materiality of technological change that I want to emphasise. Though wonderfully sociological and grounded in the material world, Nelly Oudshoorn's *Beyond the natural body: an archaeology of sex hormones* (1994) is structured by an overarching interest in abstract concepts and discourses about sex and gender. This thesis will attempt to merge Tone's agency-driven social history approach with Oudshoorn's sociological materialism by setting out to recover, not the origins of our dominant mode of thinking about pregnancy (whatever that might be), but rather a lost world of diverse historical actors, material practices, infrastructures, power relations, social networks and public cultures. I hope the result will enrich our somewhat niche histories of the laboratory, on the one hand, and make room for diagnostic testing in more mainstream social and cultural histories, on the other.

[13] See, for example, the cases of insulin (Bliss, 1988, Sinding, 2002, Feudtner, 2003), and the oral contraceptive pill (Watkins, 1998, Soto-Laveaga, 2009, Marks, 2010). See also Tone, 1996, 2000, 2002.

The first chapter examines the diagnostic resources available to potentially pregnant women, midwives and doctors from around 1900 to the invention of the Aschheim-Zondek test in 1927. It establishes a baseline for expectations about lay and medical knowledge of the signs and symptoms of early pregnancy. It also shows how laboratory researchers and pharmaceutical companies repeatedly attempted to produce clinically useful tests for pregnancy. Chapter 2, which focuses on the Edinburgh station from its establishment in 1929 to the start of World War II, shows how the entrepreneurial testers Bertold Wiesner and Francis Crew turned the potential liability of non-specificity into the asset of 'diagnostic versatility'. A main finding of this chapter is that the Aschheim-Zondek and closely related Friedman (rabbit) tests were not only used to diagnose ordinary pregnancy in healthy women, but also for differential diagnosis in pathological cases. By the end of the decade, they were generally regarded as useful tools in the detection and monitoring of cancer as well as hormonal deficiencies believed to cause miscarriage.

Chapter 3 mines women's magazines, domestic health manuals and novels to recover intimate narratives of pregnancy realisation as well as the diagnostic resources. It argues that the demand for and public visibility of pregnancy testing increased in the late 1930s and early 1940s on account of wartime conditions, propaganda and the emergency laboratory services. Yet, although maternity experts increasingly mentioned the existence of pregnancy tests, they did so less to promote them than to discourage their use as unnecessary and expensive. Chapter 4 moves beyond the priority dispute over the invention of the *Xenopus* (toad) test by shifting attention to Dr Edward Elkan, a third entrepreneurial pregnancy tester. Elkan, a Jewish refugee from Nazi Germany, started using *Xenopus* for pregnancy testing in a private clinic in London in the 1930s. A key finding of this chapter is that the Home Office decided to relax its oversight of pregnancy testing as a form of vivisection because it did not want to risk being seen as facilitating illegal abortions. After the war, the newly created NHS recruited Elkan to help set up a pregnancy diagnosis centre in Watford so that doctors in London and the South of England would not have to rely on distant Edinburgh. The Watford laboratory welcomed 'pathological' and 'social' cases, but discouraged 'curiosity' cases.

Chapter 5 examines postwar advertising and the commercialisation of pregnancy testing by the Family Planning Association (FPA) and pharmaceutical companies that marketed hormone tablets and ampoules as pregnancy tests. Beric Wright, the son of the famous birth-control pioneer Helena Wright and my fourth entrepreneur, set up a *Xenopus* laboratory in the basement of the FPA clinic at Sloane Street. Wright, who wanted the FPA service to be profitable, controversially advertised not only to doctors, but also to chemists. Considered unnecessarily risky by some, pregnancy test drugs provided maternity experts with new reasons to promote the comparatively innocuous urine tests as a viable option. By the early 1960s, women's magazines no longer portrayed the pregnancy test as an expensive luxury, but as a 'modern scientific achievement'.

A final chapter recovers the fall of *Xenopus* and the rise of commercial test kits marketed by pharmaceutical companies. Albert Sharman, a Jewish gynaecologist and pioneer of infertility treatment at the Royal Samaritan Hospital for Women in Glasgow, and my fifth entrepreneur, was a major champion of immunoassays in Britain.[14] Working closely with the pharmaceutical firm Ortho, he tested and modified reagents, and energetically promoted the age of the animal-free test kit in medical journals, magazines and newspapers. Private commercial laboratories directly advertised to and served women as 'clients' and not as 'patients' for the first time in 1965, successfully bypassing the medical gatekeeping that had reigned for 35 years. The age of the bioassay and medical gatekeeping had drawn to a close and a brave new world of consumerism, ushered in by commercially manufactured test kits, marketing campaigns and private advertising laboratories, had dawned.

[14] Many of Andrea Tone's contraceptive entrepreneurs were 'immigrants, women, or Jews': 'Denied credit and social or educational credentials needed to claim professional respectability or ascend the financial ladder, they were drawn to a trade whose illicit character and low capital requirements made it welcoming to ordinary people' (Tone, 2000, 444). Pregnancy testing was similarly illicit and, though it required significant capital investment (a laboratory and animals), seems to have disproportionately attracted immigrants, refugees, and others at the margins of both the German and British medical establishments. Jewish doctors and scientists (Aschheim, Elkan, Joseph, Kamnitzer, Kapeller-Adler, Sharman, Wiesner, and Zondek) seem overrepresented, but further analysis along these lines is beyond the scope of this thesis. On Jewish scientists in Germany, see, for example, Volkov, 2001, Charpa & Deichmann, 2007. On medical refugees in Britain, see the special issue of *Social History of Medicine* (Vol. 22., Issue 2, December 2009), edited by Paul Weindling.

Chapter 1. Clinical symptoms and laboratory tests

Mrs B, a middle-aged mother of three, 'should have been unwell' on 16 June 1925, the day she fell and broke her ankle, but 'never saw any colours or anything.' Suspecting pregnancy, she told her doctor after two weeks had gone by, but he dismissed her concern, possibly on account of her age (Mrs B was past forty), as did her attendants at the infirmary where she was convalescing from the fall. When, to her 'horror', she 'felt a movement in the body,' she first sent her sister's friend and then her husband to take a sample of her urine to a 'water doctor' (uroscopist), who claimed on both occasions that there was 'no sign of pregnancy', but that her kidneys 'were in a poor condition'. Next she had her family doctor examine her 'properly' and, although 'he could not tell for a long time', he eventually 'felt a tiny movement' and confirmed her suspicion. Finally Mrs B 'had another examination at the infirmary by a specialist' who proclaimed she 'was 28 weeks pregnant' and when she 'got home' she 'felt the child turn' and 'ever since then' could 'get no peace' for it seemed always 'on the move.' Mrs B reckoned she was 'about a month now to being confined.'[15]

In her history of motherhood in working-class London, Ellen Ross selectively quotes from Mrs B's story as evidence that the 'moment of quickening' was 'the only diagnosis of […] pregnancy that most [women] would get' (Ross, 1993, 108). However, it is immediately clear from a more attentive reading of Mrs B's protracted diagnostic experience, described in a detailed letter to birth control pioneer Marie Stopes, that quickening (when she first 'felt a movement in the body'), was only one of several diagnostic signs – beginning with a missed period (she 'should have been unwell', but 'never saw any colours or anything') – and resources, both medical (including infirmary attendants, her family doctor and a specialist) and paramedical (the 'water doctor').[16] Significantly, Mrs B had at least three pregnancies under her belt, possibly more if she had ever miscarried, so she knew what to expect, hence her persistence despite multiple misdiagnoses. Her pregnancy realisation narrative is gradual, ambivalent and irreducible to a single moment of clarity.

[15] Stopes, 1929, 29-31. A shortened version of Mrs B's letter was reprinted in Hall, 1978, 37-38.
[16] On ancient and medival urine tests for pregnancy: Bayon, 1939, Forbes, 1957, Oakley, 1984a, 19, Porter & Hall, 1995, 45, Fissell, 2003, 64-65, Stolberg, 2007, 2009, 106-116. On psychic pregnancy diagnosis in the 1920s: Bland, 2012, 120.

In this chapter I challenge and add some much needed nuance to Ross's overly simplistic but fairly representative assessment that 'pregnancy did not really begin for a nineteenth- or early twentieth-century woman until she felt the sensation of the fetus moving, sometime in the fourth or fifth month' (Ross, 1993, 108). I do this first by examining medical textbooks and advice manuals to recover the various diagnostic resources available to women and their doctors in the first three decades of the twentieth century. I then briefly survey the controversial practice of empanelling a 'jury of matrons' in criminal court to determine whether a convicted murderess who decided to 'plead the belly' was truly 'quick with child' as a means of staying her execution until after childbirth. Although leading historians have repeatedly claimed that this practice died out in the late nineteenth century, I show that it persisted in England until the 1930s. I next turn to the research laboratory, the pharmaceutical industry and the clinic to recover the reception of the two most significant 'scientific' pregnancy tests before Aschheim and Zondek's. Historians have unjustly dismissed the first, invented by the Swiss biochemist Emil Abderhalden, as a 'fraud', and ignored the second, Schering's 'Maturin', an injectable sugar tolerance test. I conclude this chapter with a brief summation of the rise of reproductive endocrinology and 'hormonal' tests for pregnancy up to the famous Aschheim-Zondek test, which would dominate laboratory pregnancy diagnosis in the 1930s.

1.1. Diagnostic delicacies and the canonical signs of early pregnancy

An eighteenth-century physician might have taken the pulse of his patient, but otherwise there would have been little physical contact between the two. Following Laennec's invention of the stethoscope in 1816, manuals of physical diagnosis published in the mid century canonised the four main procedures of inspection, palpation, percussion and auscultation. Not only Paris, but also German and Austrian universities, became favourite destinations of British medical teachers, who imported continental practices such as histology (Jacyna, 2001). General practitioners in Britain adopted the stethoscope and specialists made additional use of newly invented instruments including the ophthalmoscope, otoscope and laryngoscope. In obstetrics and gynaecology, the 'humiliating' and 'painful' vaginal speculum along with special

examination tables and stirrups became iconic of hospital practice.[17] Gynaecological examination of the female pelvis was particularly 'fraught with social and interpersonal tensions' and 'diagnostic access' remained 'problematic'. James Young Simpson, famous for having introduced chloroform as pain relief in childbirth in 1847, also used it to avoid the embarrassment during pelvic examination (Nicolson, 2011).

Physicians preferred to rely on trust when they could. 'When a woman engages you to attend her,' explained the Glasgow professor of midwifery Robert Jardine, 'you naturally believe her statement that she is pregnant, and you do not examine her before labour, unless there is some reason for doing so'. But when 'dealing with unmarried women', it was important to be 'exceedingly careful' (Jardine, 1905, 15-16). Jardine described one dramatic instance of pregnancy denial and deception up to childbirth:

> In one case, a girl, who had not menstruated for seven months, consulted me as to her condition. She had all the signs and symptoms of pregnancy, and as I distinctly felt foetal movements, and heard the foetal heart, I told her she was seven months pregnant. I was indignantly told this was quite impossible. Next day her mother called on me, furious that I had dared to say such a thing about her daughter. As I was absolutely sure of my diagnosis, I advised her to wait a couple of months, and then to come and discuss the matter with me. About two months later I was called to see the girl one night by the indignant mother, who had been diligently poulticing the daughter's abdomen for cramp until a child had been expelled, rupturing the perineum in its exit. The girl had kept up the farce to the very end, and completely deceived her mother, until the arrival of the infant made further deception impossible (Jardine, 1905, 15).

Although childbirth, stillbirth, miscarriage, or abortion would ultimately, though retrospectively, confirm that a woman had been pregnant, abdominal growth on its own could not guarantee the existence of a fetus within. Tumours, cysts and moles

[17] Bynum, 2006, 165-169. On British debates over the appropriate use of the speculum: Moscucci, 1990, 116, Bynum, 2006, 170, Nicolson, 2011, 65-67. On earlier debates over forceps in man-midwifery: Wilson, 1995, King, 2007.

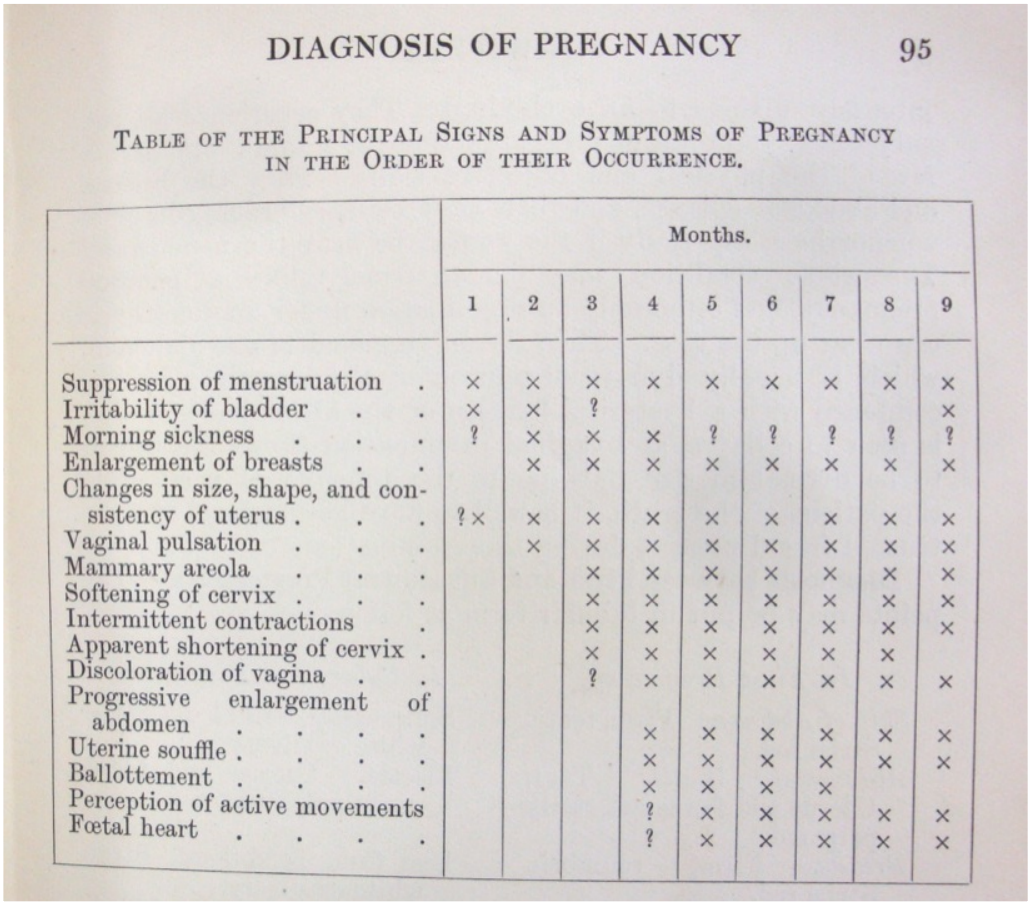
could mimic pregnancy and the pregnant belly did not bulge visibly until the fourth month. Determining pregnancy in the first trimester was medically challenging and risked social embarrassment and professional disaster. Victorian practitioners relied on 'women's own opinions' and were reluctant to perform a vaginal examination 'either to diagnose pregnancy or for any other purpose' (Oakley, 1984a, 18-20). The Edinburgh-trained physician Thomas Watts Eden, warned in the *American journal of the medical sciences* that 'except in the case of old women and little girls,' the gynaecologist and general practitioner 'must keep the fear of pregnancy ever before him.' In some circumstances it was better to avoid the matter altogether as 'nothing [would bring] him so surely to disgrace with his patients as an error here.' Eden's work at the outpatient department of the Chelsea Hospital for Women provided him with 'abundant' material to master the art; of his last 1,000 cases, fifty had involved the early diagnosis of pregnancy (Eden, 1897, 687-688).

Late Victorian and Edwardian textbooks of obstetrics and midwifery typically dedicated an entire chapter to pregnancy diagnosis.[18] In addition to diagnostic uncertainty, authors emphasised the social difficulties of early diagnosis. William Playfair's *The science and practice of midwifery* warned the practitioner that the determination of pregnancy, which 'was often beset with great difficulties,' could jeopardise 'the moral character of his patient,' and 'his own professional reputation' (Playfair, 1893, 154). Not only was a 'correct opinion' of 'extreme importance' to some patients, but, according to Guy's Hospital obstetric physician Alfred Lewis Galabin's *A manual of midwifery*, 'the result will inevitably make manifest to all concerned the medical man's skill, or want of skill, in the diagnosis'; overlooking or mistaking 'an advanced pregnancy' would 'incur ridicule' and a practitioner might 'find the result still more unpleasant if he erroneously accuses of pregnancy a virtuous unmarried woman'.[19] 'Never venture an opinion without making a thorough examination,' cautioned Jardine's *Clinical obstetrics*, 'and do not say a woman is pregnant unless you are absolutely sure of your diagnosis' (Jardine, 1905, 14).

[18] William Fetherstone Montgomery's *An exposition of the signs and symptoms of pregnancy*, first published in 1838, was entirely devoted to the subject: Fleming, 1966.

[19] Galabin, 1900, 118. District nurses and midwives were not generally called on to confirm pregnancy until the later stages. For example, Calder's *Questions and answers on midwifery for midwives* (1906), a study guide for the London Obstetrical Society's examination, posed questions on pregnancy diagnosis in 'about the fifth month', 'the latter months', and 'at full term' pregnant?' But it did not ask about the difficult first trimester (Calder, 1906, 56-61).

The canonical signs and symptoms of pregnancy were typically classified into 'presumptive', 'probable' and 'positive' (Oakley, 1984a, 18). These ranged in degree of certainty from a missed period, which could result from just about any constitutional disturbance, to the fetal heartbeat, generally regarded as the surest sign of all. Many textbooks, including Francis Haultain's *Practical handbook of midwifery* (1894) and Robert W. Johnstone's *A text-book of midwifery* (1913), tabulated the 'principle signs and symptoms of pregnancy in the order of their occurrence' (**Figure 1.1**). Presumptive signs included a missed period, morning sickness, breast changes and quickening. The absence of menstruation, or 'amenorrhoea', was considered indispensible for estimating the date of delivery. But menstrual irregularities could also result from anaemia, menopause, malnutrition, consumption and various other conditions, so a missed period could only be considered suggestive, unless corroborated by other signs.



DIAGNOSIS OF PREGNANCY 95

TABLE OF THE PRINCIPAL SIGNS AND SYMPTOMS OF PREGNANCY IN THE ORDER OF THEIR OCCURRENCE.

	Months.								
	1	2	3	4	5	6	7	8	9
Suppression of menstruation	×	×	×	×	×	×	×	×	×
Irritability of bladder	×	×	?						×
Morning sickness	?	×	×	×	?	?	?	?	?
Enlargement of breasts		×	×	×	×	×	×	×	×
Changes in size, shape, and consistency of uterus	?×	×	×	×	×	×	×	×	×
Vaginal pulsation		×	×	×	×	×	×	×	×
Mammary areola			×	×	×	×	×	×	×
Softening of cervix			×	×	×	×	×	×	×
Intermittent contractions			×	×	×	×	×	×	×
Apparent shortening of cervix			×	×	×	×	×	×	
Discoloration of vagina			?	×	×	×	×	×	×
Progressive enlargement of abdomen				×	×	×	×	×	×
Uterine souffle				×	×	×	×	×	×
Ballottement				×	×	×	×		
Perception of active movements				?	×	×	×	×	×
Fœtal heart				?	×	×	×	×	×

Figure 1.1. A typical table of the canonical signs of pregnancy (Johnstone, 1913, 95).

For Galabin, amenorrhoea was 'commonly the first sign which leads a woman to suspect herself to be pregnant.' But a deceptive (unmarried) woman wishing to 'conceal' her pregnancy could easily 'deny the suppression of the menses,' and might even 'artificially stain [her] linen to simulate menstruation' (Galabin, 1900, 118-119). Conversely, many women continued to bleed lightly even after conception and others managed to conceive during amenorrhoea. Jardine documented the case of one pregnant patient who had not menstruated in twelve months:

> A well-nourished young woman consulted me on account of amenorrhoea of twelve months' duration. A year previously she had been very anaemic, and had taken a course of Blaud's [iron] pills. When I saw her there was no evidence of anaemia, and I was struck with her plump appearance. She stated that she had got very much stouter lately, not only in the abdomen, but all over. Her breasts were very large, and there was a distinct areola. Palpation of her abdomen revealed foetal parts and distinct movements, and auscultation gave foetal heart-sounds. She was about seven months pregnant. Conception had occurred during the amenorrhoea from anaemia. She was delivered of a full-time child some two months later (Jardine, 1905, 7).

Nausea, often referred to as 'morning sickness', though it could strike at any time of day or night, was also generally regarded as symptomatic of early pregnancy, especially if combined with amenorrhoea or abdominal growth.[20] One of Jardine's patients invariably continued to bleed 'for at least three months after conception,' but was able to tell she was pregnant 'from the severe sickness which attacks her from the very first' (Jardine, 1905, 7). Breast changes (increased size, firmness and tenderness) were especially useful in the unmarried patient because a practitioner could inspect 'the breasts in passing, and so arrive at a degree of certainty such as to warrant him in instituting further diagnostic procedures' (Ballantyne, 1914, 151). Other potentially idiosyncratic and so less significant signs included the violet or 'port wine' colour of the vulva and cervix, uterine contractions, peevishness, despondency, irritability, frequent urination, toothache, pigmented patches on a pregnant woman's face, the linea nigra (a thin dark line that vertically bisected the

[20] Galabin, 1900, 118. For a recent study of morning sickness in nineteenth-century Britain: Russell, 2012, 126-162.

abdomen in some pregnancies), lactation, headache, heartburn, skin eruptions, insomnia, stretch marks, the cervical plug and food cravings.[21]

Probable signs included palpable or audible changes in the uterus and cervix detected by vaginal examination or auscultation with a stethoscope. The most important of these was 'Hegar's sign', a soft, compressible area between the cervix and the uterus (Oakley, 1984a, 25). After the gravid uterus lost its distinctive pear shape, bimanual examination could reveal a 'globular' form 'as large as a Jaffa orange' (Eden, 1897, 692). Eliciting Hegar's sign depended on 'the *tactus eruditus* gained by practice' and Galabin, for one, encouraged students to 'lose no opportunity of becoming familiar with the feel of the uterus in the early stage of pregnancy' (Galabin, 1900, 123). Although admitting that it required a 'certain amount of skill and experience' to detect, Eden's *Manual of midwifery* rated Hegar's sign as of 'very great' value when 'clearly perceived' (Eden, 1906, 57) (**figure 1.2**).

[21] One London obstetrician's patient craved 'hard, green apples which she ate heartily so long as they were procurable': Glover, 1900, 11.

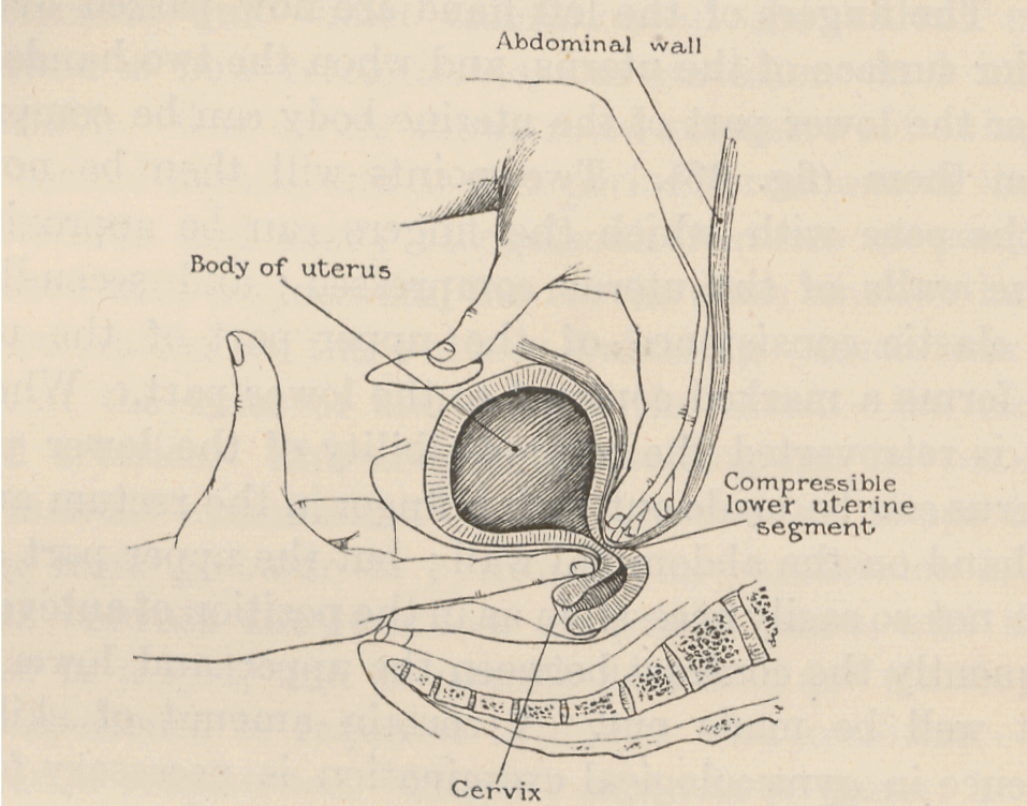


FIG. 33.—SCHEMATIC REPRESENTATION OF HEGAR'S SIGN. (EDGAR.)

Figure 1.2. Nearly every major textbook of midwifery and obstetrics included a diagram of Hegar's sign. This line drawing in Eden's *Manual of midwifery*, taken from the American gynaecologist James Clifton Edgar's lavishly illustrated *The practice of obstetrics*, first published in 1903, is typical in depicting a doctor's disembodied hands bimanually examining a patient's cross-sectional pelvis (Eden, 1906, 57). Equivalent diagrams in other books sometimes added flourishes such as the patient's pubic hair or doctor's gloved hands or sleeved arms.

Previously known as ‘placental souffle’, authors often described uterine or funic souffle as a ‘musical’ murmur probably caused by blood supplying the uterine arteries.[22] At times it might be ‘composed of several notes, which form a sort of chord’ (Dakin, 1897, 61). Although it could be detected at an earlier stage than the fetal heartbeat, it was not as diagnostically certain because uterine fibroids (common benign growths of muscle and fibrous tissue sometimes known as ‘myomas’) and other tumours could cause a similar sound. External ballottement involved keeping ‘one hand quietly applied to the one side of the abdomen,’ and giving ‘a single sharp pat with the other hand on the other side’ (Ballantyne, 1914, 160). Internal ballottement, which was generally considered more reliable, involved sending the fetus floating up in the amniotic fluid with a ‘smart push upwards’ and then waiting a few seconds to feel the distinctive ‘sensation of something lightly falling on the finger’ (Dakin, 1897, 64).

Positive signs occurred only later in pregnancy and so were of little use in early diagnosis. They were, however, generally considered decisive and so highly rated. Based on the direct detection of a living fetus in the womb by a doctor or midwife, positive signs included feeling the movements of the fetus by palpation and hearing the fetal heart sounds by auscultation (Herschkorn-Barnu, 2002). Although most authors agreed that the faint beating of the fetal heart was the only truly reliable sign of pregnancy, it was not easy to detect. Textbooks often compared it to the muffled ticking of a watch heard through a pillow. It was only audible over a small area, so careful exploration in perfect stillness and silence (with all ticking clocks stopped) was often required to confirm its presence or absence. Some authors preferred the intensifying sound of the binaural stethoscope, but others argued that intensified muscular sounds were ‘more liable to create confusion’ and so recommended instead the ‘ordinary cedar stethoscope’ (Galabin, 1900, 130). Some textbooks encouraged students to practice by listening to the heartbeat of newborn infants (Galabin & Blacker, 1910, 186-87).

Textbooks typically described ‘quickening’ not as a sharp kick, but rather as a feeble fluttering like that of a small bird in the hand. Later in pregnancy, the fetal

[22] To confirm pregnancy, Simpson used a stethoscope to listen for the fetal heartbeat or ‘placental souffle’: Nicolson, 2011, 59.

movements became more distinct and even visible to the eye. Quickening was diagnostically valued, but authors also warned that women could be intentionally deceptive or even unintentionally deceived by flatulence or wishful thinking. Some authors distinguished the patient's sensation of quickening and the doctor's detection of fetal movements 'though the abdominal wall' (Fothergill, 1900, 48). If verified by a midwife or physician, quickening or 'stirrage', as it was sometimes called, was highly rated as certain evidence of a living fetus in the womb.

1.2. Marriage manuals and juries of matrons

First published in 1684, *Aristotle's masterpiece*, the most widely circulated source of sexual and reproductive knowledge in Britain, could still be found, little altered, in sleazy London sex shops as late as the 1920s (Porter & Hall 1995, 45, Fissell, 2003). Edith Hinson, a Stockport mill girl born in 1910, first learned about the symptoms of pregnancy in a copy found under her mother's mattress (Rose, 2010, 207). The chapter on 'how a woman may know whether she hath conceived or not' noted visible or painful changes in and around the eyes, breasts and face, as well as a method of keeping urine in a glass for three days and then inspecting it for the presence of 'small living creatures'. Green nettle could also be added to the urine overnight and 'if the woman be with child, it will be full of red spots on the morrow; if not, it will be blackish.'[23]

In contrast to the notoriously illustrated 'masterpiece', a genre of respectably unillustrated domestic health and marriage manuals promising a scientific explanation of 'the facts of life' to middle-class laywomen was flourishing by the mid nineteenth century (Rosenberg, 2003). As with midwifery textbooks, they typically devoted an entire chapter to the canonical signs and symptoms, thereby setting the stage for subsequent chapters on the progress of gestation, lying-in, childbirth and infant care. Thomas Bull's *Hints to mothers*, the leading Victorian manual (Al-Gailani, 2010, 31), claimed that many possibly pregnant women 'experienced much difficulty in attaining certainly' and 'suffered months of anxiety and doubt' (Bull, 1877, 50). Henry Allbutt's *The wife's handbook*, better known for advertising

[23] *The works of the famous philosopher*, London: Smith, *c*.1850s, 81-82.

contraceptive devices (Stevenson, 1984, 154), lamented that newlyweds were generally 'ignorant of all the signs [of] pregnancy', warned that no married woman under forty-five was '*safe*', and promised that knowledge of the 'subjective' and 'objective' pregnancy signs could 'save her from much bad heath.' Allbutt atypically recommended using a looking glass to verify the change in vaginal hue from rosy to violet as an 'early and faithful sign of pregnancy' (Allbutt, 1887, 5-9), but most manuals stuck to the canonical signs found in medical textbooks: amenorrhoea ('ceasing to be unwell'), morning sickness, breast changes, quickening and the fetal heartbeat.

Most manuals emphasised the significance of quickening even as they explained that the sensation of fetal movements did not mean the child had come to life. For instance, Charles Glasson's *Motherhood*, praised in the *Lancet* as a 'useful little book' for 'the young married woman',[24] referred to the 'very great importance' of 'quickening' even as its author, the London physician, clarified 'that the child is alive from the *very first*.' *Dr. Chavasse's advice to a wife on the management of her own health* singled out quickening as 'one of the most valuable' signs because there was 'less likelihood of a miscarriage *after*, than *before it*' (Dodd, 1914, 129). It also rectified the 'old-fashioned' and 'mistaken' notion that 'the child was not alive' before quickening: life began 'from the very commencement of his formation' and the 'heinous sin' of early abortion was 'as much murder as though the child were at his full term, or as though he were butchered when he was actually born' (Dodd, 1914, 134).

'The first point of importance', according to Ada S. Ballin's *The expectant mother*, was determining that a woman was 'actually in what the Germans call "The blessed condition" ("Selige Zustand")'.[25] As with medical textbooks, Ballin explained that the causes of amenorrhoea included not only pregnancy but also anaemia and other conditions and that a 'discharge', indistinguishable from menstruation, could persist

[24] 'Library table', *Lancet*, 7 December 1901, 1592-1594, 1593.
[25] The second posthumously revised edition, published in 1914, removed this reference to the German expression. On Ballin's *Mother's magazine* and baby foods: D'Antonio, 2008.

in pregnancy.[26] She also advised the reader to engage a nurse 'as soon as' she knew she was pregnant because the 'best' ones were 'always engaged long in advance.'[27]

The Edinburgh obstetrician, teratologist and 'apostle' of antenatal care, John William Ballantyne, presented his hefty manual, *Expectant motherhood: its supervision and hygiene*, as combating ignorance, which could 'endanger her own health and [that] of the unborn child.'[28] Lack of knowledge and, worse still, 'dangerous' misinformation, could 'easily make havoc' with a woman's 'happiness' and 'her hopes as a mother.' If she failed to recognise the earliest signs of pregnancy, she might persist in risky activities 'such as taking long bicycle rides or undertaking big pieces of social or philanthropic work, with the result that abortion is threatened or actually brought about.' Or, she might take purgatives to wash away the 'obstruction' if her period had 'not come on within six weeks after marriage'. Ballantyne did not distinguish between menstrual regulation and miscarriage, which always meant 'the death of an unborn child'.[29] Although Ballantyne argued that the 'symptoms felt by the mother' and the 'signs' detected 'by her physician' were sufficient 'from the practical standpoint […] to be acted upon', he admitted that it was 'as yet impossible to be so certain of the existence of early pregnancy as to swear to its presence in […] a court of law' (Ballantyne, 1914, 148-150).

Beyond advice manuals, criminal court reporting constituted the most publicly visible discussion of pregnancy diagnosis in the late nineteenth and early twentieth century. This is because of a special procedure involving the establishment of quickening in the trial of a possibly pregnant woman who had been convicted of murder. By the 1890s, the 'error of the law […], which supposes the child not to be alive, or "quick," until the mother feels its movements' had 'frequently been protested against by the medical profession' (Playfair, 1893, 162-63). Angus McLaren argued that doctors

[26] Ballin, 1904, 1-4. See also Stephens, 1910, 88.
[27] Ballin, 1904, 6-7. See also Dodd, 1914, 216. For the pay scale of nurses before World War I: Daniel, 1925, 12.
[28] On *Expectant motherhood*: Al-Gailani, 2010, 238-241, Seigel, 2014, 48-50. Glasson similarly claimed that 'no young wife' who had read his *Motherhood* would be able to 'plead ignorance as an excuse for not knowing what was the matter with her' (Glasson, 1901, 17-18).
[29] Ballantyne, 1914, 147-48. *Dr. Chavasse's advice to a wife* also condemned the 'heinous sin' of abortion before and after quickening: Dodd, 1914, 134. For historical and anthropological views on abortifacients and menstrual regulation, see, for example, Browner, 1980, Schiebinger, 2000, and de Walle & Renne, 2001.

‘attacked the concept of quickening’, which had been legitimated by the 1803 abortion law, until the Offences Against the Person Act of 1837 ‘finally abolished the concept’ (McLaren, 1984, 138, 142). According to English law, juries of matrons were empanelled to determine ‘if a woman condemned to death for a crime was […] “pleading the belly,” claiming pregnancy as a way to postpone execution’ (Fissell, 2003, 64-65). A stay of execution would be granted to a woman sentenced to death if she was found to be ‘quick with child’. James C. Oldham claimed that the jury of matrons had ‘vanished’ by the late nineteenth century (Oldham, 1986, 32). And Thomas Forbes agreed that matrons were ‘superseded by the medical man’ in the late nineteenth century even as he noted that it was only formally abolished in 1931 by the Sentence of Death (Expectant Mothers) Act, which directed ‘that if a trial jury decided on the basis of medical evidence that a woman convicted of a capital offence was pregnant, she must be sentenced to life imprisonment’ (Forbes, 1988, 33).

In his study of the Victorian serial killer Dr Thomas Neill Cream, historian Angus McLaren claimed that ‘the last jury of matrons was struck in the 1879 trial of Catherine Webster’ (McLaren, 1993, 177). However, the very next year a jury of matrons was empanelled at the Old Baily in the trial of Emma Pleasance. At least thirteen more juries of matrons were empanelled between the 1880 trial and the 1931 Sentence of Death (Expectant Mothers) Act. Ten of these were after 1900, so about once every three years in the first three decades of the twentieth century. Seven matron-juries were empanelled in the Assize courts and another three at the Old Baily (**Table 1.1**).

Table 1.1. Juries of matrons empanelled in the Old Bailey and Assize courts, 1872-1930

Year	Convict	Court
1872	Christina Edmunds	Old Baily
1879	Catherine (Kate) Webster	Old Baily
1880	Emma Pleasance	Old Baily
1886	Hannah Leach	Gloucester Assizes
1889	Jane Jones	Lancashire Assizes
1889	Harriet Measham	Derbyshire Assizes
1902	Ethel Rollinson	Liverpool Assizes
1904	Mary Ann Boyle	Lancaster Assizes
1906	Carrie Thomas	Bodmin Assizes
1913	Ada Annie Williams	Old Baily
1914	Annie Smith	Notts Assizes
1917	Ethel Stevens	Old Baily
1918	Lily Ann Dunnigan	Leeds Assizes
1919	Maud Grime	Manchester Assizes
1926	Louie Calvert	Leeds Assizes
1930	Olive Kathleen Wise	Old Baily

In 1902, the physician George Vivian Poore, who lectured on medical jurisprudence at University College, London, could not recall a case since 1872, when a jury of matrons had decided that Christina Edmunds, the notorious Brighton 'chocolate cream' poisoner was 'not quick with child' (Poore, 1902, 342). Though particularly memorable (McLaren, 1993, 98), the Edmunds trial was followed by that of Catherine Webster in 1879 and the 'Fleetwood child murder case' in 1889, when a jury of matrons empanelled at the Lancashire Assize found Jane Jones, a domestic servant sentenced to death for drowning her child, to be pregnant. Responding to the 1889 trial, an editorial in the *Lancet* railed against the 'barbarous' law:

> What would be said if a jury of lay*men* were to be asked to decide whether a prisoner were suffering from pneumonia or from granular kidney? And yet the diagnosis of pregnancy often presents even greater difficulties. We are not aware whether on this occasion a medical man was smuggled in as a 'young gentleman not objected to'; but in any case the jury of matrons is a farce, and we think in these days none but the ignorant and uneducated would fail to recognise this. Fortunately, in our experience matrons generally believe in pregnancy in doubtful cases, and the result probably is that non-pregnant women get respited on false

pretences rather than that pregnant women get hanged; but that is not to the credit of the law.[30]

Despite such objections, the law persisted. As the barrister William McCallin explained in his concise *Introduction to medical jurisprudence* (1901), English law still demanded that in cases of capital punishment the question of pregnancy be decided 'by the verdict of a jury of matrons, who are sworn to "search the prisoner at the bar whether she be with child, of a quick child or no"' (McCallin, 1901, 47-48). The third edition of Manchester toxicologist John Dixon Mann's *Forensic medicine and toxicology*, published in 1902, similarly observed that the 'ancient proceeding' of empanelling a jury of matrons was 'only now dying out' and that pregnancy diagnosis had become the duty of 'one or more medical practitioners' (Mann, 1902, 118-119). According to Mann, the medical jurist was expected to swear on the 'fact' of pregnancy or its absence, not its 'probability'. Even an experienced obstetrician would 'hesitate to make a positive statement on oath' unless he could detect fetal heart or movements. But the only two 'infallible signs' were 'not available during the first eighteen weeks of pregnancy' and so 'no positive oath [could] be made […] until quickening [had] taken place' (Mann, 1902, 120-121).

The seventh edition of *Husband's forensic medicine, toxicology and public health*, published in 1904, noted that in Scottish courts pregnancy was proved 'without reference to *quickening*' and juries of matrons were 'unknown in that country' (Buchanan & Hope, 1904, 160). Medical experts increasingly perceived and criticised the situation in England as a source of embarrassment. The fifth edition of Taylor's *Principles and practices of medical jurisprudence*, published in 1905, admitted 'the humanity of the principle by which a pregnant woman is respited until after her delivery,' but strongly objected to 'the former practice of the common law, whereby it is made to fall short of what, in a civilised country, society has a right to expect from it'. First, 'the law allowed the question of pregnancy to be determined by a jury of ignorant women accidentally present in court' and second, 'the respite was made to depend, not upon proof of pregnancy, but upon the fact of a woman having quickened, a sign of pregnancy which is extremely variable in the time of its

[30] 'A jury of matrons', *Lancet*, 30 November 1889, 1131. See also 'The Fleetwood child murder case', *Lancaster Gazette*, 30 November 1889, 5.

occurrence.' For Frederick J. Smith, the lecturer on medical jurisprudence at the London Hospital and editor of the late Taylor's classic textbook, the English law was obviously 'bad' and 'quite unfitted for the present state of society' (Smith, 1905, 35).

Smith decried the 'absurd custom' as 'now obsolete' and observed that, in practice, most judges now requested 'the aid of a medical practitioner to decide the fact of pregnancy alone, quite irrespective of the period of conception at which the woman has arrived.' For instance, a prison surgeon had very recently assisted a jury of matrons in the case of Mary Ann Boyle, convicted in 1904 at the Lancaster Assizes of murdering her illegitimate son by drowning.[31] In Scotland, this 'incident of rare occurrence' was reported in the Angus *Evening Telegraph*: the last time a jury of matrons had been empanelled had been two years earlier in Liverpool during the sensational Bootle murder trial, 'but then it was by mistake, and their services were not required.'[32]

In 1913 the *Aberdeen Journal* reported a jury of matrons as an 'unusual proceeding at the Old Bailey'. This time, Ada Annie Williams, who was convicted for the murder of her four-year-old son, was found to be pregnant, 'whereupon the judge ordered the execution to be stayed until after the birth of the child.'[33] The *Manchester Guardian* reported that the matrons, including two wardresses, 'were brought together from various courts' and that it had been some thirty years since a jury of matrons had been empanelled at the Old Bailey.[34] The Williams trial was followed by that of Annie Smith at the Notts Assizes (1914), Ethel Stevens at the Old Bailey (1917), Lily Ann Dunnigan in Leeds (1918), Maud Grime in Manchester (1919), and Louie Calvert in Leeds (1926). Each of these trials was widely reported in the newspapers, which often sympathised with the tragic circumstances of the pregnant murderess.

[31] Smith, 1905, 36. The assizes were criminal courts held periodically in England and Wales until 1972: Nield, 1972, Cockburn, 1972.
[32] 'Jury of matrons. An incident of rare occurrence', *Evening Telegraph*, 29 January 1904, 2. On the widely reported Bottle 'pillow' tragedy see, for example, 'The Bootle murder trial. A jury of matrons summoned by mistake', *Manchester Guardian*, 16 December 1902, 5.
[33] 'A jury of women: Unusual proceeding at the Old Bailey', *Aberdeen Journal*, 12 December 1913, 8.
[34] The previous two cases at the Old Bailey were Catherine Webster in 1879 and Emma Pleasance in 1880: 'A panel of matrons: Piteous murder case', *Manchester Guardian*, 12 December 1913, 10.

Finally, on 20 December 1930, Olive Kathleen Wise of Walthamstow was accused at the Old Bailey of murdering her nine-month-old son. When Edith Picton-Turbervill first proposed in the House of Commons 'to bring in a Bill to prohibit the passing of the sentence of death upon expectant mothers', she alluded to the widely reported trial as a recent 'tragic incident', which had 'drawn public attention to the unsatisfactory state of the law.'[35] The 1931 Act was passed in response to the trial of Olive Wise. After the matrons found her to be pregnant, the judge ordered a stay of execution until the child was born and she was imprisoned for life, but released on 4 July 1932. The jury of matrons 'ultimately perished' in 1931, not 'by the growth of science' (Oldham, 1986, 32), but rather by an informed and sympathetic public that overwhelmingly sided with the pregnant mothers of hungry children in desperate circumstances.

1.3. Emil Abderhalden and the promise of serology

The ubiquity of routine diagnostic testing is central to our understanding of the rise of the laboratory in medicine from the 1830s to the 1930s (Brunton, 2004, 93). For instance, the introduction to the classic collection of essays, *The laboratory revolution in medicine*, opens with the statement:

> If you feel unwell and go to see a doctor or are admitted to hospital, the chances are that the physicians will take a sample of your body – generally blood, tissue or urine – and send it away to another place for testing; in such cases the decision as to whether you are ill or not, and if you are, what disease you have, will be primarily taken not by you and not by your doctor but by a laboratory test (Cunningham & Williams, 1992, 1).

In contrast to earlier accounts that stressed conflict and tension between the laboratory and the clinic, revisionist histories have lately emphasised cooperation and argued that in many cases clinical authority was not undermined or displaced, but rather augmented and enhanced by the laboratory (Worboys, 2007, Sturdy, 2011). It

[35] Commons Sitting of Wednesday, 4 February 1931, Hansard. See also Picton-Turbervill, 1939.

is this collaborative spirit between a range of laboratory workers and medical professionals that I want to emphasise in this section and in the rest of this thesis.

In the early 1900s serologists working in Germany on therapeutic sera for eclampsia, a still poorly understood pathological immune response to the advanced stages of pregnancy, also reported that they had discovered new serodiagnostic methods of pregnancy diagnosis (Bröer, 2004, 135). Researchers published preliminary results with various new and experimental pregnancy tests, including a modification of Wassermann's test for syphilis and a cobra venom reaction, but these were marginalised in 1913 by the great interest in Emil Abderhalden's 'biological' methods (Ballantyne, 1913, 362-363). A Swiss biochemist based at the University of Halle in the Prussian Province of Saxony, Abderhalden based his test on two principles: that the human body reacts to an injection of albumen (protein) by producing a defensive 'ferment' (enzyme) to digest the foreign substances and that during pregnancy the chorionic epithelium circulates in the woman's blood. He argued for the existence of a specific enzyme, found only in the blood of pregnant women, which 'split up the placental albumen into peptones and amino-acids' (King, 1913, 296).

Abderhalden proposed not one, but two diagnostic methods. The first, called the 'optical' method, depended on a change in rotation of the plane of polarised light before and after incubating a pregnant woman's serum together with placental peptone. Very few used Abderhalden's 'difficult' optic method, which involved the time-consuming production of 'placental peptone' (**figure 1.3**). The basis of the second 'dialysation' method was the impermeability of animal membrane to albumen, on the one hand, and its permeability to products of 'proteolytic digestion', on the other. The endpoint of this method was a visible colour-change reaction: 'ninhydrin', the chemical today used in fingerprinting, was supposed to turn the incubated solution blue or violet in a positive result while a control solution remained colourless. In practice, however, laboratory workers found themselves comparing between shades of violet (King, 1913, 298).

Even the ‘simpler’ dialysation method was technically demanding and required ‘extreme care and scrupulous exactness’. Preparing the reagents was labour intensive. Fresh human placenta, ‘washed absolutely free from blood’, needed repeated boiling in water with two drops of acetic acid until the water became ‘negative to the biuret reaction’ (Ballantyne, 1913, 363-66). Laboratory workers struggled to streamline these elaborate procedures into a simple, practical and reliable blood test for pregnancy.

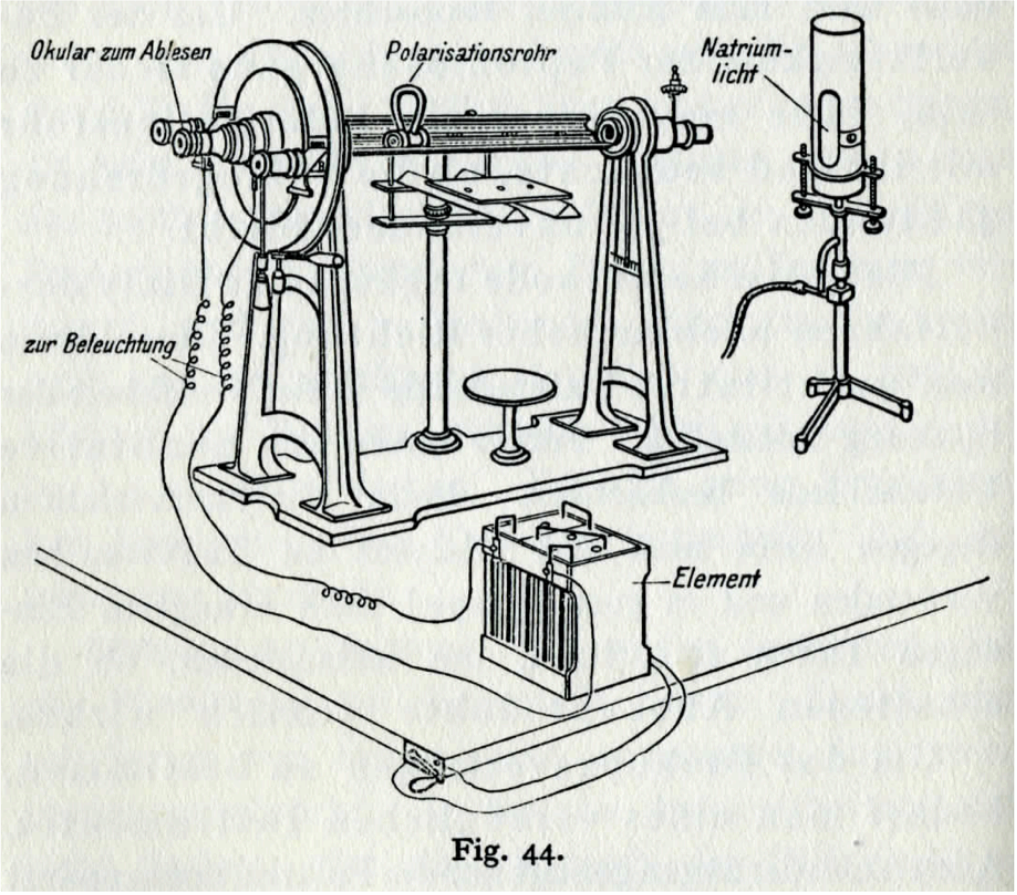


Figure 1.3. A diagram of Abderhalden’s polarisation apparatus showing the ocular for taking readings, polarisation tube, sodium flame and a battery connected to wires for illumination (Abderhalden, 1914a, 335).

Although Ballantyne admitted that the method remained ‘essentially a laboratory test and not one to be done by the general practitioner,’ he hoped that Abderhalden’s test might be used not only to detect pregnancy, especially in unmarried women, but also for differential diagnosis ‘in distinguishing between myomata and gestation; in

separating amenorrhoeas due to lactation, tuberculosis, diabetes, etc., from those caused by pregnancy; and in diagnosing chorio-epitheliomata, perhaps; and of its possible value in throwing light upon some of the diseases of pregnancy, and especially upon eclampsia' (Ballantyne, 1913, 367). Moreover, research on a laboratory test for pregnancy had already opened up new vistas in the 'physiology and pathology of pregnancy' and would lead to a better understanding of 'the complex and wonderful relationship between mother and unborn infant, which some have called a harmonious symbiosis, others a prejudicial parasitism, and others an immunity reaction.'[36]

Herbert Williamson, an obstetrician at St. Bartholomew's Hospital, argued that if a pregnant woman's blood contained 'a ferment specific to placental albumen,' if this ferment was constantly present and could be 'easily demonstrated,' and if diagnostic error could be 'readily avoided,' then Abderhalden's test would be of 'great value in both clinical and forensic medicine.' Together with the chemical pathologist R. L. Mackenzie Wallis, Williamson experimentally tested fifty pregnant patients, recently delivered patients and patients suffering from suspected ectopic pregnancy, pelvic and abdominal tumour, chorion-epithelioma, chorea, puerperal sepsis, heart disease and nephritis (Williamson, 1913, 211). In their presentations to the Royal Society of Medicine, Williamson and Mackenzie Wallis concluded that Abderhalden's test was especially useful for early pregnancy diagnosis, differential diagnosis (between fibroids and pregnancy) and the diagnosis of chorionepithelioma (Mackenzie Wallis, 1913, 256).

A house surgeon at St. Bartholomew's further proclaimed in the *Lancet* the 'practical advantage' of the test as a diagnostic aid in cases of carcinoma, 'especially in such sites as the stomach and bowels, thereby allowing early surgical interference' (Leger Brockman, 1913, 1387). But others were more cautious. For instance, a clinical pathologist at the Sheffield Royal Infirmary argued that the 'chief result' of 'a vast number of observations' had been to 'demonstrate and correct errors in technique rather than to prove or disprove Abderhalden's claims' and that it was 'too early' to ascribe 'clinical value' to test (King, 1913, 296). Nevertheless, in his review of over

[36] Ballantyne, 1913, 363. On this debate: Hanson, 2004, 9, 95, Al-Gailani, 2010, 240.

eighty (mostly German) articles in the *Journal of obstetrics and gynaecology of the British Empire*, Mackenzie Wallis concluded that researchers had 'clearly and sufficiently proved the value and reliability' of Adberhalden's tests for pregnancy (Mackenzie Wallis, 1914, 55). These were not yet perfected and it was only by cooperation and 'mutual help between the clinician and the chemical pathologist' that further progress could be made (Mackenzie Wallis, 1914, 71).

'Scientific medicine', as Ballantyne put it to the York Medical Society in early 1914, had been 'for several years trembling on the brink' […] of the discovery of a certain bio-chemical test of pregnancy, which should be available in the early months when no other certain sign is to be had.' Abderhalden's polarimetric and dialytic reactions had 'put the biological test of pregnancy on a surer basis than [ever] before.' Nevertheless, the careful preparation of placental albumin was 'a laborious and prolonged operation' and Ballantyne was concerned with the possibility of false results. So far, the blood of some diseased patients, including those suffering from cancer, had tested positive and the blood of 'some undoubtedly pregnant women', negative. Laboratory workers were, however, making the technique 'more and more rigorous': there were fewer false results and the reliability of the reaction was becoming established (Ballantyne, 1914, 352).

Meanwhile, Abderhalden's fame continued to grow. Springer published two German editions of Abderhalden's *Abwehrfermente* in less than one year. The first was praised in the *Lancet* in January 1913 as 'both interesting and suggestive' and recommended to gynaecologists and biologists on account of 'the biological diagnosis of pregnancy.'[37] In November the *Lancet* wished the second expanded and costlier edition 'as rapid a success as its predecessor.'[38] In 1914 John Bale published the first English edition of *Defensive ferments of the animal organism*, translated by Jacob Gavronsky of the Hale Clinical Laboratory, London Hospital, from the third German edition (the second had been exhausted in less than three months). A review in the *Lancet* emphasised the practical applications of Abderhalden's 'discoveries' to the serodiagnosis of pregnancy, cancer and other diseases.[39]

[37] 'Review and notices of books', *Lancet*, 4 January 1913, 39-40.
[38] 'Library table', *Lancet*, 8 November 1913, 1328.
[39] 'Review and notices of books', *Lancet*, 16 May 1914, 1399.

The ‘popularization’ of these ‘new weapons of research’, as Gavronsky called them in the preface to *Defensive ferments*, had been made possible by Abderhalden’s willingness to accommodate visitors at his institute in Halle, promptly answer written inquiries and freely supply reagents (placenta-albumen and peptone) prepared in his laboratory (Abderhalden, 1914b, viii). The pharmaceutical company Höchst marketed a placenta peptone for testing pregnancy and less reputable ‘carcinoma extracts’ and other dubious reagents were marketed ‘by some people who [were] apparently in a great hurry to make the best out of Abderhalden’s promising scientific work’ (Gavronsky, 1915, 121).

In early 1914 the Berlin correspondent to the *BMJ* warned that the pregnancy test was heading for controversy. In a ‘surprising and dramatic’ turn, Leonor Michaelis, the Jewish director of a small bacteriological laboratory of a municipal hospital in Berlin (Deichmann, 2007), reported on ‘a very large number of experiments’ in the prestigious *Deutsche medizinische Wochenschrift.* Michaelis’s assistant had learned the method directly from Abderhalden in Halle and together they argued that pregnant women’s blood did not react differently from the blood of non-pregnant women ‘or even men’; they denied the existence of ‘a specific ferment’ of pregnancy. The editorial concluded that ‘Berlin physicians’ were awaiting Abderhalden’s reply ‘with the liveliest interest’.[40]

Abderhalden responded in the *Wochenschrift* that Michaelis’s results were ‘very much at variance with those of numerous investigators’ at university clinics in Germany and elsewhere; the reliability attributed to Abderhalden’s tests varied, but was never less than 90%.[41] In the following weeks, however, the *BMJ* reported on two confirmations in the *Münchener medizinische Wochenschrift* of Michaelis’s ‘negative opinion’.[42] Faith began to collapse in Britain. Archibald Leitch, a pathologist at the Cancer Hospital in London, reported ‘adverse results’ that contrasted strikingly with those of Abderhalden and ‘his numerous disciples in all parts of Europe and America’, whose claims he now considered to be ‘amazingly

[40] ‘Berlin’, *BMJ*, 28 February 1914, 508-509, 508. On the rivalry between Michaelis and Abderhalden: Deichmann, 2007.
[41] ‘The serum reaction for pregnancy’, *BMJ*, 7 March 1914, 555.
[42] ‘Berlin’, *BMJ*, 21 March 1914, 683-684, 684.

mistaken'.[43] William Bullock of the Imperial Cancer Research Fund contrasted the 'numerous writers' who supported Abderhalden's conclusions with those 'few writers' who rejected 'the existence of specific protective ferments.' In his view, even with 'technical improvements', Abderhalden's method was 'inadequate to distinguish normal from pregnant or cancerous sera' (Bullock, 1915, 223, 228).

In 1915 the number of publications about Abderhalden's defensive ferments exceeded 300 (of which only fourteen were in English) and Gavronsky predicted that opinion over the specific ferments and their clinical applications would remain divided 'for many years to come' (Gavronsky, 1915, 119). Gavronsky had twice visited Abderhalden's institute in Halle to learn the technique before attempting it on blood samples obtained from the London Hospital and Bethnal Green Asylum. 'Paradoxical at it may sound', lamented Gavronsky, 'the more one follows Abderhalden's directions in the preparation of the substrates the less one is likely to meet with specific reactions.' The problem of specificity became acute when working with randomly selected hospital ward patients instead of those with known diseases or known to be pregnant. Even so, Gavronsky remained 'full of admiration for Abderhalden's theoretical views' and hoped that 'in time one [would] be able to demonstrate specific ferments in the blood serum' (Gavronsky, 1915, 120-123).

Even as they were primarily driven by an interest in diagnosing cancer and other diseases, pathologists and physicians preferred to experiment with pregnancy. This is because it was easier to obtain the necessary 'materials' and the end result would be conveniently 'confirmed or disproved' in nine months or less. By using pregnant women, rather than cancer patients, laboratory workers acquired 'a working knowledge of the technique' and demonstrated 'the principles and modes of application of the methods'. Mackenzie Wallis's own positive experiences convinced him that there was a 'placental splitting ferment in the blood of pregnant women.' After eighteen months of tinkering he was able to obtain 'fairly reliable results' and considered the method to be 'really quite simple,' and within reach of 'any trained laboratory worker' (Mackenzie Wallis, 1916, 148-149). But even as Mackenzie Wallis praised the usefulness of Abderhalden's reactions in scientific research, he

[43] Leitch, 1914, 332. Leitch later became director of the institute: J. A. Murray, 'Prof. A. Leitch', *Nature*, 127, 7 February 1931, 206-207.

admitted that, from a clinical perspective, they 'merely add[ed] another page to our history of failures.' In 1916 he hoped that modified forms of the tests would someday be of 'greater value, not only in the study of pathological changes associated with morbid conditions, but also as aids to clinical diagnosis' (Mackenzie Wallis, 1916, 160-161).

By the end of World War I, many of those who had previously supported Abderhalden, including his English translator, had changed their tune. 'Were it actually possible to demonstrate the presence of specific ferments in the blood serum', wrote Gavronsky in the *Lancet* in 1918, Abderhalden's test would be 'the greatest and the most useful discovery ever made in the domain of medical science.' But diagnostic laboratories had not adopted Abderhalden's methods for routine testing. This was not because the techniques were too 'complicated'; they required skill, but could be mastered by 'an average laboratory worker.' Rather, the methods were 'not generally applied' because they were '*of no use for clinical purposes*'. Abderhalden's test was 'not a clinical test at all':

> The whole story of the Abderhalden discovery is that of a great scientist who comes out prematurely with a statement, sticks to it, tries to find more and more proofs for its authenticity, and by his personal influence induces many others to repeat his assertions. Over 300 separate investigations were published before I communicated the results of my own work, the great majority confirming Abderhalden's results. Only a few recorded results differ from those of Abderhalden. But in this case time has amply proved that these few and not the majority of workers were right (Gavronsky, 1918, 830).

An anonymous critic of the use of Abderhalden's reaction to diagnose psychiatric disorders remarked in the *Lancet* in 1921 that its history would 'make an interesting study in medical science, illustrating the dominance of German opinion in Europe and America until quite recent times.' It was first announced as an early pregnancy test, 'quickly applied to the diagnosis of disease', and also crafted into 'an instrument' capable of testing 'hypotheses and theories'. But it now seemed 'clear' that Abderhalden's theoretical framework of defensive ferments was 'not sound,' and had been accepted too hastily by a credulous 'medical scientific world.' 'Perhaps

some day', the critic concluded, 'the information that the whole superstructure is a mistake will leak through into Germany, and the enviable capacity of German scientists for continuous intellectual effort will be directed along more fruitful lines.'[44]

In his contribution on bloodwork to *A new system of gynaecology*, London bacteriologist William Topley advised the clinician to 'await further developments before placing reliance on [Abderhalden's test] as a diagnostic method.' 'No reaction', he argued, could ever become 'generally useful' if it could 'only be performed by an elect few. It is essential that it should yield uniform results in the hands of at least the great majority of experienced laboratory workers, and it is absurd to attribute either inexperience or incompetence to many of those who have reported unfavourably on the test' (Topley, 1917, 213-214). And in his *Manual of midwifery*, Eden portrayed Abderhalden's 'discovery' as the 'greatest' recent advance in 'the study of the biology of pregnancy', but then added that 'some observers' had 'failed to corroborate [his] results'. He recommended the reaction as a screening test: because 'cancer and other morbid conditions' could produce false positives, a negative result could be depended on to 'exclude pregnancy,' but a positive result ought to be 'received with some caution' (Eden, 1919, 75-77).

The second edition of *A guide to gynaecology in general practice* explained that Abderhalden's test was of 'very questionable' reliability and 'not likely' to be 'accepted in a court of law' (Berkeley & Bonney, 1919, 192, 425). The fourth edition of William Robertson's *Manual of medical jurisprudence and toxicology* noted that the optical and dialysation methods were 'too elaborate for description' and had 'not hitherto proved trustworthy' (Robertson, 1921, 216). The pioneering *Combined textbook of obstetrics and gynaecology*, by four Scottish teachers, lamented that Abderhalden's test was positive in 'so many' conditions other than pregnancy that its 'practical value' was 'disappointing as yet' (Munro Kerr et al., 1923, 147-148). The fourth edition of Robert William Johnstone's popular *Text-book of midwifery* briefly mentioned that the test was 'of theoretical interest only' because its 'difficulty' made it 'impracticable in all but exceptional cases' (Johnstone, 1923, 93). Samuel

[44] 'The Abderhalden reaction', *Lancet*, 12 February 1921, 343. On Abderhalden's reaction as a blood test for madness: Noll, 2006. See also Kaasch, 2000.

Cameron's *Glasgow manual of obstetrics* similarly portrayed the 'technique of the reaction' as 'so complicated' that it was of no practical diagnostic use and further observed that 'many competent workers [had] failed to confirm Abderhalden's results' (Cameron et al., 1924, 50). And Sydney Smith's *Forensic medicine* (1925) explained how the 'doubtful' test worked in some detail, only to dismiss it as 'worthless during early pregnancy, when a diagnosis is most difficult.'[45]

1.4. Schering's 'Maturin' and the 'female sex hormone'

Advice manuals published after World War I did not mention Abderhalden's test and continued to rely on the canonical signs and symptoms. For example, the authorised English edition of Chicago obstetrician and sex radical Alice Bunker Stockham's *Tokology: a book for every woman* emphasised amenorrhoea, abdominal growth, quickening, and the fetal heartbeat.[46] Birth control pioneer Marie Stopes's *Radiant motherhood*, the follow-up to her bestselling *Married love*, claimed that although some women were 'aware of the actual moment of conception', the majority were 'less completely cognisant of the voices of their own organism, and perhaps for two or three months [were] almost unaware that anything different from the usual course of their life is taking place.[47] Stopes included a brief appendix on the 'physical signs of coming motherhood' for the benefit of the woman who suspected she was 'about to become a mother', but was unable to seek out medical confirmation (Stopes, 1920, 239). Alice (Lady) Lovat's *Marriage and motherhood* advised the reader not to wait until quickening to engage a doctor or nurse (Lovat, 1921, 63). And *For women only*, attributed to the anonymous 'physician' author of *How to be healthy*, described the fetal heartbeat as the only 'absolute proof of the woman's condition.'[48]

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[45] Smith, 1925, 243. An exception that proves the rule, Anthony Magian, a Paris-trained gynaecologist and specialist in venereal disease at the French Hospital in Manchester recommended Abderhalden's pregnancy test in *The practitioner's manual of gynaecology* (Magian, 1922, 53). Perhaps predisposed to laboratory diagnostics by his European training and experience with syphilis, he also recommended Wassermann's test, von Pirquet's reaction for tuberculosis, and Widal's test for typhoid fever. See also 'Anthony John Capper Magian, formerly Cappamagian, 1869-1956', Manchester Medical Collection, Biographical Files H-Q, GB 133 MMC/2/Magian.

[46] Stockham, 1918, 35. Derived from the Greek word τόκος (tokos) meaning 'birth', Americans referred generically to pregnancy manuals as 'tokologies': Brumberg, 1993, 111. On Stockham: Versluis, 2008, Silberman, 2009.

[47] Stopes, 1920, 123. See also Geppert, 1998.

[48] *For women only* (London: Cecil Palmer, 1924), 50, 54.

In the 1920s the most promising alternative to the intimacies of physical examination was radiography. A pioneering American handbook on obstetric radiography praised X-rays as 'a very valuable aid in the diagnosis of pregnancy', especially for differential diagnosis, but also to 'dissipate' the 'scandalous' stories told by 'venomous gossip-mongers' about 'single women or widows,' as well as in court, for settling law-suits, libel cases, and 'to disprove charges made in actions for divorce' (Dorland & Hubeny, 1926, 259, Oakley, 1984a, 100, Howell, 1995, 149-150). Fetal bones, however, did not cast shadows until about the sixteenth week of gestation and the demand for X-rays in pregnancy diagnosis significantly declined following the introduction of pregnancy testing.[49] No other method was 'absolutely and infallibly diagnostic of the presence or absence of pregnancy' and so laboratory tests were used mainly 'to strengthen the already present suspicion of pregnancy, or the probability of its absence' (Hirst & Long, 1926, 846).

As interest in Abderhalden's reaction was fading, German and American researchers began experimenting with a new kind of test, which supposedly exploited the fact that women in the early months were prone to 'glycosuria', the excretion of sugar in the urine. In 1923, John Cooke Hirst and Charles-Francis Long of the William Pepper Laboratory of the University of Pennsylvania in Philadelphia, published a preliminary report of 39 cases using a sugar tolerance test in the *New York Medical Journal*.[50] Of particular interest was a recently proposed test based on phlorizin, a glucosid derived from domestic apple tree bark available as a popular drug for lowering kidney sugar-threshold in lab animals. The protocol was to fast a patient for twelve hours and then inject her with two milligrams of phlorizin; the appearance of sugar in urine within two hours indicated pregnancy. As Hirst and Long explained, 'The simplicity of this technique, and its ease of administration, have appealed to the majority of workers in this field during the last two years, especially since the appearance of a proprietary preparation, "Maturin"', a solution of phlorizin in ampoules (**figure 1.4**). By the time

[49] Claye, 1936, Roberts, 1938, Oakley, 1984a, 98. Maternity hospitals in Britain lacked X-ray departments until the late 1930s: Hiddinga, 1995, 97. From the early 1950s, X-ray pelvimetry was frequently used in late pregnancy to detect potential difficulties with delivery, but not routinely for early diagnosis: Dry, 2006, 133. From the late 1950s, ultrasound was occasionally used to diagnose early pregnancy: Nicolson & Fleming, 2013, 139.
[50] On this laboratory: Young et al., 1997.

they published a follow-up report in 1926, the use of sugar tests for pregnancy had increased 'enormously'.[51]

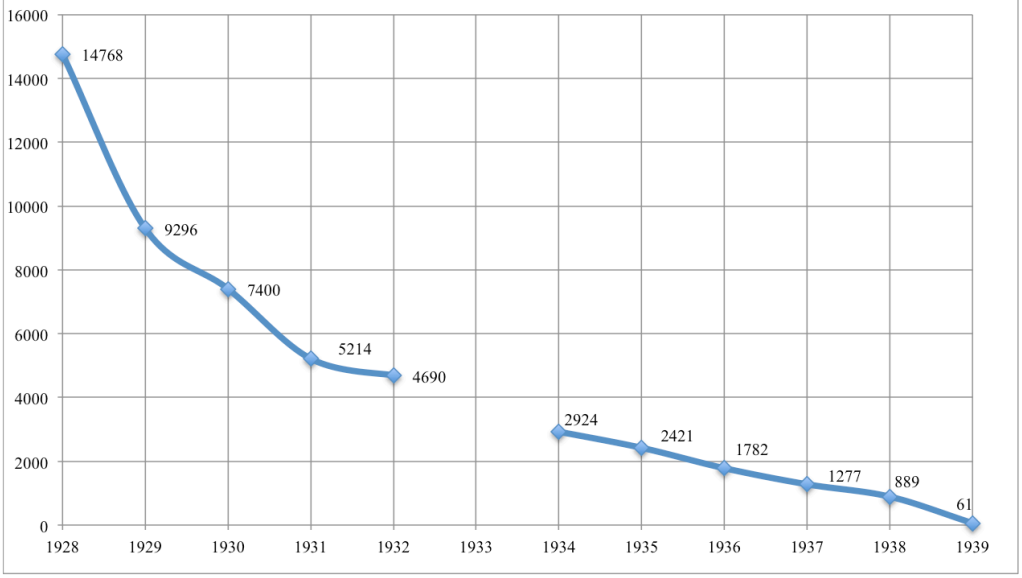
Figure 1.4. An advertisement for Drs Kamnitzer and Joseph's 'Maturin' pregnancy diagnosis test in the *Munchiner medizinische Wochenschrift* (Schering Archiv). On the importance of scientific articles in the marketing of Paul Ehrlich's Salvarsan in the 1910s: Hüntelmann, 2013.

The phlorizin test that Schering mass-produced and marketed as 'Maturin' was first announced in the journal *Therapie der Gegenwart* in 1921 by Drs Kamnitzer and Joseph of Krankenhaus Moabit, the most important Berlin hospital after the Charité and University hospitals.[52] Until it was taken over by the Nazis in 1933, Moabit was a 'reform' hospital and a centre of Jewish doctors, many of whom were prominent in newer and less prestigious fields including reproductive endocrinology and neurology (the famous neurologist Kurt Goldstein practiced at Moabit).[53] Siegbert Joseph, a popular gynaecologist and obstetrician, practiced there until 1933 when he was forced

[51] Hirst & Long, 1926, 846. See also Milnor & Fennel, 1924, 538.
[52] See for example, Kamnitzer & Joseph, 1921a,b.
[53] See Pross & Winau, 1984, Stürzbecher, 1997.

to leave.[54] In 1926 Schering produced over 35,000 ampoules of Maturin, for which the only indication was pregnancy diagnosis. Although from 1928 the only figures recorded are sales units ('Wert'), not ampoules, it is clear that production declined precipitously to virtually nothing by the start of World War II (**figure 1.5**). This was not a general trend: the manufacture of many other more successful Schering products increased in the same period. As we shall see in the next chapter, this period of decline is correlated with the rise of the Aschheim-Zondek test and other bioassays, which appear to have displaced Maturin and other glycosuria tests for pregnancy.

Figure 1.5. Maturin sales 'units', 1928-39 (Schering Archiv)



Upon surveying published reports of the test, however, Hirst and Long concluded on the basis of too many false positives that it had 'yielded no satisfactory results' (Hirst & Long, 1926, 848-849). They preferred to administer their patients a dose of table sugar dissolved in lemon-flavoured water and then collect the urine one or two hours later. This was less invasive than injections, but also had drawbacks. Several patients poured the '"lemonade"' down the sink or 'out the window' and others became nauseous and 'vomited, making the test untrustworthy' (Hirst & Long, 1926, 849-850). The test, when it was trustworthy, presented Hirst and Long with a different

[54] Joseph worked at the Jewish Hospital until 1939 and later perished in the Libau concentration camp: Martina Schlünder, email, 4 February 2014.

kind of dilemma. When one patient, an unmarried woman whose period was a few days late, tested positive, she 'induced an abortion' a few weeks later. From the Philadelphia doctors' perspective, the glycosuria test provided 'unscrupulous characters' with 'too much certainty at an early date in pregnancy' (Hirst & Long, 1926, 852).

Despite the paradoxical hazard of providing the wrong women with 'too much certainty', Hirst and Long promoted their 'extremely simple' test as a 'useful' 'aid' 'in the diagnosis of pregnancy before the gynecologic signs appear.' In a series of 150 patients, they reported an error of 6% in pregnant women (false negatives) and 8% in non-pregnant women (false positives). This beat all other pregnancy tests, they claimed, and compared favourably with the Wassermann reaction (Hirst & Long, 1926, 853). But some experts were not convinced of the need for such a test. The Catholic gynaecologist and infertility specialist John Rock dismissed 'sugar tolerance' tests as unreliable and argued in the prestigious *New England journal of medicine* that pregnancy diagnosis was 'not always of immediate importance. Time is probably still the surest aid: indeed, for all practical purposes it may be considered certain' (quoted in Marsh & Ronner, 2008, 56-57).

By the late 1920s, neither serology nor glycosuria tests seemed likely to provide clinicians with a practical alternative to physical examination. Though some doctors, like Rock, were content to simply wait and see, others adopted new laboratory tools and techniques made available by the increasingly prominent science of endocrinology. Research on sex hormones in American laboratories had produced two significant cervical smear tests: the Pap test in 1917 and the Allan-Doisy test in 1923 (Medvei, 1993, 199-219, Clarke & Casper, 1996, Casper & Clarke, 1998). The New York gynaecologist Robert T. Frank attempted to use biological assays for the 'female sex hormone' as a diagnostic test for early pregnancy. Although Nelly Oudshoorn's classic 'archaeology' of sex hormones, *Beyond the natural body*, gives the impression that Frank's test 'became widely used' in pregnancy diagnosis (Oudshoorn, 1994, 53, 147), Frank himself admitted that the serum of pregnant women did 'not contain a sufficient amount of female sex hormone to be utilizable as a test for pregnancy' (Frank, 1929, 247). But he was not the only American researcher to attempt a hormonal test for pregnancy in the late 1920s.

In February 1928 the less famous Cleveland physician Alcines Clair Siddall announced a promising new method in the prestigious *Journal of the American Medical Association* (*JAMA*).[55] Siddall reasoned that if some unknown hormone caused the changes in a pregnant woman's body, then 'similar changes' ought to 'occur in the uterus and breasts of a test animal' injected with her blood. He expected the blood from a non-pregnant woman to 'give a negative result.' Siddall first allowed his patients' blood to clot in a sterile tube before injecting the serum subcutaneously into a sexually immature virgin white mouse once a day for four or five days. He then performed the Allen-Doisy test 'to determine the phase of the estrual cycle of the mouse' and then killed the test animal and weighed it on a chemical balance. Next he dissected out the uterus and ovaries and weighed those. Finally, he divided the weight of the mouse by the weight of its reproductive organs: a ratio below 400 was 'positive for pregnancy' while a ratio above 400 was negative. After a preliminary report on 45 patients, Siddall concluded that his test seemed 'reliable' (Siddall, 1928a, 381). A *BMJ* editorial welcomed Siddall's study, commenting that 'a simple and satisfactory' pregnancy test 'would be most valuable, not only to the obstetrician, but also to the general practitioner' and hoping for further confirmation on 'a larger series' and 'with controls'.[56]

A few months later Siddall reported an additional 97 mouse tests, the results of which generally confirmed his preliminary conclusions, and further promoted his technique as a method of determining 'the potency of commercial liquid extracts of ovary, placenta and pituitary' (Siddall, 1928b, 779). Using his test, Siddall had determined that only one of the seven commercial preparations he assayed was hormonally active. Finally, he highlighted the usefulness of the test in the monitoring and management of patients receiving infertility treatment. Following a round of artificial insemination, 'Case 89', a twenty-four-year-old woman, had missed her next anticipated menstrual period. But her pregnancy test was negative and a few days later, she experienced 'a perfectly normal menstruation' (Siddall, 1928b, 781-782).

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[55] Siddall, 1928a. Upon returning from years working as a medical missionary in China, Siddall worked at Lakeside Hospital in the prosperous manufacturing city of Cleveland, Ohio: Oberlin Heritage Center, 'Alcines Clair Siddall, M.D.', http://www.oberlinheritage.org/cms/files/File/History%20Feature%20Siddall.pdf.

[56] 'A test for pregnancy', *BMJ*, 2 June 1928, 952-953.

Siddall modestly concluded that his 'hormone test' was 'not a specific test for pregnancy but simply […] for the probable presence of hormones that [were] probably increased in the maternal circulation during the gravid state' (Siddall, 1928b, 781).

But interest in Siddall's test was short lived. In February 1929 an editorial in the *British Medical Journal* (*BMJ*) reported on the 'appearance' of yet another 'reputed test for pregnancy':

> We referred last summer (June 2nd, 1928, p. 952) to A. C. Siddall's report of the discovery in the blood of a pregnant woman of a hormone which caused enlargement of the uterus and breasts. Now, in the *Zentralblatt für Gynäkologie* for January 5th (p. 15), S. Aschheim describes a technique and results of the test which he has devised with B. Zondek.[57]

For some years the gynaecologist Selmar Aschheim and the physiologist Bernhard Zondek, working together at Berlin's famous Charité hospital, had used the Allen-Doisy test to test the hormonal activity of commercial ovarian products (Finkelstein & Zondek, 1966). In 1927 they presented their discovery that the pituitary gland contained an ovary-stimulating hormone at a meeting of the German Society of Gynecologists in Bonn (Schneck, 1997). The following year, Aschheim announced the new pregnancy test based, not directly on Frank's 'female sex hormone', but on the presence of an ovary-stimulating hormone in pregnant women's urine.[58]

In contrast to Siddall's procedure of weighing mice and calculating ratios, Aschheim and Zondek based their test on the visual detection of 'blood spots' in the hormonally ripened ovaries of immature mice. A single test involved injecting a batch of five mice with urine extract twice a day for three days in a row (a total of thirty injections). After that, the mice were dissected and their ovaries visually inspected. Aschheim and Zondek interpreted the presence of 'blood spots' (a sign of sexual

[57] 'Diagnosis of early pregnancy', *BMJ*, 9 February 1929, 259.
[58] It is important to note that, in contrast to the crystalizable sex steroids, biochemists only began to elucidate the far more complicated structure of Aschheim and Zondek's 'pregnancy hormone', today known as the glycoprotein hCG, in the 1960s. See, for example, Bahl, 1969. On the 1930s debate over whether the hormone was produced in the placenta or in the pituitary: Olszynko-Gryn, 2009.

maturity) in at least one mouse as a positive reaction. Immature organs meant a negative result (**figure 1.6**).

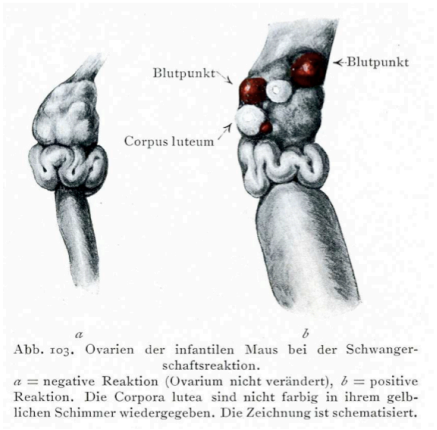


Abb. 103. Ovarien der infantilen Maus bei der Schwangerschaftsreaktion.
a = negative Reaktion (Ovarium nicht verändert), b = positive Reaktion. Die Corpora lutea sind nicht farbig in ihrem gelblichen Schimmer wiedergegeben. Die Zeichnung ist schematisiert.

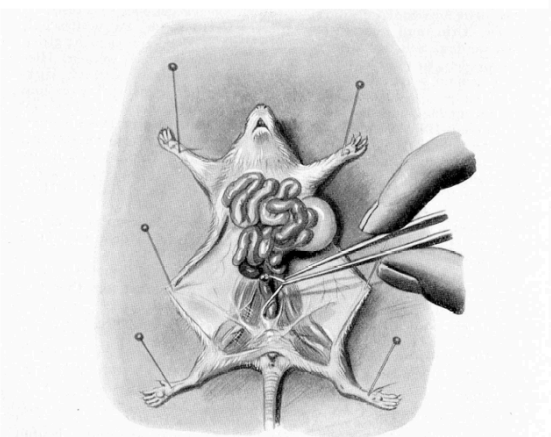


Abb. 112. Inspektion des Ovariums der infantilen Maus zur Feststellung der Schwangerschaftsreaktion bei der Frau. Die Ovarien sind klein, blaß, nicht verändert = negative Schwangerschaftsreaktion.

Figure 1.6. Left: artist's comparison of negative (left) and positive (right) Aschheim-Zondek reactions; note the conspicuous blood spots ('Blutpunkt'). Right: a dissected Aschheim-Zondek mouse, showing a negative reaction ('negative Schwangerschaftsreaktion') (Zondek, 1931, 302, 306).

With cautious optimism, the *BMJ* editorial claimed that the 'reliability' of Aschheim and Zondek's test appeared, at least 'in the hands of Aschheim,' to be 'considerably greater than that of the other biological tests for pregnancy which have been described from time to time.'[59] Frank corresponded with Aschheim, 'obtained immature mice from a dealer', and performed 'the test with considerable success'. The results impressed him: 'The blood points in the ovaries are unmistakable, and a positive reaction is recognized. This is by far the best test for pregnancy as yet discovered' (Frank, 1929, 48). As an American commentator later observed, Siddall's 'important observation' was 'completely overshadowed' by the Aschheim-Zondek test, as it came to be called (Henriksen, 1941, 572).

Conclusion

In her history of motherhood in 'outcast' London, Ellen Ross contrasts the pregnancy 'project' outlined in late twentieth-century advice manuals, 'something a woman *does*', with 'pregnancies a century ago [that] *happened* to women; the mothers were

[59] Ibid.

conscious mainly of getting fat and of eventually feeling fetal movements' (Ross, 1993, 108). But a more attentive examination of one of Ross's key sources, Mrs B's letter to Marie Stopes, discussed at the start of this chapter,[60] reveals that quickening was not the 'only diagnosis of […] pregnancy that most [women] would get' (Ross, 1993, 108). Penned in 1925, three years before the invention of the Aschheim-Zondek test, the letter described a range of diagnostic resources, including self-diagnosis, uroscopy and clinical examination.

In this chapter I have investigated the diagnostic resources available to women and doctors in the first three decades of the twentieth century. I have reconsidered the practices of self-diagnosis and clinical examination as well as the diagnostic status of amenorrhoea, morning sickness, breast changes, quickening and the fetal heartbeat in medical textbooks, advice manuals and newspapers. Against the widespread assumption that quickening 'vanished' as a legal concept in the late nineteenth century (Oldham, 1986, 32), I have also argued that quickening remained significant in criminal courts until the 1930s. Finally, I have examined the invention and reception of several forgotten pregnancy tests of the 1910s and 1920s.

Despite repeated attempts over many years in dozens of laboratories, Abderhalden's serodiagnostic test for pregnancy was never made routine. Though retrospectively dismissed as fraudulent by some, I have argued that testers abandoned Abderhalden's methods chiefly because they were considered too elaborate and technically demanding to be made practical for routine clinical use. Though entirely neglected by historians, glycosuria tests for pregnancy, notably Schering's Maturin, dominated the mid 1920s. These tests did not require any elaborate laboratory technique and so were readily taken up by clinicians in everyday practice. They did, however, require that the patient ingest or be injected with a sugary solution, which was somewhat invasive. In the late 1920s, American and German researchers used the Allen-Doisy test to develop pregnancy tests based on the detectable excretion of hormones in pregnant women's urine when injected into mice. Though not the first 'hormone test' for pregnancy, the Aschheim-Zondek would succeed where others failed. The next chapter is about the adoption and routinisation of this test in Britain.

[60] For the letter: Stopes, 1929, 29-31, Hall, 1978, 37-38.

Chapter 2. Medical demand, diagnostic versatility and laboratory services

The Aschheim-Zondek reaction is generally regarded as the first modern test for the pregnancy hormone, today known as 'human chorionic gonadotrophin' or hCG.[61] Though not the first laboratory pregnancy test, it was the first to become prevalent on a large scale. Invented by Berlin gynaecologists Selmar Aschheim and Bernhard Zondek in 1927 (Finkelstein & Zondek, 1966, Schneck, 1997, Hinz et al., 1994, Bröer, 2004, Rudloff & Ludwig, 2005), by the mid 1930s a diagnostic service in Edinburgh was performing thousands of tests every year for clinicians and hospitals around Britain (Oakley, 1984a, 97, Clarke, 1998, 320, Gurdon & Hopwood, 2000, 45-46, Hanson, 2004, 136, Wilmot, 2007, 433, McLaren, 2012, 100-101). Mice and rabbits, the story continues, were eventually replaced by the more efficient toad, *Xenopus laevis*, which in turn was replaced by laboratory immunoassays and finally, in 1971, by home test kits.[62] In her classic history of antenatal care, sociologist Ann Oakley claimed that 'the A-Z test launched the modern era in which obstetricians would eventually be able to claim a knowledge superior to that possessed by the owners of wombs themselves, as to the presence of a guest, invited or uninvited, within' (Oakley, 1984a, 98). Yet beyond the fact that the test was invented in Berlin and implemented on a large scale in Edinburgh, surprisingly little is known about how it worked in practice or the purposes for which it was used.

Above all, there is the problem of demand. Many women were aware of their menstrual cycles and familiar with the early signs of pregnancy, especially if they had already borne children (Usborne, 2007, 180). In early twentieth-century Britain, they rarely called on doctors or attended antenatal clinics before the second or third trimester, so it was unusual for medical practitioners to be involved in the early stages of pregnancy (Brookes, 1988, 62-63). A woman who did seek out medical advice to confirm or allay her suspicions was usually told to return in a month's time, unless 'there was some particular reason why [she] should know', in which case an Aschheim-Zondek test might be arranged (Oakley, 1984a, 97-98). Women who were

[61] A version of this paper has been published as Olszynko-Gryn, 2014.
[62] Henriksen, 1941, Bruehl, 1952, Johnstone, 1954, Cianfrani, 1960, 408-409, Hurry, 1982, Medvei, 1993, 224, O'Dowd & Philipp, 1994, 85-86, Burnstein & Braunstein, 1995, Shampo, 2001, Bröer, 2004, Jones & Kraft, 2004, Wide, 2005, Leavitt, 2006, Layne, 2009, Haarburger & Pillay, 2011, Marcus, 2011, Tone, 2012, Childerhose & MacDonald, 2013. See also the website, 'A thin blue line: the history of the pregnancy test', http://history.nih.gov/exhibits/thinblueline/.

contemplating abortion probably 'preferred not to involve their GP in tests' (Jones, 2007, 135). Rather, it was commonplace for women to take steps to bring on menstruation every month, a practice they did not necessarily equate with aborting a fetus (Fisher, 1999, 221-222, Jones, 2007, 134). So if neither women nor doctors relied on the laboratory to help detect pregnancy, what was the Aschheim-Zondek test used for?

In this chapter I explain the adoption and institutionalisation of the Aschheim-Zondek test, in terms not of the medicalisation of ordinary pregnancy, but of clinicians' increasing reliance on laboratory services for differential diagnosis. Crucially, the test 'did not actually detect the presence of a live fetus', but rather living placental tissue and so was 'strongly positive' for pathological growths such as hydatidiform mole or placental cancer, 'where there was no viable fetus but plenty of chorionic epithelium.'[63] Conversely, a weakly positive reaction could 'indicate danger of miscarriage' (McLaren, 2012, 101). I will show how the Aschheim-Zondek test was made, less into a yes-or-no test for normal pregnancy, and more into a versatile tool for differential diagnosis, calibrated to monitor placental tumours and hormonal deficiencies believed to cause miscarriage.[64] I do not doubt that the pregnancy tests were, as Adele Clarke has put it, 'early and important technoscientific products of the reproductive sciences' (Clarke, 1998, 149), but innovation is not the whole story. A case study in use-based history of medical technology, my account will focus less on the novelties of scientific research than on the establishment and maintenance of routine practices.[65] It will also situate pregnancy testing within the little-studied world of commercial laboratory services (Rosenberg, 1990, Chen, 1992, Worboys, 2004, Crenner, 2006, Close-Koening, 2011).

[63] Sengoopta, 2006, 281. Men with certain testicular tumours also tested positive: Finkelstein & Zondek, 1966, 9, Leavitt, 2006, 321, Han, 2013, 12.
[64] For a discussion of the ultracentrifuge as a versatile tool: Rheinberger, 2010, 130.
[65] On the merits of use-based history of technology, with countless military examples and few from medicine: Edgerton, 1999, 2006, 2010.

2.1. Testing the Aschheim-Zondek test

An expectant mother who visited the antenatal clinic or was seen at home by a midwife in the early twentieth century might have had her blood pressure taken, her urine examined for albumin or sugar, or her blood tested for syphilis, but it was not routine to test the urine of an apparently healthy woman to confirm pregnancy (O'Dowd & Philipp, 2000, 21). By 1914, nearly half the adult population of Britain was covered by the 1911 National Health Insurance Act. Most women, all children, the elderly and self-employed were, however, excluded and benefits to women workers were cut in 1915 and again in 1932 (Digby & Bosanquet, 1988, Hardy, 2001, 80). Because they were unlikely to be covered by health insurance, working-class women did not usually visit a doctor except in an emergency (Brookes, 1988, 62). The 1911 Act made no provision for laboratory services, so patients who could afford them paid out of pocket for diagnostic tests. Basic urinalysis was a side-room practice performed by a general practitioner, nurse, or midwife, but bacteriological and biochemical tests were left to clinical pathologists (Foster, 1961, 1983, Cunningham, 1992, Prüll, 1998, 2003). The wartime campaign against syphilis created state demand for mass Wassermann testing and the introduction of insulin and liver treatments in the 1920s increased interest in biochemical and haematological testing (Stevens, 1966). Routine analysis became increasingly structured around new divisions of labour and new specialities such as X-ray and laboratory technicians who provided diagnostic services, not directly to patients, but to doctors (Amsterdamska & Hiddinga, 2003).

The Aschheim-Zondek reaction was first established in Britain at Francis Crew's Department of Animal Breeding Research (later the Institute of Animal Genetics) at the University of Edinburgh. (Hutt, 1931, Deacon, *c*.1971, Marie, 2004, Clarke, 2007). Of the three animal breeding research institutes in 1920s Britain (at Cambridge, Edinburgh and Reading universities), this was the only one to branch out into medical research (Wilmot, 2007, 433). Although Crew was better known for his work on sex reversal and intersexuality in the domestic fowl, he also aspired to make a name for himself as an expert in human heredity, eugenics and social biology (Hogben, 1974, Porter, 1997, Richmond, 2007, Ha, 2011b). But first he needed to medicalise his department, which was beholden to the Ministry of Agriculture. With

help from Edinburgh professor of physiology Sir Edward Sharpey-Schafer, Crew attracted public and private donors for medical research, including controversial work on chemical spermicides (Borell, 1987, Soloway, 1995, Löwy, 2009, 2011). When Thomas B. Macaulay, a wealthy Canadian financier with Scottish ties, paid for a lectureship in endocrinology, Crew hired Bertold P. Wiesner, a young Austrian physiologist and 'rejuvenationist' he had met in 1926 at a Berlin Congress for Sex Research (**figure 2.1**).[66]

A product of Eugen Steinach's controversial Institute of Experimental Biology in Vienna (the 'Vivarium'), Wiesner modelled the 'Macaulay Laboratory' on that institution.[67] When the Medical Research Council (MRC) refused Crew's request for funding on the grounds that his institute was too agricultural, Crew turned to Robert W. Johnstone, the influential chair of the midwifery department, for support.[68] Swayed by Johnstone, the MRC agreed to finance Wiesner's work for one year.[69] Wiesner and Crew began to collaborate with Johnstone, exchanging valuable research material (pregnant women's urine and placentas) and access to patients for experimental therapeutic products (made from the urine and placentas) and access to laboratory animals.[70]

[66] On Macaulay: Li, 2003, Smith, 2009. On the sex congress: Marcuse, 1927, Riddle, 1927, Dose, 2003.
[67] On glandular rejuvenation: Hamilton, 1986, Sengoopta, 2006. On the Vivarium: Coen, 2006, Logan, 2007.
[68] Fletcher to Crew, 8 and 15 May 1928, in 'Sexual hormones: research by Dr B P Wiesner, Edinburgh University, 1928-32', FD 1/2816, National Archives, Kew, London. On Johnstone: Peel, 1976, 221-223.
[69] Fletcher to Wiesner, 13 March 1929, FD 1/2816. On the MRC's limited support for sex physiology: Thomson, 1975, 42-43, Austoker & Bryder, 1989, 27, 49.
[70] This cooperative arrangement fits Steve Sturdy's assessment of the Edinburgh medical school as a place where lab-clinic collaboration, not conflict, was the norm: Sturdy, 2007. Sex physiology, as a marginal and weakly institutionalised field, is also notable for its many instances of interdisciplinary collaborations and material exchanges: Oudshoorn, 1994, Clarke, 1987, 1998. Revisionist historians are generally beginning to challenge the conflict-oriented narrative of the lab-clinic relationship: Hull, 2007, Hammerborg, 2011, Sturdy, 2011, Wall, 2011.

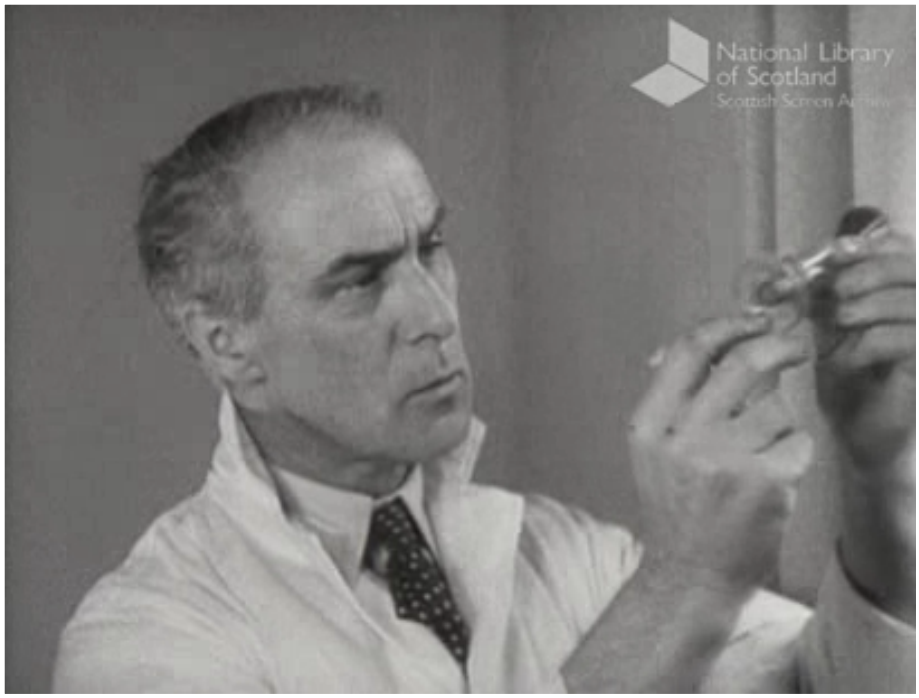


Figure 2.1. Above: a photograph by Shackleton, Piccadilly, of Bertold Wiesner as a visionary scientist, *c.*1930s; courtesy of Jonathan Wiesner. Below: a screenshot of Crew in the laboratory from *They made the land*, directed by Mary Field (Films of Scotland, 1938), http://ssa.nls.uk/film/1063.

During the endocrine 'gold rush' of the 1920s and 1930s, drug companies isolated and mass-produced the internal secretions of the ovaries, testicles, pituitary and placenta (Parkes, 1966, Borell, 1985, Oudshoorn, 1994, Gaudillière, 2005). The Aschheim-Zondek test was a by-product of this 'heroic age' of reproductive endocrinology, or 'sex physiology' as it was then called, and first Wiesner used the reaction, not as a test for pregnancy, but to verify the potency of potentially therapeutic substances.[71] Impressed by its efficacy in drug standardisation, he then proposed to offer diagnostic testing as a routine service for doctors, beginning with Johnstone. He had three main reasons. First, the station would test the test on a large number of clinically unselected patients, thereby demonstrating the value of the agricultural institute to medical practitioners and researchers. Second, any surplus (hormonally rich) pregnancy urine sent to the station could be redirected towards research (injected into rats). Third, the station would charge a fee and so was expected to be self-financing or even to turn a profit that could be ploughed back into research, an economic strategy that other university and hospital laboratories were then adopting.[72]

Collaborating with Wiesner offered Johnstone several clear advantages too. First, with sex hormones a novelty in gynaecology, Wiesner supplied Johnstone with new and experimental therapeutic substances. The chance to test the expensive extracts on his private patients placed Johnstone at the forefront of clinical research. He also gained access to a new and potentially powerful diagnostic tool that could be tested on his hospital (and private) patients. A controversial specialist in infertility treatment, Johnstone used the Aschheim-Zondek test, not simply for pregnancy diagnosis, but to calibrate hormone injections in cases of endocrine deficiency believed to cause miscarriage.[73] Last but not least, Johnstone needed Wiesner for animal injections, which were forbidden on infirmary property (Sharpey-Schafer, 1930, 31, Lawrence, 2005, 36).

[71] As did Zondek, initially in Schering's testing laboratory: Gaudillière, 2010.
[72] The University of Manchester operated a profitable diagnostic service and St. Mary's Hospital, a lucrative vaccine-producing operation: Valier, 2002, Chen, 1992. The Dutch firm Organon offered free Aschheim-Zondek tests as propaganda and the American JAX Lab performed tests for area physicians to raise funds for in-house research: Oudshoorn, 1994, 97, Rader, 2004, 171.
[73] See Johnstone et al., 1932, and the critical editorial, 'Sex hormone therapy', *Lancet*, 3 September 1932, 525.

Animal experiments, including routine injections, were permitted only in labs registered by the Home Office under the 1876 Cruelty to Animals Act and regularly spot-checked by medical inspectors. Every year, hundreds of thousands of animal injections were performed by the MRC, public health authorities and private companies (under the Therapeutic Substances Act of 1925) in the routine production, testing and standardisation of millions of doses of drugs, sera and vaccines.[74] These accounted for 95% of all licensed animal experiments in Britain and required 'Certificate A' (in addition to the license) to forego the use of anesthetics in mice and other species. As antivivisectionists gained public support in the late 1920s, hospital administrators became increasingly wary of losing the voluntary contributions of wealthy patrons and tended to keep animals away from hospital property (Tansey, 1994). For instance, the Middlesex Hospital in London used the animals kept at the Courtauld Institute of Biochemistry next door and the Royal Infirmary of Edinburgh fostered a cooperative attitude towards off-site laboratories (Stone, 1932, 383, Lawrence, 2005, 66).

The Aschheim-Zondek test, Johnstone later quipped, raised mice to the 'rank of obstetrical consultants' (Johnstone, 1947, 11). The increasing demand for laboratory mice was met in Britain chiefly by the specialist commercial breeder and distributor, A. Tuck & Son's 'Mousery' in Rayleigh, Essex (Kirk, 2008, 285). The agricultural correspondent of the *News Chronicle* called Mr Tuck 'the uncrowned king of mice fanciers' and the *Daily Mirror* reported that his 'farm' housed 200,000 mice and dispatched up to 3,000 'of all sizes, shapes and colours' daily (quoted in Bayly, 1936, 25). Tuck supplied young, female mice for use in Edinburgh, where Crew's staff initially followed Aschheim and Zondek's original technique to the letter (**figure 2.2**).

[74] Rogers, 1937. On the standardisation of therapeutic agents made from living organisms: Gradmann & Simon, 2010, von Schwerin et al., 2013. On standard laboratory animals in Britain: Kirk, 2005, 2008, 2009.

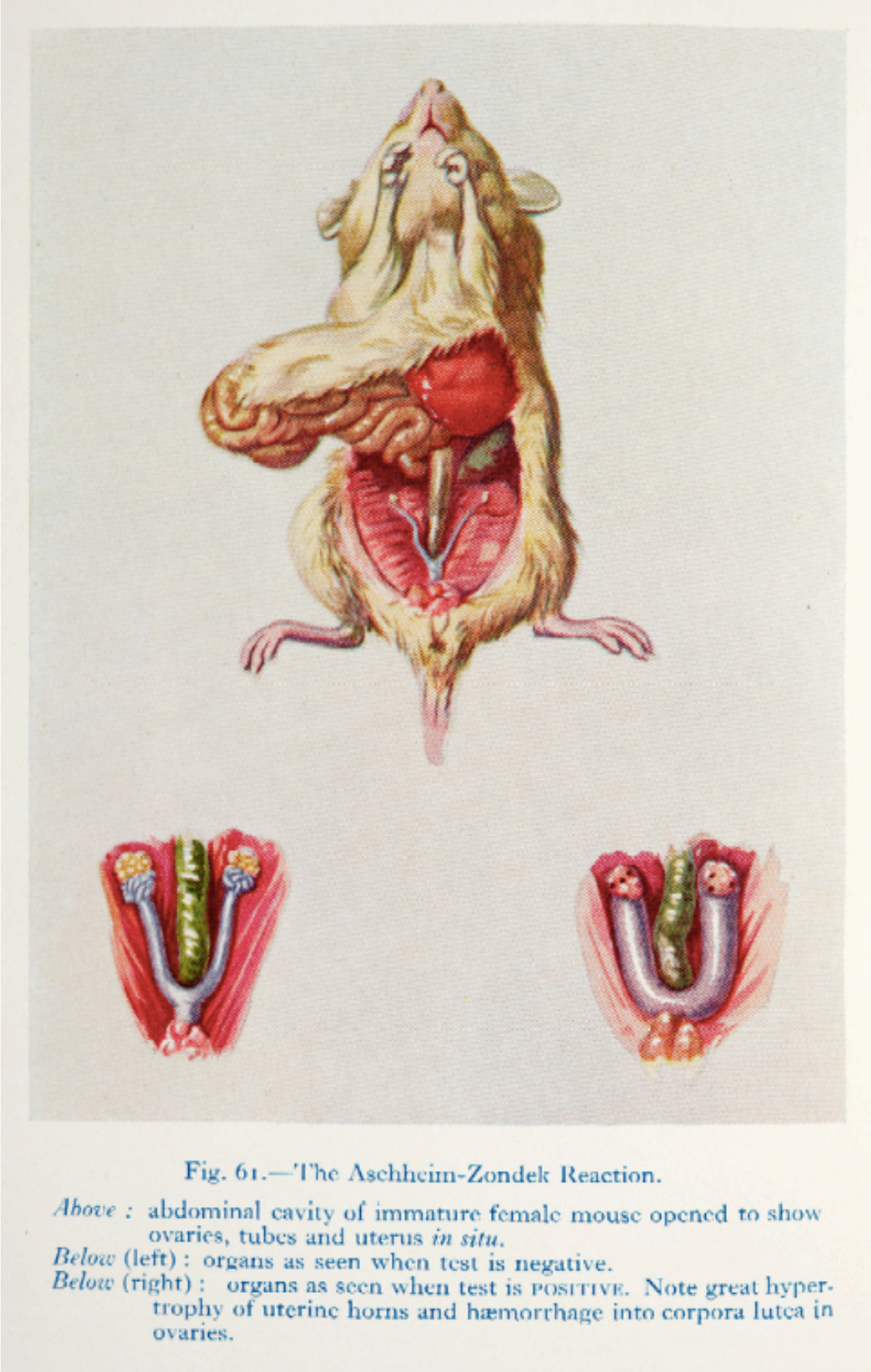


Fig. 61.—The Aschheim-Zondek Reaction.

Above : abdominal cavity of immature female mouse opened to show ovaries, tubes and uterus *in situ*.
Below (left) : organs as seen when test is negative.
Below (right) : organs as seen when test is POSITIVE. Note great hypertrophy of uterine horns and hæmorrhage into corpora lutea in ovaries.

Figure 2.2. A colourful illustration of the Aschheim-Zondek reaction from the seventh edition of Johnstone's popular textbook (Johnstone, 1934, unpaginated plate between 82 and 83).

Aschheim and Zondek intended the use of multiple test animals to mitigate the variability of individual mice and so increase the sensitivity of their test, which required several days to perform because infant mice would not tolerate an injection of the required amount of extract all at once. Preparing the urine was also time consuming, but failing to do so often resulted in dead mice before a conclusive result could be obtained. Crew's staff initially sectioned the ovaries and inspected them under a microscope. To further simplify, streamline and speed up the procedure, they soon abandoned microscopy in favour of naked-eye inspection, which was usually adequate. In borderline cases, an intact ovary could be pressed between cover-slips and examined under a hand-lens or held up to the light, where small and deeply embedded blood points could usually be distinguished from even the densest yellow bodies without going to the trouble of slicing (Crew, 1930). For the first three months, Crew and Wiesner tested urine specimens provided by Johnstone and then, satisfied with their results, they decided to go postal.

2.2. Going postal and redescribing errors

A *Lancet* editorial had first mentioned the Aschheim-Zondek reaction in October 1928 as a 'specific' new test for the 'presence or absence' of early pregnancy. The editorial anticipated the 'very great value' of the test, assuming the promising results obtained in Berlin would be 'confirmed by other workers.'[75] A few months later the *Lancet* and *BMJ* carried a letter from Johnstone explaining that by indiscriminately testing any specimen sent by a doctor, Crew and Wiesner would investigate the sensitivity and specificity of the Aschheim-Zondek test. This was said to be trustworthy from two weeks after a missed period and the only requirements were a few ounces of urine, a covering letter with clinical data and a postal order for the fee. Results would be returned in about a week (Johnstone, 1929a,b). A supportive *BMJ* editorial amplified Johnstone's hope that many doctors would take advantage of the station and endorsed the fees as 'very moderate'. Laboratories in Germany and other countries were beginning to test the test and to publish their reports in research journals (**table 2.1**). However, the editorial argued that a large-scale trial on

[75] 'Biochemical diagnosis of pregnancy', *Lancet*, 20 October 1928, 834-35.

unselected material was still needed to confirm the 'clinical value' of the test in Britain.[76]

Table 2.1. Numbers of pregnancy tests with location of laboratory in descending order of number of tests; adapted from Zondek (1931), 315.

Place		Number of tests
Berlin	(Aschheim and Zondek and others)	1200, 200, 109, 12
Frankfurt am Main		1080
Dresden		413
Edinburgh	(Crew)	400
Düsseldorf		249
Göttingen		243
London	(Dickens)	207
Cologne		139
New York		132, 100
Marburg		129
Breslau		127
Munich		110
Moscow		100
Italy		91, 36, 30
Prague		79, 30
Kiel		51
Münster		49
Greifswald		46
Würzburg		36
Utrecht		33
Vienna		30
Paris		30
Buenos Aires		24
Total		5515

In the six weeks following the publication of Johnstone's letters, the station received around ninety specimens. This was a fair start but there were some logistical problems, so Crew provided additional guidelines in another letter. Mice had to be purchased and looked after and some doctors failed to pay up, so he reminded them that the service was not free. Private cases were charged a 'modest fee' of five

[76] 'Diagnosis of early pregnancy', *BMJ*, 9 February 1929, 259.

shillings, intended to permit a reduced hospital fee of one and six.[77] The station required two ounces of fresh morning urine in a clean bottle enclosed in a sturdy package, accompanied by case notes, especially the date of the patient's last menstrual period, but doctors frequently posted 'too much, too little, or too stale urine,' often in packages that broke in transit (Crew, 1929a,b).

The General Post Office, Britain's largest employer in the 1920s (Griffiths, 1997, 678), allowed urine and other normally prohibited substances to be sent to any recognised medical institute or qualified practitioner. Diagnostic laboratories typically appointed a medical superintendent to oversee operations, a position filled by Edwin Robertson in Edinburgh. Every year, tens of thousands of packets containing pathological specimens (mostly urine) circulated in the post. Many reached the Clinical Research Association (CRA), a large London-based commercial laboratory that supplied doctors with regulation containers and ready-addressed envelopes or boxes for return (Worboys, 2004). The frequency of broken and spilled packages induced the Postmaster General repeatedly to specify regulations in the *BMJ* (Cunningham, 1992, 311). Specimens needed to be securely packed in a strong wooden, leather, or metal case to prevent shifting about and with sufficient absorbent sawdust or cotton wool to prevent leakage. The container had to be conspicuously marked 'Pathological specimen—Fragile with care', and any packet found to contravene regulations would be destroyed and the sender liable to prosecution.[78]

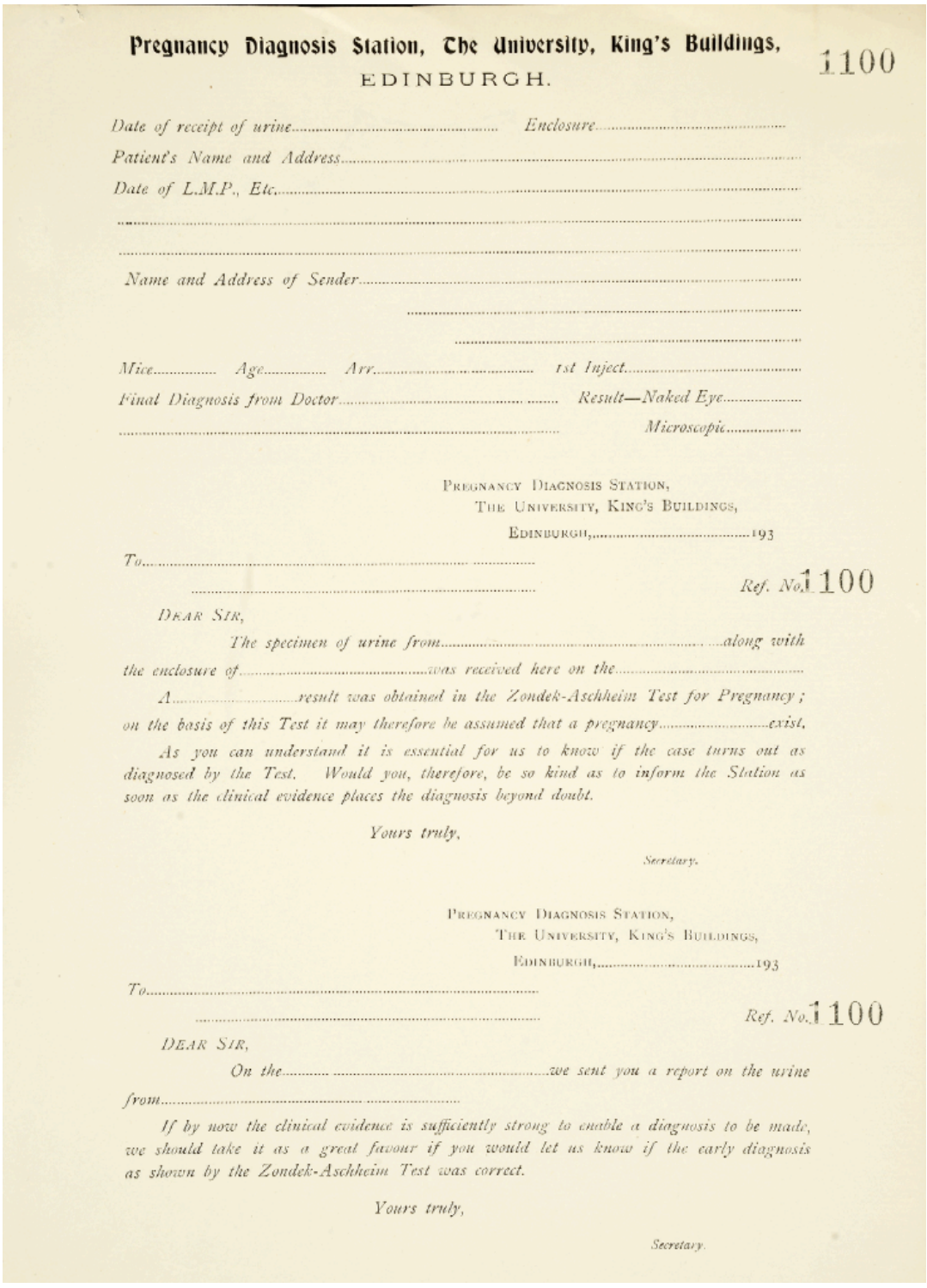
Nurtured by the requirements of life assurance companies for urinalysis, the CRA and other commercial labs scaled-up diagnostic services to meet an increasing demand from doctors (Dupree, 1997, 100, Worboys, 2004). A pregnancy test cost about as much as haemoglobin estimation or Wassermann reaction, which ranged from two shillings a test for panel patients and their dependants to ten and six for the well-heeled (Foster, 1983, 32-37). Specimens that survived the trip to Edinburgh were

[77] This is respectively equivalent to the spending worth in 2005 of around £8.30 (the cost of an over-the-counter Clearblue Plus Pregnancy Test) and around £2.50. I used the National Archives Currency converter for all estimates of present-day monetary values in this thesis, http://www.nationalarchives.gov.uk/currency/.

[78] CRA, 1929, 168. Many specimens sent in homemade containers were 'lost in the post', in other words, destroyed by the postal authority. In Edinburgh, a small hand press was eventually built to extract the urine from the contents (correspondence and all) of broken packets: Crew, 1937b, 996. For a discussion of packaging and posting issues in the case of radium: Rentetzi, 2011.

filtered on arrival by laboratory workers into numbered bottles. Crew's staff then entered the particulars in a special logbook with perforated pages to produce numbered labels for the urine container and mouse cage, record cards for injection and filing and 'result' and 'follow-up' letters. No later than six days after receipt of specimen, a secretary would post the 'result' letter to the sender. Two months after that, she would post a reminder letter to find out if the doctor had corroborated or contradicted the laboratory diagnosis by clinical evidence of pregnancy or its absence (**figure 2.3**).[79]

[79] On the technical and secretarial staff of medical research laboratories in mid-twentieth-century Britain: Tansey, 2008.



Pregnancy Diagnosis Station, The University, King's Buildings,
EDINBURGH.

1100

Date of receipt of urine..... *Enclosure*.....
Patient's Name and Address.....
Date of L.M.P., Etc......
.....
.....
Name and Address of Sender.....
.....
.....
Mice..... *Age*..... *Arr.*..... *1st Inject.*.....
Final Diagnosis from Doctor..... *Result—Naked Eye*.....
..... *Microscopic*.....

PREGNANCY DIAGNOSIS STATION,
THE UNIVERSITY, KING'S BUILDINGS,
EDINBURGH,.....193

To.....
.....
Ref. No. 1100

DEAR SIR,

The specimen of urine from.....*along with the enclosure of*.....*was received here on the*.....

A.....*result was obtained in the Zondek-Aschheim Test for Pregnancy; on the basis of this Test it may therefore be assumed that a pregnancy*.....*exist.*

As you can understand it is essential for us to know if the case turns out as diagnosed by the Test. Would you, therefore, be so kind as to inform the Station as soon as the clinical evidence places the diagnosis beyond doubt.

Yours truly,

Secretary.

PREGNANCY DIAGNOSIS STATION,
THE UNIVERSITY, KING'S BUILDINGS,
EDINBURGH,.....193

To.....
.....
Ref. No. 1100

DEAR SIR,

On the.....*we sent you a report on the urine from*.....

If by now the clinical evidence is sufficiently strong to enable a diagnosis to be made, we should take it as a great favour if you would let us know if the early diagnosis as shown by the Zondek-Aschheim Test was correct.

Yours truly,

Secretary.

Figure 2.3. The Edinburgh pregnancy diagnosis station printed result, follow-up and reminder letters. L.M.P. stands for 'last menstrual period' and though it would become conventional to refer to the Aschheim-Zondek test, in these forms it was referred to as the 'Zondek-Aschheim' test (FD 1/2816).

Other labs had reported a disturbingly large error of up to 5%, which provoked debate over the specificity and clinical value of the Aschheim-Zondek reaction. Delegates from the Edinburgh station defended the test in January 1930 at a London meeting of the prestigious Royal Society of Medicine. John Hannan, a registrar at the Soho Hospital for Women had used rats instead of mice and reported a 7% error. He doubted the usefulness of any method that was not 'absolutely reliable' and preferred the 'old method of seeing the patient in a month's time' (Hannan, 1930, 637). Wiesner insisted that the Aschheim-Zondek reaction could only be evaluated fairly if the original unmodified method was tested with 'sufficient material collected under clinical conditions.' This had been done, he claimed, not in London, but in Edinburgh, where the error was a satisfactory 2%. But he emphasised that a positive reaction was 'a sign of placental activity' only and looked forward to the day when a 'chemical test' would be able to detect 'the presence of a living fœtus'. Meanwhile, Wiesner was the first to admit that the Aschheim-Zondek reaction was simply 'not a pregnancy test, *sensu strict[o]*' (Hannan, 1930, 638).

The influential obstetric surgeon Louis C. Rivett claimed that clinical diagnosis was 'easy' in 99% of cases and that an expert could usually handle the doubtful 1% without recourse to the lab. He had provided biochemist Frank Dickens at the Courtauld Institute with over 200 specimens collected from Queen Mary's Hospital, where East End women competed for limited beds by applying for accommodation at the first sign of pregnancy (Allan & Dickens, 1930). Dickens was reasonably satisfied with the reliability of the test, but like Hannan he discontinued routine testing to free up laboratory animals for more prestigious pituitary research.[80] Arthur Giles, a well-known gynaecologist at the Chelsea Hospital for Women, amplified Rivett's criticism about lack of specificity. The test gave positive results for non-pregnant women in a 'considerable variety of conditions' and most gynaecologists, he claimed, would probably agree that 'for the present they had better trust to their fingers and their

[80] Dickens did 'not undertake private work' and the *Lancet* redirected inquiries from 'anxious' practitioners to Crew's station: 'Biological diagnosis of pregnancy', *Lancet*, 11 January 1930, 94.

senses generally for the diagnosis of pregnancy'.[81] He did, however, praise the ability of the test to detect placental cancer.[82]

Rarely, in the early stages of pregnancy, the fingerlike protrusions of the placental membrane (chorionic villi) transform into bunches of grape-like cysts. As the 'hydatidiform mole' grows, the embryo usually dies and is reabsorbed. At first a 'molar pregnancy' looks and feels normal, but then the uterus begins to grow abnormally fast and becomes soft and boggy to touch, with no fetal parts to feel, or heartbeat to hear.[83] Before the Aschheim-Zondek test, the only foolproof diagnostic criterion was a discharge containing tiny cysts, resembling 'white currants in red currant juice' (Johnstone, 1934, 267). Once diagnosed, a mole could be manually squeezed out, but any retained bits were liable to develop into a highly malignant trophoblastic cancer known as 'chorionepithelioma' or 'chorioncarcinoma', which could rapidly and fatally spread to the lungs. So following surgical removal or spontaneous delivery, a patient would be instructed to check in regularly for up to a year, or at once if there were any irregular bleeding.

Aschheim had been one of the first to report a positive reaction in a case of chorionepithelioma following the expulsion of a hydatidiform mole (Aschheim, 1929). Although chorionepithelioma was rare and not effectively treatable with chemotherapy (methotrexate) until the 1950s,[84] cancer specialists nevertheless embraced his test as a significant breakthrough in diagnostics.[85] Early detection and treatment (usually with some combination of surgery, radium and chemotherapy) was a cornerstone of the 'crusade' against cancer more generally in early twentieth-century Britain (Austoker, 1988, Medina-Domenech & Castañeda, 2007, Cantor, 2008, Löwy, 2009, Moscucci, 2009). Yet few general practitioners saw many patients

[81] 'Reports of societies', *BMJ*, 25 January 1930, 150-153, 151.
On the importance of 'trustworthiness' to MRC clinical trials in this period: Cox-Maksimov, 1997, 70-80.
[82] The Aschheim-Zondek reaction was neither the first nor the last pregnancy test to be used to detect cancer. In the 1910s and 1920s, Abderhalden's reaction doubled as a test for cancer and in the 1970s, American scientists invented a new radioimmunoassay for pregnancy while researching a tumour marker for 'choriocarcinoma': Vaitukaitis, 2004.
[83] On molar pregnancies in early-modern Europe: McClive, 2002, McClive & King, 2007, Blanarsch, 2009.
[84] See, for example, Buckle, 1959.
[85] The incidence at the London Hospital, a large teaching hospital, for example, was on average only three cases of hydatidiform mole every year and one case of chorionepithelioma every two years: Brews, 1939, 814.

suffering from malignancy, which made early diagnosis a real challenge (Donaldson et al., 1936). Hopeful researchers announced new serological tests for cancer on a regular basis and by 1930 over twenty serodiagnostic methods had been proposed (Wright & Wolf, 1930). 'Unfortunately,' as Liverpool gynaecologist William Blair-Bell lamented, 'none had proved specific for malignancy.' Even as he 'doubted' whether 'science' would ever produce 'a test so delicate as to indicate the existence of a few cancer cells in the human body', he implored 'biochemical investigators' to 'not lose sight of the immense importance' that would attach to such a discovery.[86]

Robertson, who had also been at the London meeting, echoed Rivett's hopes for cancer monitoring and control in an address to the Edinburgh Obstetrical Society. One local patient with chest symptoms caused by a metastatic mass had tested positive, demonstrating how repeated testing at regular intervals could be used to monitor the results of surgery or other treatment. Leading Edinburgh gynaecologists were easily persuaded of its value: Theodore Haultain was having one of his patients tested on a weekly basis after she had delivered a hydatidiform mole and James Young proposed that interval testing should be made routine in all such cases. The president of the society congratulated Robertson, who 'had only to ask' if he needed specimens, 'for those who had listened to him and to his facts would be only too glad to help to further the uses of such a test' (Robertson, 1930, 131).

Despite this locally warm reception, however, the Edinburgh station incurred a deficit of £135 in its first year and was threatened with closure. Some doctors had failed to pay up and dozens of tests had been repeated when batches of mice were killed by toxic urine or the visible changes in their bodies were ambiguous. Retesting with second and third specimens was costly and usually fruitless. An increasing demand suggested that the station was 'appreciated by hospitals and practitioners', but this did not necessarily justify its continued existence. Wiesner informed the MRC that the station had met its stated research goal of testing the test and that he would need to propose new research aims to justify any continued funding. On the other hand, standards of animal stock had been established and the necessary infrastructure built

[86] Blair-Bell, 1930, 221. Endocrinology and oncology intersected in the use of hormones to diagnose and treat tumour growth: Blair-Bell argued that normal chorionic tissue was malignant because of its capacity to invade maternal tissue (Cramer, 1930, Peel, 1986, 31), and the carcinogenic potential of sex hormones was first debated in the 1930s (Johnstone, 1933, Gaudillière, 2006).

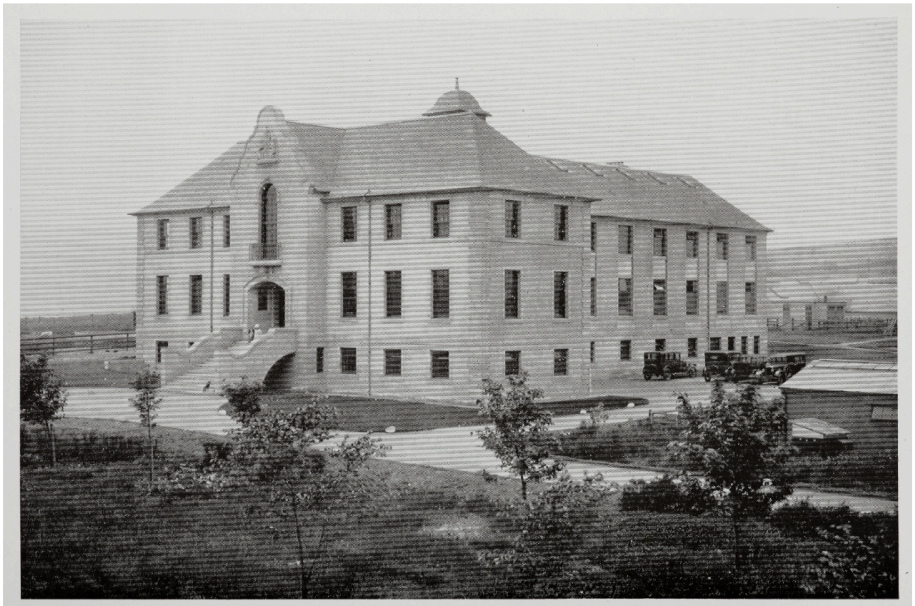
up to support a routine service independent of any research agenda. This relatively well equipped and smoothly running laboratory was now 'ready for use by anybody' willing to uphold the necessary standards.[87]

At this critical juncture, Wiesner was the first to declare that the station could simply be shut down. But he stood by the value of the service and advised its relocation to some other adequately equipped institution, such as the Laboratory of the Royal College of Physicians of Edinburgh. Alternatively, he estimated that doubling the fees would cover expenses in a second year of operation. He also expressed an interest in continuing to work with the test and with the surplus urine it brought him. Crew's weak position within the British medical establishment, in an agricultural department far from the great London teaching hospitals, enhanced for him the value of Wiesner's initiative and in the end the station remained in Crew's institute, which moved into a new building in March 1930. Wiesner promised to tighten up his bookkeeping and the MRC agreed to cover the station for a loss of up to £50 for one year only.

Crew's first annual report announced that fees would be increasing to ten shillings for private cases and three for hospitals (still well within the range of a Wassermann test). This was a winning strategy and in one year the station had become financially 'self-supporting', even generating 'a small balance' to be 'carried forward as reserve' (**figure 2.4**).[88] Crew's report further clarified the potentially misleading use of the word 'pregnancy' in communications by the station. A few doctors had complained that a negative result was followed by miscarriage, proving that the patient had been pregnant (with a dead fetus) at the time of the test (Johnstone, 1930, 175). Rather than admit error, Crew creatively reinterpreted 'false' negatives as positive indications of a hormonally deficient pregnancy that would probably not go to term (Crew, 1930, 662). Far from discouraging, such 'errors' opened a window of opportunity for Crew and Wiesner, who began to calibrate the test so that laboratory results would match clinical expectations.[89] In addition to the asset of 'false positives' in cancer diagnosis, they redescribed 'false negatives' as positive predictors of 'fetal death' and began to

[87] Wiesner to Thomson, 8 February 1930, FD 1/2816.
[88] Wiesner to MRC, 18 February 1931, FD 1/2816.
[89] On calibration as the exertion of control over how the results of a test should be interpreted: Collins, 1985, Pinch, 1993.

remake the Aschheim-Zondek test into a detector of women who were likely to miscarry.[90]



DEPARTMENT OF ANIMAL GENETICS

STATEMENT OF ACCOUNTS OF THE PREGNANCY DIAGNOSIS STATION,

From 1st January, 1930 to 18th February, 1931.

INCOME	£	s.	d.	EXPENDITURE	£	s.	d.
(1) Balance carried forward from 1929	5	:	: 3	(1) Wages and Insurance	174	: 12:	1
(2) Specimen fees	264	: 5:	9	(2) Purchase of Food, Hay, etc.	12	: 5:	-
(3) Sale of Mice, etc.	53	: 18:	11	(3) Purchase of Mice	91	: 16:	11
(4) Repayment by Section E	20	: 13:	4	(4) Telegrams, Postage Telephone	16	: 3:	4
				(5) Bank Charges	1	: 13:	3
				(6) Stationery (including printing of forms)	8	: 16:	10
				(7) Equipment & Chemicals	5	: 7:	1
				(8) Sundries	3	: 3:	10
				(9) Money lent to Section E	20	: 13:	4
				(10) Repayment of advanced sums	4	: -:	-
				(11) Balance in Hand:			
				Cash 4:10:5			
				Bank 16:2	5	: 6:	7
	£343	: 18:	3		£343	: 18:	3

Figure 2.4. Above: an official photograph of Crew's institute at the King's Buildings Site, viewed from the northeast ('The Department of Animal Genetics', *University of Edinburgh Journal*, Autumn 1930, 35-40, unpaginated plate between 36 and 37). Below: income and expenditures of the pregnancy diagnosis station in 1930-31 (FD 1/2816).

[90] On medical understandings of miscarriage and abortion in the first half of the twentieth century: Elliot, 2014.

2.3. Clinical pathologists, family doctors and rabbits

In the late 1920s, the well-connected physician Sir Thomas Horder had lamented 'the existence of laboratories in which the personal element as between doctor and pathologist is quite eliminated', even as he admitted that they were 'necessary' and had 'come to stay' (quoted in Lawrence, 1998, 99). A decade later the *Practitioner* generally recommended working with a local pathologist, rather than relying on a 'remote laboratory' (Dukes, 1936), a practice later derided as 'mail order' or 'postal' pathology.[91] Despite the distance, its many southern clients generally welcomed the Aschheim-Zondek reaction and the Edinburgh station. This was a significant achievement at a time when some diagnostic tests were renowned for their 'great reliability' and others 'definitely black-listed.'[92] The procedure for collecting a specimen was lauded as the 'simplest imaginable' (it did not require a catheter as with urine for bacteriological tests) and the manageable error was 'easily guarded against by ordinary clinical observation.'[93] One article in the *Clinical Journal* recommended London hospitals for pregnancy testing (Green-Armytage, 1934), but Crew's service was usually singled out.[94] Although Liverpool gynaecologist Arthur Gemmell cautioned that the station was not 'always accurate' (he had received two incorrect results), he did not reject the test, but instead recalled that it 'was not a test for pregnancy, but for the presence of living chorion, and that its reported result must be carefully considered in connexion with the clinical findings.'[95]

As we have seen, a few elite gynaecologists trusted their own senses more than a test that gave the wrong answer in one out of every fifty or even twenty cases. But there was no consensus on the error, which varied by laboratory, and Crew and Wiesner were creatively redefining mistakes to convert the liability of non-specificity into the advantage of versatility. Furthermore, family doctors had their own reasons for preferring a postal service to the delicacies of pelvic examination. A note in the *Lancet* in 1930 recommended the Aschheim-Zondek test as 'sufficiently reliable for all clinical purposes,' and for 'the further advantage that in delicate circumstances it

[91] See, for example, Cameron, 1945, 59.
[92] 'Accuracy of laboratory diagnosis', *Journal of Clinical Research*, October 1934, 141-142, 141.
[93] 'New and valuable tests', *Journal of Clinical Research*, April 1933, 63-65, 64.
[94] As in this specially commissioned article by the staff of the Macaulay Laboratory: 'Laboratory tests for pregnancy', *Journal of Clinical Research*, July 1933, 88-90.
[95] 'Reports of societies', *BMJ*, 28 February 1931, 351-356, 353.

can be done without the knowledge of the patient or her friends.' The note predicted that, although the 'technique needs practice', it was 'likely to be acquired by clinical pathologists' now that its 'value' had been 'confirmed'. 'The family doctor', it concluded, 'will be 'grateful for the simplicity of his share, which consists only in collecting morning urine from the patient and possibly adding a drop of tricresol as a preservative.'[96]

For the ordinary family doctor, pelvic examination was complicated by the ever-present possibility of normal pregnancy, which generally needed to be confirmed or excluded. Light bleeding, however, could complicate a diagnosis and the presence of fibroids challenged even 'the most erudite' (Green-Armytage, 1934, 53). The most important clinical method of early pregnancy diagnosis involved the bimanual palpation of the uterus, but, as a somewhat later commentator made explicit, 'attempts to elicit Heger's sign [could] be as effective in terminating a pregnancy as the abortionist's curette' (Stallworthy, 1951, 119). Perhaps even more importantly, a mutual feeling of 'delicacy and sensitiveness' between a patient and her doctor strongly discouraged the practice of pelvic examination unless absolutely necessary.[97]

Textbooks began providing practical instructions on how to collect and post a urine specimen for pregnancy diagnosis. The second edition of Haultain and Fahmy's *Ante-natal care* claimed that the Aschheim-Zondek test could be performed only 'in a laboratory, by expert observers', and specifically mentioned Edinburgh (Haultain & Fahmy, 1931, 31). The sixth edition of Johnstone's textbook instructed doctors to post specimens, a brief history and ten shillings to the 'Pregnancy Diagnosis Station, University—King's Buildings, Edinburgh' (Johnstone, 1932, 83). The fourth edition of Blair-Bell's *Principles of gynaecology* enthusiastically proclaimed that the Aschheim-Zondek test had 'revolutionized' pregnancy diagnosis (Blair-Bell, 1934, 149). Aleck Bourne's *Midwifery for nurses*, recommended as a study guide for the Central Midwives Board examination, suggested posting urine to Edinburgh 'with the name and age of the woman, the date of dispatch, date of her last menstruation, and a postal order for 10*s*' (Bourne, 1935, 68-69).

[96] 'A reliable test for pregnancy', *Lancet*, 4 January 1930, 36–37.
[97] Chisolm, 1930. For a discussion of similar issues in Victorian diagnostic practice: Nicolson, 2011.

As with X-rays and the Wassermann test in mass screening, the cost of an Aschheim-Zondek test decreased as demand increased (Macleod, 1936, Davis, 2008). But some critics objected to the organisation of pregnancy testing in Britain. In his public speech at the opening of Crew's institute in 1930, Sir Edward Sharpey-Schafer complained that the resources of a research institute 'should not be diverted to a routine method of diagnosis which might as well be done anywhere else' (Sharpey-Schafer, 1930, 31), a complaint that was repeated in the *Scotsman* under the subheading 'Certificate for a mouse.'[98] Crew's institute was licensed for vivisection, but pregnancy testing as such was not specifically addressed by the Home Office until 1932, when an inspector advised a doctor to obtain a license and Certificate A, setting a precedent for subsequent would-be pregnancy testers.[99]

Even as the *BMJ* complained that doctors were forced to rely on 'special centres' that concentrated and maintained 'large stocks of mice' and 'skilled service', it doubted that pregnancy testing would ever become practical as a side-room technique. So the search continued for the 'ideal test', one that was not 'unpleasant to patient or physician, but simple, capable of being used by the geographically isolated general practitioner, cheap in time and money, and, of course, reliable.'[100] Researchers at London hospitals and Crew's student Cecil Voge in Edinburgh investigated cheap, quick, and simple biochemical reactions, but after hundreds of tests on surplus pregnancy urine they were forced to admit that infant mice beat their *in vitro* tests.[101] Others experimented with adult mice and (male and female) rats, but the next major breakthrough came in 1931 when researchers in Philadelphia announced a new rabbit test (Friedman & Lapham, 1931).

The 'Friedman test' used one or two large, female adult rabbits instead of a batch of five tiny, immature mice. Because rabbits only ovulate immediately after mating (or when one doe 'jumps' another), an isolated animal with a known history could be

[98] 'Professor's defence of vivisection', *The Scotsman*, 1 July, 6. American commentators blamed antivivisectionists for the centralisation of pregnancy testing in Britain: Harding, 1931, Rock, 1932.
[99] M. J. A. Giles, 'The position of pregnancy tests under the Cruelty to Animal Act, 1876', 'Vivisection, pregnancy tests: legal option as to the necessity for licence coverage, 1943-63,' HO 45/25145. See also 'Vivisection: Crewe, Dr F A E: pioneer in animal genetics and pregnancy testing techniques', HO 45/24715.
[100] 'Laboratory methods for the diagnosis of pregnancy', *BMJ*, 24 March 1930, 962.
[101] Voge, 1929, Hannan, 1930, Dodds, 1930. On Voge's subsequent Rockefeller-funded work on spermicides in Crew's department: Borell, 1987, Soloway, 1995, Clarke, 1998, 2000, Löwy, 2010.

used at any time without fear of a false positive from spontaneous ovulation. Rabbits, like mice, had to be sacrificed, but were comparatively easy to handle and inject in the ear-vein, an already standard procedure in bacteriological testing and vaccine production. They could also tolerate larger doses of urine and soon became the pregnancy-test animal of choice in American laboratories (Leavitt, 2006). Compared to mice, housing rabbits individually in cages (to prevent ovulation) was expensive and required more space, but Friedman's test dramatically reduced the waiting time for a result from five days to twenty-four hours, offering doctors a more flexible service in urgent cases.

The Edinburgh station soon experimented with the Friedman test, charging one pound, ten shillings to private doctors and one pound to hospitals (around fifty and thirty-three pounds respectively in 2005 money) to cover the higher cost of rabbits and telegraphic communication of the results (Wiesner, 1931, 1932). Contrary to Crew's expectations, demand for Friedman testing in Edinburgh remained low, mainly because it was expensive and because large teaching hospitals in London and other cities managed to establish facilities of their own.[102] Crucially, the use of rabbits facilitated the establishment of local alternatives to Crew's remote (for clients outside Edinburgh) service.

By 1935 most London teaching hospitals were equipped for the Friedman test. Ronald Kelson Ford's *Short ante-natal and post-natal handbook* called it the 'more generally used' pregnancy test in Britain (Ford, 1935, 6), and the *BMJ* claimed it was 'well established in clinical midwifery practices.'[103] A pathologist at St. Thomas's Hospital praised the 'much simpler' Friedman test, reporting over 700 reactions in 1936 (Bamforth, 1936, 132). Unlike 'delicate to handle' and 'difficult to obtain' mice, rabbits were 'much more satisfactory' to work with at St. John's Hospital, Lewisham. There, a specially constructed box was used to bunch up the rabbit's back and prevent it from kicking at one end while holding its neck between two boards 'after the manner of an old-fashioned pillory' at the other (Ralph, 1934, 57) (**figure 2.5**).

[102] On the London hospitals: Rivett, 1986.
[103] 'Friedman's pregnancy test', *BMJ*, 2 February 1935, 211.

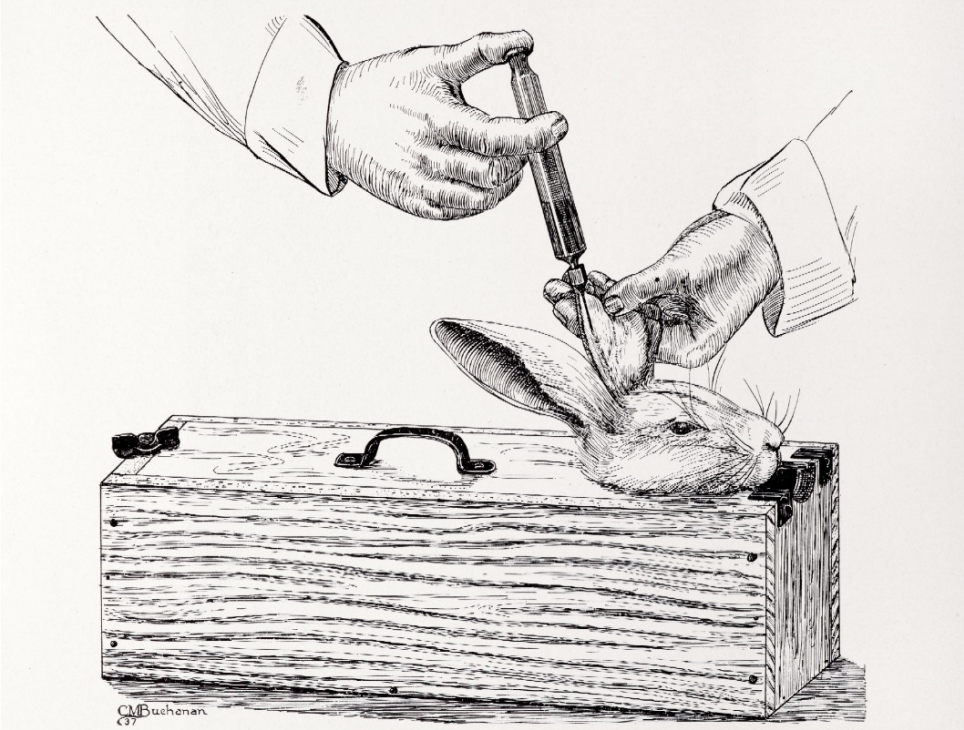


FIG. 198. Injecting the marginal ear vein of a rabbit with urine in performing a Friedman test for pregnancy. Note the style of wooden box which restrains the animal in a satisfactory way.

Figure 2.5. Line drawing of a rabbit injection with restraining box in Roy Kracke's *Textbook of clinical pathology* (Kracke, 1938, 513).

Peter Bishop, a clinical endocrinologist at Guy's, modified the Friedman test by introducing a delicate surgical procedure to identify spontaneous ovarian blood spots that might otherwise have led to a misdiagnosis (Bishop, 1932, 1933, 1934). This involved operating on each rabbit before and after every test. Bishop's modified technique was considered impractical in Edinburgh, where Friedman's test was combined with a confirmatory Aschheim-Zondek test, a control that required 'much less surgical skill' (Crew, 1936a, 993). The Edinburgh station had been made for mice, which were more convenient to house on a large scale. Rabbits, in contrast, were locally expensive, 'difficult to breed, to procure, and to accumulate in large numbers' (Crew, 1937, 990). In Crew's words, different tests were 'equally satisfactory in the hands of different people' (Crew, 1936b, 1093). When it came to pregnancy testing (and probably diagnostic tests more generally), each lab implemented its own protocols, locally adapted to suit particular needs and constraints.

2.4. Calibrating mice for diagnostic versatility

Even as Johnstone claimed that the station was 'not a commercial undertaking,' and that it served 'the interest of the [medical] profession and of science' (Johnstone, 1933, 557), Wiesner's research programme had become marginalised within Crew's institute and was finally shut down in 1934. Crew had come under increasing government pressure to use national funds for work with farm animals only and the economic depression dried up Macaulay's money (Deacon, c.1971). The new financial situation strained Crew's relationship with Wiesner, whose work on sex hormones had embarrassingly led to the development of a placenta-based drug by their chief competitor, the Montreal biochemist James B. Collip (Li, 2003). Crew later recalled that Wiesner's research on the maternal behaviour of rats (Wiesner & Sheard, 1933), which had little relevance to 'either animal genetics or animal breeding', was 'getting out of hand' and so Crew was not 'unhappy to see it come to an end.'[104]

Wiesner moved to London to set up an infertility clinic with his second wife Mary Barton (Lane-Roberts et al., 1939, 1948, Pfeffer, 1987, 1993). Artificial insemination by donor was becoming more widely used in British clinics as a medical fix for male infertility in married couples and Wiesner integrated the Aschheim-Zondek reaction (as an early pregnancy test) into infertility diagnosis and treatment regimes.[105] He also circularised clients of the Edinburgh station to inform them that he was taking it with him to London. Crew responded in the *BMJ* that testing would not stop just because Wiesner was leaving. The station was larger than 'the personal activities of one man', and would continue under the supervision of Wiesner's assistant, John M. Robson.

Though centrally located by Scottish standards, Crew's station was financially dependent on custom from London and the South of England. Scaling up had made

[104] 'An interview with Francis Albert Eley Crew (1886-1973), geneticist and professor of animal genetics, University of Edinburgh (8 CDs)', 1969-71, GB 0237 Science Studies Oral History Project Da 55 SCI 1.
[105] Richards, 2008, 211. Today Wiesner is best known as a notorious sperm donor. See, for example, Tom Kelly, 'British scientist "fathered 600 children" by donating sperm at his own fertility clinic', *Daily Mail*, 8 April 2012, http://www.dailymail.co.uk/health/article-2126761/Bertold-Wiesner-British-scientist-fathered-600-children-donating-sperm-fertility-clinic.html.

the service financially viable, but also vulnerable to competition as thousands of tests had to be made annually to cover the running costs. To keep serving Scotland, Crew would have to serve England as well and he was unwilling to give up that lucrative share of his market without a fight. Crew admitted that if endocrinology were a more advanced science 'there would of course be room for more diagnostic laboratories'. But for now, he claimed, a centralised, non-commercial service was needed to produce knowledge about the 'unusual' and 'exceptional' cases that would someday lead to new breakthroughs in hormone therapy (Crew, 1934, 531).

By 1936, the Aschheim-Zondek test was 'becoming one of the everyday tools of the practitioner'.[106] The third edition of *Recent advances in endocrinology* called it 'probably the most accurate biological test known' (Cameron, 1936, 331). A handbook for general practitioners on the early diagnosis of cancer claimed it was 'so reliable that a positive result must be accepted as proof of the presence of chorion epithelioma' (Donaldson et al., 1936, 28-29). Even the previously sceptical Hannan had begun to recommend fortnightly interval testing in 'all cases where the histological picture is suggestive of chorion carcinoma' (Hannan, 1933, 1047). Crew declared that the 'widespread demand' for pregnancy diagnosis had been 'successfully met' and predicted that 'as their usefulness [became] more generally known' the number of tests performed every year would continue to 'increase' (Crew, 1936b, 1092). Competition had intensified, but so too had demand.

Meanwhile, several laboratory workers and clinicians in Britain, dissatisfied with the impracticalities of mice and rabbits, tried out the new methods that continued to be reported in American or German journals (**table 2.2**). In 1936 Gladys Dodds, a physician at University College Hospital and Clapham Maternity Hospital, investigated the Visscher-Bowman test of Cleveland, Ohio, but concluded that too many false positives rendered it worthless (Dodds, 1936, 225). Jocelyn Patterson, a biochemist at Charing Cross Hospital, compared the Schmulovitz-Wylie (oestriol) test of Baltimore, Maryland, to rabbits. Although reliable, it was tedious and labour intensive and Patterson did not expect it to become routine (Patterson, 1937, 524). In

[106] 'The female sex hormones', *BMJ*, 18 July 1936, 126.
See also Robson, 1934a,b. In the mid 1930s, medical journals filled with 'enthusiastic reports' of 'miraculous' new pregnancy tests, most famously the bitterling test: Crew, 1936, Weisman, 1938.

1937 a *BMJ* editorial cautioned that the perfect record claimed for a new spectroscopic test by its German inventor was too good to be true.[107] Drs Alan Morton Gill and John Howkins of Middlesex Hospital condemned an intradermal sensitivity test for pregnancy test using 'Antuitrin S', a commercial gonadotrophic product marketed by Parke, Davis & Co., as 'valueless' (Gill & Howkins, 1937, 1069).

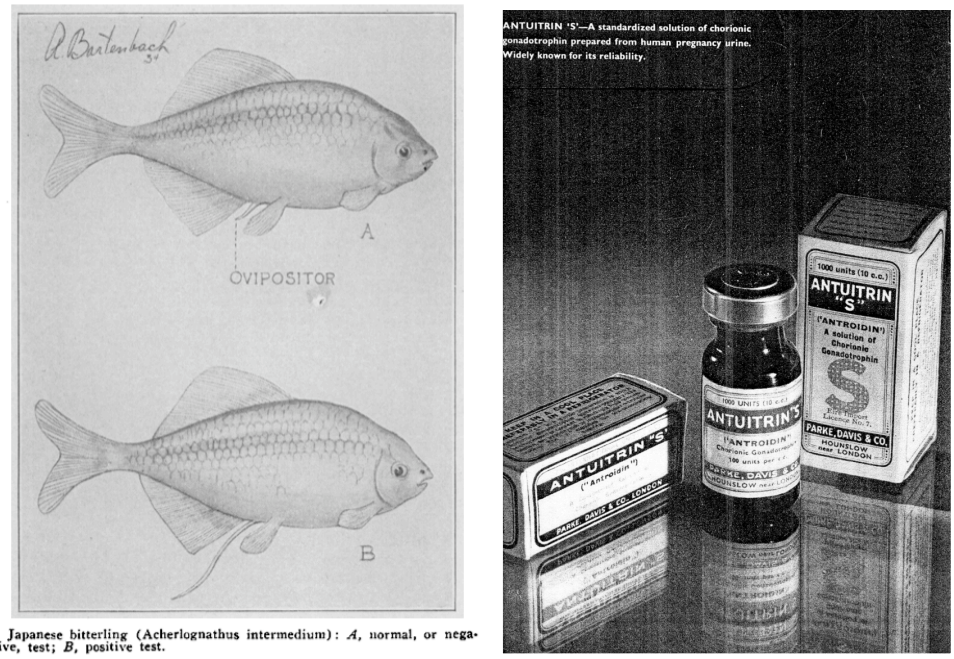
Table 2.2. Numbers of pregnancy tests by kind of test, hospital, and published source, 1930-38

Number	Test	Hospital	Source
700+		Guy's	Bishop (1934)
700+	Friedman	St Thomas's	Bamforth (1936)
395	Friedman	Guy's	Bishop (1933)
380	Friedman	University College	Dodds (1930)
265	Biochemical	St. Bartholomew's	Hannan (1930)
237	Biochemical	Queen Mary's	Allan & Dickens (1930)
234	A-Z	Royal Free	Keevil (1938)
180	Biochemical	University College	Dodds (1936)
147	Intradermal	Middlesex	Gill & Howkins (1937)
98	Friedman	Soho	Hannan (1930)
65	Biochemical	Charing Cross	Patterson (1937)
53	Friedman	University College	Dodds (1931)
50	A-Z	St. Bartholomew's	Brewer (1934)
25	Intradermal	Portsmouth	Way (1937)
?	Friedman	St John's	Ralph (1938)

Albert Sharman, a gynaecologist and pioneer of infertility treatment at the Royal Samaritan Hospital for Women in Glasgow, and Nora Keevil of the Royal Free Hospital in Hampstead independently tested the Antuitrin S test before abandoning it as unreliable.[108] Scientists in Europe and Japan, where the carp-like bitterling was plentiful, had for some years induced colour change in the male and ovipositor extension in the female to assay hormone preparations when three Chicago doctors proposed the fish as a pregnancy test animal (Kanter et al., 1934, 2027). In Britain, Dr Stanley Way of the General Lying-in Hospital in Portsmouth initially had 'great success' with the bitterling (fish) test until a batch he purchased from a dealer was already 'in oestrus' and so 'giving positive results' even before they could be put to

[107] 'Another test for pregnacny', *BMJ*, 16 October 1937, p. 757.
[108] 'Antuitrin S intradermal pregnancy test', *BMJ*, 11 December 1937, p. 1199. See also Sharman, 1938.

use (Way, 1937, 1143). Although the bitterling test caused some excitement in the US,[109] Way found the fish to be 'a great nuisance to look after' (**figure 2.6**).[110] He also found the Antuitrin S test to be 'hopelessly inaccurate' and abandoned it after about just 25 attempts (Way, 1937, 1143). Whether they liked it or not, pregnancy testers continued to rely on mice and rabbits.



Japanese bitterling (Acherlognathus intermedium): *A*, normal, or negative, test; *B*, positive test.

Figure 2.6. Left: a drawing by medical illustrator Angela Bartenbach of the Japanese bitterling (today classified as *Rhodeus*) showing negative (above) and positive (below) reactions (Kanter et al., 1934, 2027). Right: an advertisement for Antuitrin-S, the standardised hCG product made from pregnancy urine and marketed in Britain by the Hounslow-branch of the American company Parke, Davis & Co. (Parke, Davis & Co., *c*.1949, 16). On the company: Deeson, 1995.

The unique selling point of Crew's station over competitors was the degree to which laboratory workers calibrated test mice to produce 'a graded series of reactions

[109] For example, in 1935 an imaginative *Time* magazine reader predicted that 'every standard American home' would soon be 'equipped with an aquarium containing a female bitterling that would be as handy as the radio, the vacuum cleaner, the bottle of antiseptic, etc., in maintaining the even tenor of existence, especially in times when the budget of most households does not permit haphazard payments to obstetricians' ('Bitterling possibilities', *Time*, 18 February 1935).

[110] In 1989 the Science Museum, London, received a specimen jar labelled 'Japanese bitterling ♀ for pregnancy test' from the Institute of Medical Laboratory Sciences, but its exact origins are unknown (Robert Bud, email, 10 April 2013). See 'Specimen jar containing three female Japanese Bitterlings, 1930-1980', Object 1994-1009, http://www.sciencemuseum.org.uk/broughttolife/objects/display.aspx?id=92488.

ranging from a "strong" positive through the ordinary "standard" to "weak" and "extremely weak" positives, […] to the ordinary unequivocal negative.' Graded results produced information beyond the 'existence or non-existence of normal pregnancy' by showing 'the difference between an exceptionally low hormone concentration and the "normal" concentration in cases of early pregnancy, and thus [disclosing] the threat of imminent abortion.' They could also 'distinguish between true pregnancy and the endocrine repercussions of abnormal emotional states, and between pregnancy and menopausal conditions' as well as track the 'stages of recrudescence of chorion epithelioma and hydatidiform mole' (Crew, 1939, 767).

In the case of a suspected placental mole or malignancy, the station also offered special dilution tests. For example, an Edinburgh lab report sent to Alan Brews, a leading gynaecologist at the London Hospital, stated: 'We have examined the specimen of urine and have found that the concentration of gonadotrophic hormone is very high, dilutions of 1 in 200, giving positive reactions when the normal doses are employed. The result supports your diagnosis of chorion-epithelioma' (Brews, 1935, 1225). Others complained that in their hands the test was 'capricious', but Brews emphasised its value 'as an aid to diagnosing [hydatidiform mole] and as a means of excluding the subsequent growth of a chorion-carcinoma.'[111] By 1939 he had used the Aschheim-Zondek test in six cases, 'where no part of the mole had escaped from the uterus; in 5 a positive reaction was obtained in a dilution of 1/200 (in 1 case up to 1/800) and in the remaining case a negative reaction was obtained in undiluted urine.'[112]

The number of urine specimens sent to Edinburgh for pregnancy testing increased from around 840 in 1929 to over 10,000 in 1939 (**figure 2.7**).[113] About half the demand came from private cases, the other from hospitals. About half were for non-pregnant women (negative results), many of whom were near menopause. The other half tested positive. Although I have found no records that further break down this demand quantitatively, it is possible to put together a qualitative picture from

[111] 'Hydatidiform mole', *Lancet*, 6 April 1935, 823.
[112] 'Hydatidiform mole and chorionepithelioma', *Lancet*, 4 February 1939, 283-285, 284. See also Brews, 1939.
[113] This scale is comparable, though on the small side, to diagnostic laboratories that specialised in mass bacteriological, biochemical and serological testing: Ritchie, 1953, 66, 80, Foster, 1961, 120, 1983, 36, Lawrence, 2005, 196.

published reports. Doctors called on the station when patients were unmarried, when obesity or vaginismus impeded ordinary physical examination, in cases of unusual amenorrhoea or vomiting, if fetal death was suspected and when differential diagnosis was difficult, for instance between ordinary pregnancy and an abdominal tumour, ectopic pregnancy, pseudocyesis (phantom pregnancy), or fibroids. They also requested tests when therapeutic abortion was indicated in expectant mothers with tuberculosis or toxaemia (pre-eclampsia) and, occasionally, in medicolegal circumstances—to establish or exclude pregnancy in cases of criminal abortion, rape, or divorce.[114] Sometimes a doctor requested a test for allegedly domestic reasons as when a woman was planning to 'accompany her husband' to the tropics, but would stay home instead if she happened to be pregnant (Crew, 1936a, 993). For those who could afford it, testing was used to calibrate expensive hormone treatment of infertility (Jeffries, 1935).

[114] For example, in the landmark trial, *R v. Bourne*, gynaecologist Aleck Bourne waited for the (positive) result of a pregnancy test, probably from the Edinburgh station, before performing an abortion on his patient, a young rape victim. See Sir Bernard Spilsbury's report, 'Respecting the diagnosis of early pregnancy', 16 July 1938, in 'Bourne, Dr Aleck W: Abortion' (NA DPP 2/564). On the trial: Brookes & Roth, 1994. On Spilsbury: Burney & Pemberton, 2011.

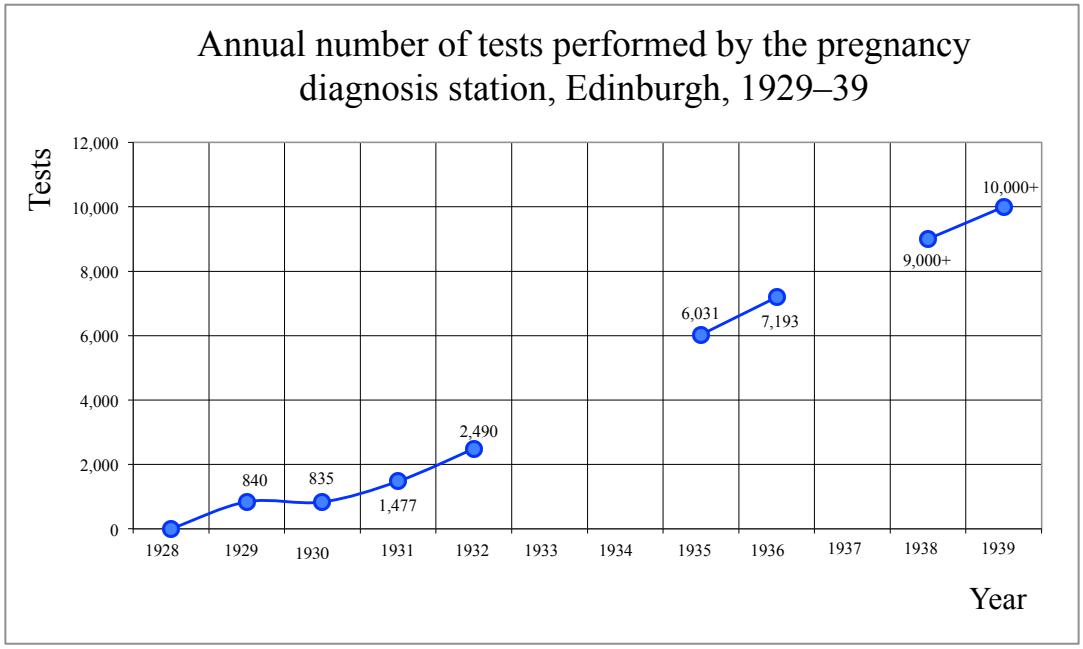


Figure 2.7. Chart based on annual reports (Crew, 1930, 1936a, 1937a,b, Wiesner, 1931, 1932, 1933). For comparison, the total number of diagnostic tests of all kinds performed by the older Laboratory of the Royal College of Physicians of Edinburgh was 14,798 in 1929 and 16,714 in 1939 (Ritchie, 1953, 154).

The Edinburgh station 'quite commonly' received brilliant green urine specimens posted by doctors that were lethally toxic to mice, which Crew attributed to 'single women' trying to 'avoid pregnancy' by chemical means (Crew, 1937, 994). By the end of the decade the station received and refused to test five or six urine specimens every week from women 'who send it in themselves, or chemists, or men.'[115] These two or three hundred rogue specimens per year suggest that at least a minority of women had learned of the station, despite the evident lack of publicity.[116] Crew rejected this demand and continued to deal exclusively with the medical profession in order to maintain the respectability of his diagnostic service.[117] In practice, however, women who knew about the service and could afford to reimburse a sympathetic doctor could order a test for any reason whatsoever: the Edinburgh service was

[115] 'Evidence of Professor F. A. E. Crew, Inter-Departmental Committee on Abortion, Tuesday, 21 June 1938', 'Interdepartmental Committee on Abortion (Ministry of Health; Home Office), A.C. paper 53, MH 71/27, NA. See also 'Memorandum of Professor Crew', AC Paper 138, NA MH 71/26.
[116] The term 'indirect advertising', which covered dealings with the non-medical press, was coined in 1925 by the BMA's Central Ethical Committee, which in turn dated from 1902: Morrice, 1994, Nathoo, 2009, 36-37.
[117] In the 1930s, American birth control clinics used the Aschheim-Zondek test to reject pregnant patients: Hajo, 2010, 56, 203.

'unrestricted' in this sense and 'never made a distinction between the medical and social reasons for doing a test'.[118]

When the British Congress of Obstetrics and Gynaecology convened in Edinburgh in April 1939, Crew boasted that the large volume of urine handled by his laboratory was 'a measure of the quality of the service that pregnancy diagnosis offers to the clinician, great numbers of whom regarded it as an essential item of their diagnostic equipment'.[119] With a view towards further expansion, Regina Kapeller-Adler, a refugee biochemist from Vienna who had recently joined Crew's team, was working on a promising new histidine reaction,[120] and Crew prepared to replace his mice and rabbits with *Xenopu*s, 'the toad that has not to be slaughtered' (Crew, 1939, 768). Demand had increased to the point that Crew confidently recommended the creation of new facilities in London, Leeds, Manchester, Glasgow, Dublin and Belfast. In addition to providing routine diagnostic services, these laboratories could also actively research new tests for sex hormones. The future was, Crew punned, 'pregnant with the promise of great discoveries'.[121]

Conclusion

Thirty years ago, sociologist Ann Oakley claimed that the Aschheim-Zondek test launched a 'modern era' of obstetric knowledge, which asserted its superiority over that of pregnant women themselves. Yet laboratory scientists did not generally promote the test as a means of extending the medical surveillance of pregnant wombs belonging to normal, healthy women. Instead, they often reminded clinicians that the reaction was a test not for the presence of a fetus, but for hormonally active placental tissue. These reminders were not always intended to undermine others' ability to diagnose ordinary pregnancy, but also to promote the clinical usefulness of the diagnostic laboratory. Following Fleck, I have recovered how the Aschheim-Zondek reaction was made into a clinically useful test, not overnight by its eponymous inventors, but incrementally by the collective labour of entrepreneurial laboratory

[118] B. M. Hobson, 'Facilities for pregnancy diagnosis in Britain', 1966. Laboratory services: Pregnancy diagnosis services, 1946-71, HH 102/858, National Archives of Scotland (NAS).
[119] 'The eleventh British Congress of Obstetrics and Gynaecology', *Journal of Obstetrics and Gynaecology of the British Empire*, June 1939, 582-589, 585.
[120] Adler-Kastner, 1998. See also Collins, 2009, Weindling, 2009a,b.
[121] Crew, 1939, 768.

workers. I have also attempted to place the diagnostic laboratory 'more carefully into a wider social canvas' (Gooday, 2008, 786).

As I have argued in this chapter, the reputation of the Aschheim-Zondek test had more to do with differential diagnosis, malignant disease and infertility treatment, than with ordinary pregnancy. Diagnostic versatility may have threatened to become a 'major problem with the test' (Sengoopta, 2006, 281), but Crew and Wiesner made it into a major selling point. This is because doctors, not women, were the predominant diagnostic consumers. Crucially, the vast majority of women did not rely on mice or rabbits to tell them they were pregnant and those who turned to a family doctor were generally advised to wait and see. Despite the rise of antenatal care, the state kept pregnancy testing (like contraception and infertility treatment) at arm's length and was wary of tacitly sanctioning criminal abortion by making an early diagnostic service widely available. Unlike for syphilis or cervical cancer, from the state's perspective, a woman could simply wait to find out whether she was pregnant or she could pay out of pocket.[122]

In the first half of the twentieth century, new and esoteric practices, including injecting living animals with women's urine, became the norm in laboratory work. The Aschheim-Zondek reaction became a routine diagnostic tool in the period when laboratory testing became 'deeply embedded in medical culture' (Sturdy, 2011, 740). It may have been 'unwieldy' for 'regular use or mass-production' (Leavitt, 2006, 322), yet it was made practical and efficient, streamlined and scaled-up in Edinburgh and elsewhere. As I have argued in this chapter, demand for the Aschheim-Zondek test was driven less by the medicalisation of pregnancy or the managerial state than by medical entrepreneurs and diagnostic consumers, in this case women and more especially their doctors, who were increasingly willing and able to pay for laboratory services in the 1930s.

[122] On contraceptive consumers in the 1930s: Tone, 1996. On the patient-consumer in Britain: Mold, 2010, 2011, 2013.

Chapter 3. Domestic demand, diagnostic resources and 'democratisation'

In an interview with historian Margaret Deacon, the Edinburgh geneticist Hugh Donald recollected that pregnancy testing was 'a thoroughly unmentionable subject' in the 1930s.[123] In her March 1931 address on 'Birth Control and the Right to Abortion' to the Women's Ethical Union, socialist feminist Stella Browne questioned why knowledge of a 'modern biochemical technique [that] could establish the fact of impregnation at an extremely early date' was 'kept from women who needed it' (quoted in Hall, 2000, 290). Browne had particular reasons for promoting the pregnancy test. A founding member of the Abortion Law Reform Association (ALRA), she argued that abortion was a woman's 'absolute right' and should be available on request 'ideally in the first three months of pregnancy' (Brooke, 2011, 102). Her address, more broadly publicised in the Malthusian League's monthly journal, *New Generation*, argued that the Aschheim-Zondek test could potentially avert 'the weeks of anguished uncertainty so many women endured'.[124] Yet, statements by historians about the 'absence' or 'lack of' pregnancy tests in the 1930s, though technically incorrect, attest to their general invisibility and inaccessibility in this decade (Brookes, 1988, 75, McIntosh, 2000, 88, Usborne, 2007, 134, 149).

Explicit discussion of sex, pregnancy and contraception, which had been taboo before Marie Stopes's *Married love* was first published in 1918, became increasingly accessible in the interwar years (Geppert, 1998). Yet, as oral historian Kate Fisher has persuasively argued, ignorance remained 'an important identity for many; women in particular sought to preserve and maintain a state of naivety in defiance of the spread of information. Ignorance implied moral purity, innocence and respectability' (Fisher, 2006, 27). This is why the women interviewed by Simon Szreter and Kate Fisher for *Sex before the sexual revolution* 'consistently asserted that they were ignorant, while at the same time presenting details of the information they did obtain' (Szreter & Fisher, 2011, 90).

[123] According to Donald, Wiesner's work particularly contributed to the 'air of impropriety' about Crew's institute, which was reputed to be 'slightly immoral and absorbed with sex': Interview by Margaret Deacon with Prof Hugh Paterson Donald, 1908-1989 (geneticist and director Animal Breeding Research Organisation, The University of Edinburgh), Edinburgh University Science Studies Unit, 1969-1971, Institute of Animal Genetics, C1271/04/01.
[124] Hall, 2011, 178, "Miss Browne's meetings," *The New Generation*, 10, March 1931, 29.

This chapter asks what 'ordinary' women might have known about pregnancy testing in the 1930s. It investigates the available information within a public culture of sexual ignorance and silence (Leap & Hunter, 1993, 72-82, Alexander, 1996, Vincent, 1998, Szreter & Fisher, 2010, 64-65), on the one hand, and an expanding market for frank and biologically detailed knowledge about pregnancy, on the other.[125] Picking up on the discussion of advice manuals in Chapter 1, this chapter examines women's diagnostic resources (books and magazines) from the invention of the Aschheim-Zondek test to the end of World War II. It first argues that maternity experts mentioned pregnancy testing, not to encourage women to rely on the laboratory, but to discourage the use of tests as expensive and unnecessary. It then traces and attempts to explain the increasing visibility and acceptability of pregnancy testing up to the end of World War II. It does this by contextualising the available information in terms of the 1930s public debate over abortion law reform and the emphasis of wartime propaganda on pregnancy and motherhood.

3.1. Intimate narratives of pregnancy realisation

Visibly pregnant women were hidden from public view in the 1930s and the word 'pregnancy' was not mentioned in polite conversation. Popular euphemisms included 'making bread', 'a bun in the oven', 'a kick in the back', 'fallen', 'carrying', 'in the family way', 'clicked', 'caught', 'missed', 'like that', 'done up', 'up the stick' and 'up the spout'.[126] The national daily press, read by an estimated two-thirds of Britain's adult population, was socially conservative and rarely printed the word 'pregnancy'; court reports that dealt with illegitimacy or abortion would refer to 'a certain condition' (Bingham, 2009, 129). Pregnancy was 'a sackable offence' and some factories routinely sent married employees 'up to the surgery to be examined' (Glucksmann, 1990, 108). A Lincoln woman recalled, 'When you were late, you went to the doctor. They examined you inside; it wasn't nice. You always felt embarrassed' (Sutton, 1992, 57-58). Girls sometimes complained to their mothers 'of

[125] For a survey of sex manuals published between 1918 and 1972: Cook, 2004, 341-354. See also Porter & Hall, 1995.
[126] Sutton, 1992, 58. Note that, although used in Sutton's list of pregnancy euphemisms, 'clicked' was not used as a term for pregnancy by Szreter and Fisher's interviewees, but merely for 'getting off' with member of opposite sex, with or without sexual intimacy: Szreter & Fisher, 2010, 185.

morning sickness, not realizing it was a symptom of pregnancy' (Humphries, 1988, 75).

Kate Fisher asked her informants about 'the process of working out that one was pregnant', but received 'very little "narrative" as a result.' She speculates that, before World War II, many women initially 'suspected they might have been pregnant and then such suspicions grew, gradually becoming more of a certainty by the time they were 2 or 3 months into their pregnancy', perhaps earlier for those who suffered seriously from morning sickness.[127] Although first-hand accounts are scant, memoirs can provide insight into women's experience of morning sickness in the 1930s. For example, Vera Brittain acknowledged 'the malaises of pregnancy' (Brittain, 1957, 54) and Elizabeth Longford joked: 'I had morning and evening sickness, and the smell of our new distemper at the Stairways made me feel sick in the middle of the day too' (Longford, 1986, 140-141). Novels written by women can also shed light.[128]

Most fiction published between the wars was produced and consumed by women. Middle-class novelists wrote for female readers leading similarly leisured lives for whom 'novel reading was one of life's chief pleasures' (Beauman, 1983, 3). The commercialisation of publishing during the economic depression transformed novels from luxury goods into cheap commodities and mass unemployment encouraged escapist reading, which was cheaper than theatre or the cinema (McAleer, 1992). Located in most large towns, Boots and W. H. Smith provided a cheaper alternative to exclusive London libraries and the *Times* Book Club. By the mid 1930s, Boots had become the largest circulating library in Britain with over 400 branches and 500,000 subscribers; 35 million books were exchanged among Boots branches in 1939 (Beauman, 1983, 10).

Working-class novels were obsessed with the 'major traumas' of unwanted pregnancy followed by either a hasty marriage or a back-street abortion (Worpole, 1983, 99-100). The middlebrow fiction that dominated the publishing market from the 1920s to the 1950s was ambivalent about maternity, which was often 'bestowed

[127] Kate Fisher, email, 18 October 2010.
[128] For the first extended analysis of 'abortion in British literature and film, 1907-1967': Bigman, 2014.

on the most stupid and animalistic of women.'[129] Motherhood was 'frequently and fervently endorsed' in the popular light romantic fiction published by Mills & Boon (McAleer 1992, 129) and edgier women's fiction, often drawing on autobiography, portrayed 'the misery of pregnancy' with 'a new frankness' (Ingman, 1998, 16).

Rose Macaulay's terse description of Denham's morning sickness in *Crewe train* ('Denham felt, and often was, sick in the mornings') offended some readers in the 1920s. One critic complained that Macaulay had presented Denham as 'very earnestly sick in the cause of having a baby. After all some thousands of women are daily sick in the good cause, but the matter is merely one of discomfort to the person concerned.'[130] A decade later, literary representations of morning sickness had become more elaborate and less contentious. Anna Morgan, the young Caribbean heroine in Jean Rhys's *Voyage in the dark*, compares morning sickness to 'seasickness, only worse, and everything heaving up and down. And vomiting. And thinking, "It can't be that, it can't be that. Didn't I always....And besides it's never happened before. Why should it happen now?"' (Rhys, 1934, 2000, 138). When Julia Almond in F. Tennyson Jesse's *A Pin to see the peepshow* realises she is 'going to have a child', she takes 'every kind of patent medicine that urged married ladies to end irregularities and delays now' (Jesse, 1934, 273).

Naomi Mitchison's controversial novel, *We have been warned*, portrays the anxiety of a missed period as the partially shared experience of Dione and Tom, a married couple with four children:

> Like most of her married friends and contemporaries, Dione would occasionally have two or three days of anxiety, sometimes acute and very oppressive. It was hard to do anything requiring intelligence with that hanging over one; it was difficult not to be cross and snap at Tom and the children. Tom, nearly as well aware of her times as she was, would usually share her anxiety towards the end, but not so immediately or continuously. This time it was five days late. She had already tried a large dose of castor oil; vague pains had resulted, but now she was feeling dreadfully well again. 'Perhaps it's this cold weather coming so suddenly

[129] Humble, 2001, 222. On middlebrow literary cultures: Brown & Grover, 2012.
[130] Braybrooke, 1927, 46. See also Bensen, 1969, 98, Passty, 1988, 14-15, Beauman, 1983, 155.

> after January being so warm,' suggested Tom, more to cheer her up than because he thought so. They were sitting in her bedroom before dinner. He had just come back from college hoping to find she had started while he'd been away at work, and would now be feeling happier. But no such luck.[131]

Having experienced pregnancy before, Dione's wishful denial finally breaks down when she begins to 'feel absolutely definite signs of *malaise*, a dislike of certain foods, all the old things'. She then admits to herself and to Tom that 'the little wretch has taken root in me and it's so tough that it won't move for quinine and stuff. It's got the will to live.' Determined not to have another child, she makes arrangements to terminate the pregnancy in Paris and meanwhile busies herself with 'a good deal of heavy digging in the garden', hoping to 'bring it on' (Mitchison 1935, 492).

An older married friend guesses that Olivia is pregnant in *Jew boy*, Simon Blumenfeld's provocatively titled novel about working-class life in Whitechapel. When Olivia complains that she feels 'a bit sickish', Ettie reminds her that she had been sick 'yesterday morning as well...' and wonders if she has 'Any idea what it could be?' Olivia suggests it is something she has eaten, but Ettie leans in and whispers, '...Sure you haven't clicked?' Olive smiles and shakes her head, 'No it couldn't be that.' But reckoning up quickly, she realises she is 'a few days late!' Ettie reassures her that a couple of days is 'nothing! Might be something you've eaten after all!' In the next few weeks Olivia wishfully tells herself: 'Maybe it was a false alarm', but the nausea returns to finally convince her: 'Sick again. Sick again. I'm for it all right!' Olivia takes hot plunges in public baths, walks to work, runs up and down stairs, lifts heavy weights, and doses herself with Epsom salts, until desperately turning to Ettie to help her 'get rid of it somehow!'[132]

Olivia Curtis, the déclassée heroine of Rosamond Lehmann's *The weather in the streets* begins to worry as soon as she is a few days late:

> I was happy...till I got worried. Even after that of course; because, of course, there's no need to worry. Six, seven days late...I'm worried. But it's happened

[131] Mitchison, 1935, 487. See also Mitchison, 1979, 14.
[132] Blumenfeld, 1935, 200-203.

> once before, the first year Ivor and I were married; over a week then, I was beginning to be sure—but it was a false alarm....That was in August too—so I expect it's the time of year, I'm sure I've heard it does happen sometimes; or all that long cold bathing, lake water's very cold, that might easily account for it...I'm worried. Falling for one, Mrs. Banks calls it. 'When I fell for our Doris...' I feel a bit sick. Train-sick, I expect. I've never been train-sick in my life. This morning when I got up, suddenly retching as I began to wash....Nerves. Lying down like this I feel fine. Be all right tomorrow. Sleep. Thank God for lying down, a sleeper to myself. Supposing I'm sick when I get up to-morrow....That would clinch it. No, it wouldn't. A long journey like this often upsets people.'[133]

Olivia's pregnancy wasn't planned and her reaction to amenorrhea and nausea is profoundly ambivalent. She recognises the telltale signs for what they are and at the same time rationalises them away in terms of the weather and train sickness. A *Times* review that mentioned Olivia's abortion described the novel not as provocative but as 'completely typical of the day'.[134]

Nancy Mitchell, the poor wife of an unemployed clerk in Winifred Holtby's *South Riding* realises to her dismay that she is 'pregnant again' and briefly contemplates '[taking] things for it' or going to the Kingsport women who 'did things'. Having read the 'police-court cases reported in the papers', however, she is deterred by the prospect of a shamefully public inquest and so decides to keep the baby (Holtby, 1936, 238). When Gordon Comstock, the chronically underemployed poet of George Orwell's *Keep the aspidistra flying*,[135] learns that his girlfriend, Rosemary, is 'going to have a baby', he asks the 'usual fatuous question: "Are you sure?"' She replies, '"Absolutely. It's been weeks now. If you knew the time I've had! I kept hoping and hoping—I took some pills—oh, it was too beastly!"' (Orwell, 1936, 251). For Rosemary, certainty is achieved, not with a positive test result, but when the abortifacients she took fail to have their desired effect. They decide to get married

[133] Lehmann, 1936, 228-29, original ellipses.
[134] 'New novels', *The Times*, 7 July 1936, 11.
[135] Although there is no direct evidence and the jury is still out, it is tempting, especially considering the reproductive subject matter of the novel, to interpret the surname 'Comstock' as an oblique reference to Anthony Comstock, the American postal inspector whose infamous 'Comstock Law' prohibited trade in obscenities, including contraceptive devices and information (Rodden & Rossi, 2012, 39; Colls, 2013, 247n119). On Anthony Comstock: Tone, 2001.

and keep the baby and the novel closes with the hopeful moment of quickening. 'I felt it move!' she exclaims as Gordon kneels to press his ear to her belly, but it is too early to hear anything: '*You* can hear it at seven months, *I* can feel it at four. I think that's how it is', she explains. Yet they both know that, 'Somewhere in there, in the safe, warm, cushioned darkness, it was alive and stirring' (Orwell, 1936, 277).

In Christopher Isherwood's novella *Sally Bowles*, the eponymous fictional character based on the British actress and writer Jean Ross, Isherwood's flatmate in Berlin, is 'curled up on the sofa' and 'thoughtfully smoking' when she suddenly wonders aloud if she is 'going to have a baby.' When Christopher asks, 'Do you really think you are?' Sally's ambivalent answer is: 'I don't know. With me it's so difficult to tell: I'm so irregular...I've felt sick sometimes. It's probably something I've eaten....' He suggests she should see a doctor, but Sally is in 'no hurry' (Isherwood, 1937, 45). Based on the author's experience as a trainee nurse at an Oxford infirmary (Sweetman, 1993, Zilboorg, 2001), Vivian, the overworked heroine of Mary Renault's *Purposes of love*, completely loses track of her menstrual cycle. Only when a colleague asks 'a few questions about her general condition: including one which, in the stress of hard work and worry, she had quite forgotten lately to ask herself', does she realise that she is probably pregnant. When a friend asks if she is sure, Vivian's equivocal response is, 'How can one be sure? It's probably only because I'm tired or ill or something. I'd forgotten till today. But I daren't risk it any longer. It's the third week now' (Renault, 1939, 165-66).

Philip Meyer, the self-consciously Jewish protagonist of Pamela Frankau's *The devil we know* (1939), asks his friend Sally Fisher if she is 'sure' she is pregnant: 'People can make mistakes about that, can't they?' But it has already been two months and she has already tried 'taking things' purchased from a Charing Cross Road chemist (they weren't 'any good'). Later, when she opts for marriage over abortion, the fetus is consolidated as 'a baby; not a thing to get rid of. I was being sorry for it all the time' (Frankau 1939, 197). One reviewer in Scotland praised Frankau's 'smooth and polished' 'modern' prose, but complained that she dealt 'too frankly with unpleasant subjects, and the discussion, in particular, on how a young woman is to evade the

effects of her misdeeds might very well have been left out, even if it does show up the Jew as ready to help a friend in distress.'[136]

The characters in these novels, several of which are semi-autobiographical, are often portrayed as understanding all too well that a missed period and morning sickness are likely signs of pregnancy, even when they wishfully blame the weather, train sickness, or something they have eaten. But this knowledge does not deter them from 'taking things' to 'bring it on' or to 'get rid of it'. Fictional representations of menstrual regulation support Kate Fisher's argument, based on oral-history interviews, that despite the euphemistic language that shrouded pregnancy and abortion, some women 'also took abortifacients when it was clear that they were actually pregnant and they did not ignore the realities of what they were doing' (Fisher, 1998, 35). Fictional pregnancies in the 1930s did not begin with quickening or a positive Aschheim-Zondek test result, but rather with a missed period, morning sickness and, above all, the failure of abortifacients to take effect.

3.2. 'Is there a baby on the way?'

As more women took on traditionally masculine roles, newspaper articles, many written by female journalists, increasingly discussed women's greater prominence in modern society and public culture. The new image of woman as citizen and mother, wage earner and wife, reflected the increased presence of (unmarried) women in the workforce, suffrage reforms, ascendant consumer culture and the mainstreaming of psychoanalysis and sexology (Hackney, 2002, 115-116). Women's magazines traditionally focused on society and fashion, but in the interwar years they expanded their remit to embrace practical domestic advice. The Hearst Corporation launched Britain's first 'service' magazine in March 1922. Priced at one shilling, the British version of *Good housekeeping* offered practical domestic and consumer advice to middle-class households with an annual budget of at least £1,000. It soon attained a circulation of 150,000 and a single (monthly) issue might contain up to 100 pages of advertisements. Rival houses targeted families earning less than £500 a year by

[136] 'A sensitive Jew', *The Inverness Courier*, 10 January 1939, 3.

launching downmarket versions for sixpence an issue (Barrell & Braithwaite, 1988, 13, Hackney, 2002, 117-118).

The industry changed significantly in 1932 when Newnes launched *Woman's own*, the first mass-circulation weekly women's magazine. Priced at twopence, it established a winning formula that was soon emulated by Amalgamated Press's *Woman's illustrated* (1936) and Odhams's *Woman* (1937).[137] In 1937 Odhams first used photogravure to rapidly produce large runs of *Woman*, a full-colour illustrated magazine priced to compete with the black-and-white letterpress weeklies. A game changer, *Woman* made competitors look drab and captured a mass market almost on a par with newspapers. By the end of the decade there were over fifty titles, several of them printed in runs of hundreds of thousands. The relatively niche *Mother* (1936) sold 115,000 every month by 1939 and *Woman*, the leader of the pack, over one million copies weekly in 1940.[138]

Woman's own soon replaced its childcare advice page, 'written by the unscientific' "Mumsie"' with 'the more professional-sounding Nurse Vincent' and, in 1934, launched Nurse Vincent's 'Baby Circle': for a shilling members were sent two exclusive booklets promoting motherhood and Infant Welfare Centres' (Greenfield & Reid, 1998, 170). Women from diverse backgrounds purchased and read these magazines, especially the problem pages, not only for diversion and entertainment, but also as a valuable source of information that was unavailable elsewhere. Though largely silent on sex and contraception (Porter & Hall, 1995, 265), maternity experts writing in the new women's magazines often supplied detailed information on early pregnancy diagnosis in response to letters attributed to readers who inquired directly about 'the first signs of motherhood'.[139] Whether genuine, edited, or even fabricated, these exchanges were well placed to mediate how women experienced and interpreted the uncertain and ambiguous physical changes in their own potentially pregnant bodies (**figure 3.1**).[140]

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[137] *Women's own* innovatively coordinated its commercial and editorial messages about domesticity, motherhood and shopping: Greenfield & Reid, 1998, 161.
[138] On women's magazines in Britain: White, 1970, Tinkler, 1995, Barrell & Braithwaite, 1998, Greenfield & Reid, 1998, Hackney, 2007, 2008, 2010.
[139] *Woman's illustrated*, 21 August 1937, 16, 26 September, 1937, 26.
[140] Newspapers invested considerable resources in responding to hundreds of real letters every week: Bingham, 2012, 52.

Figure 3.1. Left: the iconic stork remained symbolic of pregnancy for 'Mumsie' (*Woman's own*, 15 October 1932, 30). Right: an anonymous doctor reading letters sent to the 'Questions You Ask Our Doctor' page of *Woman's own* (11 November 1933, 138).

Mother's maternity expert Nurse Crawford cautioned that it was 'not always possible to be certain that Baby is on his way until there have been two months without a period, and by that time there should be other signs of pregnancy.'[141] However, even for a knowledgeable woman attuned to her menstrual cycle, disruptions caused by anaemia, breastfeeding, or menopause could confound self-diagnosis. A middle-aged Hull mother, whose youngest child was sixteen, confided to *Woman's own* that her own 'irregular menstruation' caused her to suspect that she 'might again be pregnant.' The magazine's medical adviser reassured her that she was not pregnant and instead recommended hormone tablets for menopausal symptoms.[142] One request for information about 'the first signs of pregnancy' came from a woman whose legs

[141] *Mother*, May 1938, 40.
[142] *Woman's own*, 11 November 1933, 138. On hormone replacement therapy in menopause: Watkins, 2007.

had been 'rather puffy' for a couple of days.[143] A breastfeeding woman wanted to know if she was pregnant again so that she could start weaning her firstborn, but was 'not quite sure' how to 'tell for certain'.[144] Another anxiously breastfeeding woman asked, 'When do periods normally return?' Nurse Crawford explained that conception could happen at any time unless reliable contraceptives were used.[145]

Bleeding in pregnancy or while breastfeeding sometimes caused anxiety. One reader who suspected pregnancy despite the persistence of menstruation asked whether 'any other signs' could confirm her suspicion. Nurse Crawford explained menstruation in pregnancy as 'nature's warning that [a pregnant woman's] muscles are not as strong as they should be' and recommended medical treatment to prevent miscarriage.[146] 'Is there any way in which I can tell if I am pregnant?' asked a mother who had menstruated twice since the birth of her baby Pamela, but not after that. She had no other signs of pregnancy, but intended to wean Pamela if another baby was on the way.[147] This time Nurse Crawford suggested that her 'periods' might have been residual bleeding from childbirth and advised her to see a doctor 'if only to ease your mind.'[148]

[143] *Mother*, December 1936, 53.
[144] *Mother*, September 1939, 36-37.
[145] *Mother*, October 1937, 55.
[146] *Mother*, March 1938, 54.
[147] *Mother*, June 1938, 49.
[148] *Mother*, September 1939, 36-37.

IS THERE A BABY ON THE WAY?

Nurse Agnes Patterson, S.C.M., has some wise advice to give prospective mothers this week. Please don't hesitate to ask her any little baby or personal hygiene problem, for she loves to help you. Send your letters, with a stamped, addressed envelope, to Nurse Patterson, c/o "Woman's Illustrated," The Fleetway House, Farringdon Street, London, E.C.4.

MANY a young wife faced with this question is probably too shy to discuss the matter with a friend, and will not consult a doctor until more proof is forthcoming. Actually there are no definite signs of pregnancy. Cessation of menstruation usually takes place, but this may also be due to anæmia or other reasons. But when that slight swelling and perhaps tenderness of the breasts and a frequent desire to pass urine is present, one wonders if Baby has started on his journey.

Producing an infant is a perfectly normal state of affairs, and an expectant mother should be in no way an invalid. She may suffer from temporary minor discomforts such as sickness in the morning, heartburn and constipation, all of which are experienced by many women, but can be and should be remedied by suitable treatment. Later on there may be a certain amount of backache; but this, too, can be relieved by the wearing of a properly fitting maternity belt to give the necessary support.

When the second period time has passed without result, a doctor should be consulted. In most districts are doctors who specialise in maternity work, and it is much happier from every point of view to engage a man or woman who enjoys the work and who is skilled. If one is a stranger to a district, a chat with the superintendent at the nearest infant welfare centre or ante-natal clinic will usually bring forth the names and addresses of the most successful doctors and nurses in the neighbourhood.

It is not because the expectant mother needs special care that she is advised to see her doctor or midwife early. But by a periodical chat with the person in charge of the case a friendship is established which considerably helps when the time for Baby's birth arrives.

At the first interview with the doctor various questions as to past medical history are asked, the answers to which help the physician to decide whether any one part of the maternal machinery needs assistance. For instance, if the expectant mother has suffered from anæmia, medicine containing iron and a diet rich in iron is prescribed, that Baby may stock his own larder instead of delving into his mother's.

A baby takes forty weeks to develop, and to estimate the approximate date of the birth we count forward nine months

(Continued on next page.)

Figure 3.2. This typical headline shows that women's magazines took seriously women's anxieties about the early signs of pregnancy (*Woman's Illustrated*, 6 February 1937, 45).

Advice columns frequently reminded women that it was not 'fussy' to see a doctor in the 'months of waiting', a pattern that suggests many expectant mothers shared this concern. *Woman*'s 'Questions Mothers Ask' page advised one reader who was two months overdue to visit her doctor even if she was feeling 'quite well'. Nurse Agnes Patterson testified to the social awkwardness of pregnancy diagnosis when she observed in *Woman's illustrated* that many young wives were 'probably too shy to discuss the matter with a friend, and will not consult a doctor until more proof is forthcoming.' She advised the expectant mother to see a doctor or midwife after two missed periods, not because she needed 'special care', but rather in order to establish a friendly rapport with the professional who would eventually attend to her confinement (**figure 3.2**).[149] This was not 'fussy', but 'simply a matter of routine'.[150] Although quickening occurred relatively late in pregnancy and so was not considered much use as an early sign, its absence could be a source of anxiety. *Woman's*

[149] *Woman's Illustrated*, 6 February 1937, 45.
[150] *Woman's Illustrated*, 17 July 1937, 20

illustrated published a letter from a 'very worried' woman whose baby was due in four months, but had 'not yet felt any movements.' Her doctor had reassured her that everything was fine, yet she still anxiously turned to the magazine's 'baby expert', Mrs Ruth Best, who advised her to trust her doctor: 'movements are not felt at all until well into the fifth month, and often later, so you have no cause for alarm.'[151] A similarly concerned woman, 'nearly five months on the way', wrote to *Woman* that she had 'not yet felt any movements' and was advised that a doctor would be able to ease her mind 'by listening to Baby's heart.'[152]

Women's pages in newspapers were dominated by housewifery and articles on motherhood typically discussed child psychology and childhood education, rather than pregnancy management (Hackney, 2002, 115-116, Bingham, 2004, 102-105). The word 'pregnancy' was rarely printed and court reports that dealt with illegitimacy or abortion would refer instead to 'a certain condition' (Bingham, 2009, 129). The national daily press, read by an estimated two-thirds of Britain's adult population, remained socially conservative in the 1930s and was 'very reluctant' to publish details on the biological aspects of sex or reproduction. Following the lead of *News of the world*, the mass-circulation dailies began printing sexy pictures of semi-nude young women, but rarely discussed potentially educational matters such as contraception and venereal disease (Bingham, 2004, 178). Designed to appeal to a mixed audience of young and old readers of both sexes, newspapers did so very little to alleviate ignorance about the female body.

Despite this policy of self-censorship, it was occasionally difficult for journalists to avoid mentioning the Aschheim-Zondek test in connection to other news items. When the test inescapably came up in connection to another story, the opportunity to discuss its significance was consistently passed up. When Francis Crew's department of animal genetics was opened in June 1930, Sir Edward Sharpey- Schafer's address described 'the Zondek-Aschheim test for pregnancy' in some detail and blamed antivivisectionists for the fact that one departmental laboratory diverted resources intended for research to 'a routine method of diagnosis which might as well be done anywhere else' (Sharpey-Schafer, 1930, 31). A lengthy article in the *Scotsman*

[151] *Woman's illustrated*, 17 April 1937, 46.
[152] *Woman*, 9 July 1938, 41.

mentioned the 'method of testing for pregnancy', but emphasised the 'professor's defence of vivisection.'[153] Less extensive coverage in the *Times* and other papers focused exclusively on the vivisection angle, to the exclusion of the pregnancy test.[154]

When Bernhard Zondek was dismissed from his Berlin post in 1933, twenty British scientists, including Crew and Huxley, signed a letter to the *Times* encouraging Britain to welcome Germany's Jewish scientists; they obliquely explained that Zondek's 'contributions to sex physiology' had 'banished' the 'anxieties' of 'countless sufferers'.[155] In 1934, some months after Zondek had been hired by the Manchester Jewish hospital, the *Guardian* described him as 'the celebrated gynaecologist responsible with Asc[h]heim in Germany for the famous 'Asch[h]eim-Zondek' test, but did not say what the test was for.[156]

In 1937 Dr Ivor Beaumont of the *Daily Mirror* advised worried first-time mothers to put their 'whole pregnancy under the supervision of experts and leave any worrying to them,' but elided the diagnostic process: 'You realised you were going to have a baby. The realisation frightened you.'[157] The pregnancy test was infrequently mentioned in newspaper coverage of the famous 1938 trial of gynaecologist Aleck Bourne, a landmark in abortion law reform known as the 'Horse Guard case.'[158] The *Daily Telegraph* and *Hull Daily Mail* quoted Bourne in an interview with two Scotland Yard detectives on the day of the operation as having said: 'The girl was brought to me by her mother to my house at Wimpole-street on May 31. She was admitted to St. Mary's Hospital and placed in my ward, under my care, on June 4 or thereabouts. Since then she has been waiting for a pregnancy test, which was positive.'[159] The *Times* acknowledged that, in light of the 1929 Infant Life (Preservation) Act, it was crucial that Bourne had operated on 'a girl in the earliest

[153] Professor's defence of vivisection', *Scotsman*, 1 July, 6.
[154] 'Defence of vivisection', *Times*, 1 July 1930, 18. On the public debate over vivisection in the late 1920s: Tansey, 1994.
[155] 'Jews in Germany', *Times*, 26 April 1933, 12.
[156] 'A Jewish token of gratitude The Victoria Memorial Hospital: year of 'tremendous progress', *Manchester guardian*, 22 January 1934, 11. See also: 'Manchester Jewish Hospital New Appointments', *Manchester Guardian*, 30 September 1933, 13, 'The Zondek Brothers', *Manchester guardian*, 10 July 1934, 10. The Nobel Committee judged Aschheim and Zondek 'prizeworthy' in 1931, 1932, 1934 and 1936, but they were passed over each time (Björk, 2001, 399).
[157] *The Daily Mirror*, 1 December 1937, 27.
[158] Keown 1988, 49-59, Brookes & Roth, 1994.
[159] 'Surgeon who "deliberately defied the law"', *Daily Telegraph*, 2 July 1938, 'Surgeon for Trial', *Hull Daily Mail*, 1 July 1938, 14.

stages of pregnancy', but did not link this to his use of the test.[160] Behind the scenes, Sir Bernard Spilsbury used up-to-date obstetrics textbooks to verify the existence of 'a test which can be made with the patient's urine, the Aschheim Zonde[k] or the Friedman test, which is claimed to be very reliable and which enables pregnancy to be diagnosed about a fortnight after its commencement', suggesting that even the famous forensic pathologist was unaware of the test.[161]

3.3. Subordinating a new technology to self-diagnosis

A little-studied genre of encyclopaedic domestic health manuals aimed at young married women and first-time mothers flourished in the 1930s. Roy Porter and Lesley Hall's landmark study of sexual knowledge understandably focused on 'the most prominent' titles from *Aristotle's masterpiece* to *Married love* (Porter & Hall, 1995, 5), and Hera Cook included 'only a small number of health guides and encyclopedias' in her analysis of sex and marriage manuals (Cook, 2004, 342). Though their foremost stated aim was to prepare women for pregnancy and motherhood, historians have emphasised the sexual and contraceptive knowledge they contained. Not merely a respectable camouflage for more risqué topics, though they were that too, advice manuals promised to deliver up-to-date scientific information to hopefully expectant mothers about their own changing bodies (Mechling 1975, Brown, 2003, Sauerteig, 2009, Seaman, 2011, Seigel, 2014).

Many public libraries refrained from stocking 'indecent' books and some London bookstores would only sell to a doctor or medical student, so publication did not guarantee availability (Porter & Hall, 1995, 259-260). Cheap mail-order services became an important means of conveying information to wives and mothers in a rapidly expanding network of women's magazines, mothercraft centres, antenatal clinics and baby clubs.[162] For women who were too embarrassed or otherwise reluctant to visit a doctor, the post office offered an attractively anonymous means of obtaining the up-to-date knowledge required of modern motherhood (**figure 3.3**). As

[160] 'Surgeon found "not guilty"', *Times*, 20 July 1938, 9.
[161] Sir Bernard Spilsbury, 'Rex v. Dr. Bourne. Report. Respecting the Diagnosis of Early Pregnancy', 16 July 1938, DPP 2/564. On Spilsbury: Burney & Pemberton, 2011.
[162] On the importance of gay-oriented mail order catalogues in the 1960s: Johnson, 2010. On mail order retailing in Britain: Coopey et al., 1999, 2005.

literacy improved and books became cheaper, more and more Britons learned about sex, contraception, pregnancy, childbirth and mothercraft by reading. Truby King and Grantly Dick-Read became (middle-class) household names.[163] Some mothers bought their daughters a 'doctor's book' in preparation for marriage (Porter & Hall, 1995) while boarding-school girls from bookish homes surreptitiously looked up 'confinement', 'miscarriage', 'after-birth', 'puberty', 'menses' and 'life, change of' in health guides and encyclopaedias (Rose, 2010, 214).

Figure 3.3. A typical advertisement for a 'home doctor' book in the magazine *Woman* (21 January 1939, 38-39).

Available to *Women's own* readers for gift stamps and a postal order, John Dixon Comrie's *Woman's own home doctor* dispelled the 'popular' misapprehensions that breastfeeding prevented pregnancy and that quickening meant the child had come to life.[164] Comrie, an Edinburgh physician and medical historian, considered the canonical signs to be 'important', but singled out the fetal heartbeat as the 'only

[163] Davin, 1978, 47-48, Hardyment, 1983, 167-179, Thomas, 1997, Raphael, 2010, McIntosh, 2012, 60, Davis, 2012, 115-119.

[164] See the papers of John Dixon Comrie (1875-1939), GB 0120 MSS.1776-1778, Wellcome Library.

absolutely certain sign of pregnancy' (Comrie, 1931, 292). The Amalgamated Press's *Concise home doctor* informed readers that only 'a physical internal examination' could definitely confirm or rule out pregnancy.[165] Dr Gladys M. Cox's *Woman's book of health*, portrayed amenorrhea as 'very suggestive' but 'not conclusive' and cautioned that first-time mothers were apt to mistake quickening for 'the colicky movements of the bowel'. Cox, a medical officer to the Walworth and East London birth control clinics, advised the reader to 'place herself in the care of a doctor or qualified midwife as soon as she realises that she is pregnant' (Cox, 1933, 292). Odham's *Universal home doctor illustrated* listed the conventional signs and also warned of 'danger signals' including bleeding, fits and the cessation of fetal movements in the womb, which required immediate medical attention.[166]

In *Why be childless?* (1929), Mrs Cicely Quicke Erskine, a controversial proponent of prenatal sex determination and wife of the independent conservative politician Sir James Monteith Erskine, claimed that some women suspected pregnancy immediately after conception while others remained unaware until after quickening. She dismissed the view that there was 'more "*life*" at quickening' than at conception (Erskine, 1929, 131). In *The ideal management of pregnancy*, natural childbirth advocate Dr Cyril Pink portrayed self-diagnosis in terms of the feeling of 'malaise' coupled with the 'shock' that the routine of menstruation 'has been suddenly broken' (Pink, 1930, 13-14). Neither book mentioned the recently invented Aschheim-Zondek test. From the mid 1930s, however, domestic health manuals began mentioning the test. But they did so less to promote the diagnostic laboratory, than to subordinate it to established methods of self-diagnosis.

In *Every woman's home doctor* (1934), the London physician and founder of the New Health Society, Sir William Arbuthnot Lane, mentioned 'a special examination of the urine' that would settle 'the question with great accuracy', but also presented the 'conjunction' of amenorrhoea with morning sickness as 'an almost certain indication' of pregnancy.[167] Herbert Meredith's *The modern home doctor* revealed that pregnancy could be diagnosed 'as early as the third week [...] by means of an

[165] *The concise home doctor* (London: Amalgamated Press, 1932), 1055-1056.
[166] *The universal home doctor illustrated* (London: Odhams Press, 1934), 567.
[167] Arbuthnot Lane, 1934, 490. On Arbuthnot Lane's New Health Society, which blamed constipation for the crisis of civilisation: Zweiniger-Bargielowska, 2005, 2007.

examination of the urine,' but similarly presented the conventional signs as 'quite sufficient to justify a positive diagnosis' (Meredith, 1935, 350). Waverley's *The new people's physician*, edited by the medical writer Dr Douglas Hay Scott and his assistant Dorothy Allmand, mentioned the test, but placed greater emphasis on the ability of a 'skilled observer' to feel the position of the unborn child's head, perceive its movements within the womb and eventually detect its heartbeat. Scott instructed the 'average laywoman' to see a doctor 'as soon as pregnancy is discovered (and the earlier the better) [...] After that, the expectant mother need not worry too much about her signs and symptoms' (Scott, 1936, 2135-2137).

British books on the science of sex and reproduction marketed as 'popular' were no more informative on pregnancy testing than 'home doctor' books. Julian Huxley, H. G. Wells and his son, G. P. Wells, did not mention the Aschheim-Zondek test in *Reproduction, heredity and the development of sex* (1935), the fourth volume in their successful 'Science of life' series, and neither did Crew in his own general-interest books on sex and reproductive.[168] Crew gave several BBC radio talks on heredity, eugenics and the 'rights of the unborn' in the 1930s, but kept silent about pregnancy testing.[169] Even Wiesner mentioned the test only in passing in *Sex* (1936), his contribution to Thornton Butterworth's Home University Library.[170] British readers were somewhat more likely to discover a detailed explanation of the Aschheim-Zondek test in books written by American authors or translated from German.

Stella Browne's translation of Theodoor Hendrik van de Velde's *Fertility and sterility in marriage*, published by Heinemann in 1931, described the test in a technically dense appendix to a chapter on reproductive physiology; the Dutch gynaecologist maintained that most women would in any case feel pregnant 'from the moment that the fruit has taken root—or adhered.'[171] The imaginary pupil in the

[168] Wells et al., 1935, Crew 1931, 1932, 1933. See also Bowler, 2006, 173, 2009, 106.
[169] Crew 1930, 1939. The BBC 'established itself as an essential feature of everyday life' in the 1930s: Nicholas, 1995, 247. For a history of science on the air: LaFollette, 2008.
[170] 'Administration of [pregnant women's urine] to immature mice results in [...] changes which can be readily recognized and allow the rapid diagnosis of pregnancy during very early stages' (Wiesner, 1936, 62). On Butterworth's library, which was taken over by Oxford University Press in 1940, and other publishers' series: Bowler, 2009, 114-142.
[171] Van de Velde, 1931, 133, 283-285. The English edition of *Ideal marriage*, published by Heinemann in 1930, 'went through 43 printings and sold some 700,000 copies': Bullough, 1994, 601. See also Melody & Peterson, 1995. On Heinemann: St John, 1990.

leftwing zoologist Curt Thesing's *Schule der Biologie* (1934) had 'read somewhere that by the use of hormones it is possible to ascertain earlier than in any other way whether a woman is pregnant or not.'[172] Translated by the socialist physician Eden Paul and his wife, the singer and journalist Cedar Paul (née Gertrude Mary Davenport), Routledge published *School of biology* in 1935.[173] An anonymous reviewer complained in *The listener* that the 'popular book on biology' had 'suffered in translation' and that 'the Aschheim-Zondek pregnancy test' was 'rightly described' and 'wrongly explained' in 'the same paragraph.'[174] Dr Edward Griffith's *The childless family: its cause and cure* (1939) unreservedly endorsed the 'extremely reliable', 'very useful' and 'cheap and easy to perform' test in connection with infertility treatment. A Harley Street physician and pioneer of sex education and marriage counselling, Griffith was personally acquainted with Wiesner and recommended the test, not for pregnancy diagnosis in normal healthy women, but to help doctors decide whether to administer hormone injections to prevent a likely miscarriage (Griffith, 1939, 98-99).

The small amount of space devoted to pregnancy testing in these books and, occasionally, in reviews, would have been easily missed by all but the most attentive reader. A far more extensive discussion of the Aschheim-Zondek test was to be found in the Left Book Club edition of Drs Hannah and Abraham Stone's *A marriage manual: a practical guide to sex and marriage* (1936). The Stones' structured their marriage manual, first published in New York by Simon and Schuster, as a series of questions and answers between patient and doctor. Allies of Margaret Sanger and pioneers of family planning in their own right, the Stones revealed that the test had been invented by 'two German physicians' and involved injecting a patient's urine into 'a young female mouse or rabbit.' The Stones argued that women were neither 'emotionally nor physically' aware of the early stages of pregnancy and, although

[172] On socialist 'popular' science in Weimar Germany: Hopwood, 1996.
[173] On the Pauls' socialist eugenics: Mazumdar, 1992, 178, 305n99. See also Paul, 1984, 1988.
[174] 'The Listener's Book Chronicle', *The listener*, 19 June 1935, 1068. In addition to *Radio Times*, 'the BBC's official popular weekly programme magazine', from 1929 to 1990, the BBC also published *The listener*, 'a serious weekly journal designed to support the broadcasts by publishing some of the talks, together with regular views and other articles on music, literature and science' (Kavanagh, 1999, 83-84).

they considered the test to be 95% accurate, they cautioned that it was 'not infallible' and should be considered only in relation to other signs.[175]

As late as 1939 it was still possible to dispense pregnancy diagnosis advice without mentioning or endorsing the laboratory test. For instance, the paediatrician and general practitioner Dr Lindsey Batten's *The single-handed mother* simply advised readers to see a doctor 'early in pregnancy—as soon as two periods have been missed, if not before—to confirm, as far as may be, the fact that a child has been conceived' (Batten, 1939, 21). Pink's *The foundations of motherhood* (1941) acknowledged that in 'recent years a certain laboratory test has been devised which involves the use and eventual killing of guinea-pigs'. But, according to Pink, some doctors preferred an 'electrical test' relying on a modified version of Albert Abrams's 'box' or 'oscilloclast', and most women were in any case satisfied with their doctor's ability 'to diagnose pregnancy at a very early stage by mere examination.'[176] Pink was a theosophist, vegetarian and antivivisectionist (Moscucci, 2003, 170), so his preference for electrical diagnosis over animal dissection almost certainly reflects his decidedly marginal allegiances. In any case, most authors did not present Aschheim and Zondek's bioassay or Abrams's box as particularly necessary or desirable accessories of early pregnancy diagnosis.

3.4. Abortifacients and 'democratisation'

Anxiety over the incidence of criminal abortion increased dramatically in the mid 1930s when it was considered to be a significant cause of the perceived rise in maternal mortality, especially among the poor (Fisher, 2006). The National Council of Women demanded a government inquiry into abortion in 1936 and a Ministry of Health report on maternal mortality in 1937 resulted in the establishment of an interdepartmental committee on abortion by the Home Office and Ministry of Health known as the 'Birkett committee' (Lewis, 1980, 209, Brooke, 2011, 95). Francis Crew was invited to submit a memorandum and, in June 1938, he appeared before the committee to answer questions about pregnancy testing. He had previously argued in

[175] Stone & Stone, 1936, 116-117. On Victor Gollancz and the Left Book Club: Samuels, 1966, Neavill, 1971.
[176] Pink, 1941, 3. On Abrams's controversial method of electrical diagnosis: Lawrence, 1999, 19-21.

a prestigious American journal that the Aschheim-Zondek test could be mobilised by the state in the struggle against the falling birth rate and the 'dwindling' population: the Edinburgh station operated on a large enough scale to offer 'graded fees that would make the tests available for all, irrespective of income category, and, at the same time, accumulate data sufficient for profitable analysis' (Crew, 1937, 989). Now that he had the attention of the state, Crew promoted the expansion of pregnancy diagnosis services in the 1930s language of 'democratisation.'[177]

According to Crew, laboratory pregnancy tests were performed 'only for a very small proportion' of those who could benefit from them; they had 'not been properly democratised'.[178] Ideally, the service would be available to every woman 'when pregnancy is first suspected'. He recommended the establishment of specialised laboratories 'in every large medical area' that would deal exclusively 'with pregnancy diagnosis and the quantitative estimation of the sex hormones'. Only by testing at least fifty specimens every day could a laboratory technician acquire the 'necessary skill' to interpret 'the different grades of reactions, relating these to the different clinical conditions.'[179] Once pregnancy diagnosis had been sufficiently 'democratised', doctors would be able to distinguish patients who were 'likely to [spontaneously] abort' from those who were not.[180] 'We in Edinburgh started it', Crew boasted to the committee. The famous test had been 'elaborated and exploited and democratised' in Edinburgh first. Nearly a decade later, he estimated that an additional 2,000 specimens every year were tested in laboratories around Britain in addition to the 9,000 processed in Edinburgh. For Crew this was 'an entirely desirable democratisation' that justified his own initiative. Expansion demonstrated the existence of an unmet need for pregnancy tests, which were still not 'placed at the disposal of all those who could profit from them.'[181]

Lady Ruth Balfour, who had studied medicine at Newnham College, Cambridge, and worked in biochemistry research at the Lister Institute, asked about the cost of

[177] On democratisation as a 1930s concern: LeMahieu, 1988, Hilliard, 2006.
[178] 'Memorandum of Professor Crew', AC Paper 138, MH 71/26.
[179] Ibid.
[180] In the 1930s, the word 'abortion' was used interchangeably to refer to 'spontaneous' and 'induced' miscarriage. See Elliot, 2014.
[181] 'Evidence of Professor F. A. E. Crew', MH 71/27.

expansion.[182] Crew contrasted the 'considerable' running cost of a small-scale laboratory, which would need to charge at least one guinea per test, to a large-scale operation such as the one in Edinburgh, which was able to reduce the cost to around three shillings per test. Crew argued that the provision of pregnancy tests should be 'a State affair,' until it was superseded by a more efficient 'chemical test' that did not require signing a Home Office license 'for 56,000 animals a year.'[183] Sir Comyns Berkley, an obstetrician at Middlesex Hospital, asked if the urine of an apparently healthy pregnant patient would reveal whether she was 'likely to abort?' and Lady Juliet Rhys-Williams, a writer and Liberal politician, asked whether an expanded service would prevent abortions. Crew estimated that his service had prevented around fifty abortions in the past year because it had put doctors in a better position to treat pregnant patients. A weakly positive reaction could indicate a 'pregnancy in which danger exists, and that is very common.' Crew did not, however, supply advice on hormone therapy, which was 'conducted according to the doctor's own ideas'. Hormone testing could be extended until 'the danger period' was over, but after the fourth month there was 'no point' in continuing.[184]

Crew raised the related issue of the medicalisation of abortifacients. Lord Horder had previously warned the committee that in the near future doctors would be able to use 'inverted endocrine therapy' to induce, rather than prevent, abortion. When asked about this, Crew predicted that, unless the state intervened, synthetic and potent 'endocrine equivalents' capable of 'producing a non-reproductive condition of the reproductive organs' would soon be marketed and sold in shops. Lady Balfour wondered if these would be 'permanent in their effects', but Crew speculated that they would 'give us perfect control' by rendering the uterus 'quite incapable of accepting fertilisation' in the earliest weeks of pregnancy. The committee debated whether such effects would count as contraception or abortion and whether such drugs would be legal. Despite personal misgivings, Crew argued that morality had changed and there was no turning back from reproductive control. The British would 'never be a small people encompassed by enemies who can only escape from bondage by imitating the rabbit.' Parenting should be 'a serious adventure gladly

[182] 'Death of Lady Ruth Balfour', *Glasgow Herald*, 31 August 1967, 7.
[183] 'Memorandum of Professor Crew'.
[184] Ibid.

undertaken,' but only if society made room for children. Crew regretted the declining population, not because Britain was 'the flower of the earth', but because he did 'happen to prefer what other people call our culture.'[185]

Having just returned from a trip to India, Crew argued that more people should be raised in Britain because it mattered 'to the world.' Not 'as a stock,' he clarified, but British traditions were 'very much worth while extending. He saw himself as representing 'something that is very precious' whenever he traveled abroad. For these reasons he was against the rise in birth control, but saw no other way, 'because we live in a world in which frankly I think there is not much room for a child.' Crew blamed 'Hollywood and all the rest' for creating new and non-reproductive 'standards of the ideal feminine types', exemplified in the shift from the curvaceous Gibson girl to boyish flapper. Unless art changed and society's standards and values along with it, 'we shall wipe ourselves out', he lamented. When Lady Baldwin, a member of the National Birthday Trust, joked that Hollywood encouraged marriage 'because everybody marries about half a dozen times', Crew countered that these marriages were not of 'the reproductive type.'[186]

The official report of the committee in 1939 noted that 'endocrine tests' were 'commonly employed' with a 'very high degree of accuracy' in the determination of early pregnancy and that the Edinburgh experience demonstrated that the cost of each test could be 'greatly reduced, if the service is on a sufficiently large scale.' Beyond pregnancy diagnosis, the 'more extensive use of these tests' could reduce the incidence of spontaneous abortion and the committee officially 'recommend[ed] that the desirability of expanding the existing facilities for carrying out these tests should be fully explored, with a view to making such facilities more generally available, irrespective of income.'[187] Though the majority report of the committee rejected legalising abortion for social or economic reasons, Mrs Dorothy Thurtle, a social worker, birth control activist, and the only untitled female member of the committee, prepared a dissenting minority report that proposed allowing abortions for mothers of four or more children (Brooke, 2001). The report contained a memorandum by Dr

[185] Ibid., 8
[186] Ibid. On the Fund: Susan, 1997.
[187] Ministry of Health and Home Office, 1939, 110.

Joan Malleson, a Harley Street-doctor and founding member of the ALRA, which argued that 'apart from their usefulness in relation to spontaneous abortion,' the Aschheim-Zondek test would also be of 'great value to worried women who damage their health by taking abortifacient drugs when their periods are overdue.'[188] According to Malleson, many of these women were not in fact pregnant and so risked their health and wasted their money unnecessarily on dangerous and illegal substances.

Malleson's memorandum, which was subsequently communicated in the *Lancet*, proposed that 'mothers' welfare centres', based on a Danish model, should provide working-class women with access to pregnancy tests and, if necessary, referrals for therapeutic abortion. 'Many institutions', Malleson claimed, were able to provide an Aschheim-Zondek test for four shillings and sixpence, which was cheaper than purchasing 'expensive abortifacients whenever a menstrual period is late!' For Malleson, the 'reassurance which a negative Aschheim-Zondek gives to women in certain circumstances is inestimable.' This was especially true of the menopausal woman, who was 'often the most desperate in her fear of pregnancy' (Malleson, 1939, 366-367). Stella Browne responded that any diagnostic service should guarantee 'anonymity', so as to ensure that positive reports could not be used for purposes of notification' (Browne, 1939, 478). In his address to the National Association of Maternity and Child Welfare Centres, Carlos P. Blacker, the general secretary of the Eugenics Society, proposed a 'regional system' to alleviate the 'mental stress and ill-health' of possibly pregnant women: 'If the public could be educated as to the very high degree of reliability of these tests, and could be induced to avail themselves fully of such pregnancy-diagnosis services, the sales of abortifacients and the practices of abortionists might be substantially curtailed' (Blacker, 1939, 93).

In her address to the Eugenics Society, Thurtle argued that pregnancy tests should be made available at the antenatal clinic because many women 'dose themselves with drugs unnecessarily under the impression that they are pregnant when in fact they are not'. In the case of a positive test result, 'unless she is really desperate,' a woman

[188] Ibid., 150.

could be persuaded to go through with her pregnancy as long as she was promised contraceptive advice. Instead of feeling 'like a trapped animal with no one to help her', the promise of postpartum fertility control would supposedly 'give her the courage to go through it once more, in the knowledge that in the future she will not be so helpless.' Meanwhile, the start of World War II had added a new sense of urgency to Thurtle's argument: 'the future of all social services looks very black. But if the country is to survive, the health of our mothers must be maintained, and we can only hope that our statesmen, recognizing this, will eventually take the necessary steps to secure healthy, happy motherhood' (Thurtle, 1940a, 15-16).

This tactical argument was crafted to ally pregnancy diagnosis with motherhood in the campaign against illegal abortion. Thurtle extended these views in a slim book, *Abortion: right or wrong?*, which likewise endorsed pregnancy diagnosis as part of routine antenatal services in order to reduce women's reliance on abortifacient drugs. 'Much ill health', she claimed, 'is caused to women who are not pregnant by the irregularity of the menstrual period.' Though the fear of pregnancy 'might deter a woman from attending for a test,' Thurtle suggested that the promise of contraceptive advice 'after the birth' might persuade her otherwise. On the other hand, if the test result was negative, 'her own health would have been saved, and probably much expense on abortifacient drugs.' Many women thus 'saved from abortifacient drugs and violence by means of a pregnancy test may well become mothers later on, with their health in a correspondingly better state than if they had been left to their own devices. These tests', Thurtle concluded, 'should therefore become part of the routine of the ante-natal clinic' (Thurtle, 1940b, 75-76).

3.5. 'Dare you have a war baby?'

World War II dramatically reconfigured the administration of medical research, public health, and laboratory services in Britain.[189] Crew set up a pregnancy diagnosis service for the Women's Land Army,[190] and the Royal Air Force Medical Services used the Aschheim-Zondek test to rule out early pregnancy in women whose menstrual periods had stopped upon joining the Women's Auxiliary Air Force (Sher,

[189] On the mobilisation of British scientists in World War II: de Chaderavian, 2002, 20-49.
[190] Crew to Chief Medical Officer, Scotland, 21 January 1946, HH102/858, NAS.

1946, 348). In 1939 the Ministry of Health established the Emergency Medical Services (EMS) in anticipation of air-raid casualties, epidemics, biological warfare, and the need for blood transfusion.[191] In addition to a maternity service for evacuees, the EMS also comprised an extensive network of public health and pathological laboratory services, linking mainly university clinical laboratories around England and Wales (Scotland independently set up its own system in parallel) and placing them under control of various MRC subcommittees.[192]

As Norah Schuster, a clinical pathologist whose career stretched from 1916 to 1960, later recalled, the EMS changed 'everything'. Old laboratories were refurbished, new ones built, and London pathologists, including Schuster, were recruited and sent to work in the Home Counties. Diagnostic laboratory testing became available to many local doctors for the first time and clinical pathologists found themselves in demand from hospitals, nursing homes, and private houses 'all over the countryside'. Although the Ministry of Food promoted rabbit meat for human consumption,[193] making it difficult for pathologists to obtain supplies for pregnancy testing,[194] Schuster 'managed with the help of a local resident to collect them from small holdings in the district.' She later recalled that pregnancy testing 'became fairly frequent' during the war (Schuster, 1983, 21). Dr James Alfred Giles, the chief inspector at the Home Office responsible for enforcing the Cruelty to Animals Act, similarly perceived the 'volume' of pregnancy testing 'in all parts of the country' to have 'increased out of all measure' in the early years of the war.[195]

Although record keeping was abandoned in Edinburgh during the war, it seems likely that the upward trend documented for the 1930s continued, possibly accelerating as a result of the emergency services making pregnancy testing more widely available (for

[191] On the EMS: Dunn, 1952, 1953. On blood transfusion during World War II: Whitfield, 2013.
[192] On the emergency laboratory services: 'Public health in the war years: Ministry of Health retrospect', *BMJ*, 21 September 1946, 432-434, Valier & Timmermann, 2008, 497. On the Scottish system: 'Scotland: Emergency Bacteriological Service', *BMJ*, 10 February 1940, 228, Dunn, 1953, 64-68. See also Balmer, 2001, 22-24, 2002, 126-127.
[193] Zweiniger-Bargielowska, 2000, 2011. Once perceived as a pest, rabbits became a 'necessity for the larder' and baked rabbit the prize-winning recipe in a wartime cookery competition arranged by the *Farmer and stockbreeder* in 1940: Martin, 2010, 271.
[194] 'The University of Edinburgh Pregnancy Diagnosis Laboratory', HH 102/858.
[195] J. A. Giles, 'The position of pregnancy tests under the Cruelty to Animals Act, 1876', 2 February 1944, 2, 'Vivisection: Pregnancy tests: legal opinion as to the necessity for licence coverage', HO 45/25145.

details, see Figure 4.10). The reasons for wanting to confirm a suspected pregnancy at an early stage also multiplied. Sexual relations were reconfigured as men joined the forces, mothers and children were evacuated, and women were put to work in factories or as land girls (Summerfield & Crockett, 1992, Summerfield, 1998). Illegitimate births increased and criminal abortions known to police quadrupled (Hall, 2013). At the same time, wartime propaganda and journalism promoted traditional maternity as a valiant patriotic duty (Riley, 1981). In 1942, Winston Churchill warned of the 'dwindling birth-rate' in a radio broadcast and the Beveridge Report, a key document in the construction of Britain welfare state, concluded that 'housewives as mothers have vital work to do in ensuring the adequate continuance of the British race and of British ideals in the world' (Soloway, 1990, 312). Leaflets distributed to local food offices reminded mothers that a child's life 'starts nine months before birth' (**figure 3.4**).

Figure 3.4. A Ministry of Food and Health leaflet explains an expectant mother's 'duty' to take advantage of the extra nourishment recommended by doctors and provided by the state ('Extras needed by mother and child in wartime and how you can get them', LEEWW: 2001.906.2.3, Second World War Experience Centre).

As Ann Oakley put it, World War II was 'the best thing that had happened to pregnant women for a long time' (Oakley, 1984a, 125). Householders were paid extra for taking in an evacuated pregnant woman and, on production of a medical certificate of pregnancy, expectant and nursing mothers were issued an additional green (child's) ration book to collect coupons from the food office.[196] Between 1940 and 1942, first milk, then orange juice, cod-liver oil, vitamin tablets, meat, eggs, oranges and bananas were subsidised for pregnant women (Zweiniger-Bargielowska, 2000, 131). From August 1941, pregnant women were entitled to 50 coupons to buy materials for a baby's layette (Zweiniger-Bargielowska, 2000, 144). In September, *Mother* magazine announced that, upon production of a certificate from the doctor or midwife booked to attend the birth, an expectant mother could obtain the certificate from an antenatal clinic or Maternity and Child Welfare Centre: 'Where a positive diagnosis of twins has been made and confirmed, a double number of coupons will be issued.'[197] In practice, ration books and coupons for expectant mothers encouraged and formalised the early medical confirmation of a suspected pregnancy, though not necessarily with help from a laboratory test.

After an initial drop to a record low in the first two years of the war, fertility began to 'rise dramatically' (Soloway, 1990, 313). As the number of babies born, illegitimate childbirths, and illegal abortions increased, so did the public visibility of pregnancy testing. Having previously dispensed advice on the signs of pregnancy and clinical examination, women's magazines first began to comment on the Aschheim-Zondek test. In October 1939, soon after the start of the war, *Mother* magazine launched 'Preparing for motherhood', a column for expectant mothers. Advice columns, previously the domain of female nurses, had typically aimed at young mothers, not pregnant women. This one, however, featured an anonymous male expert presented as a 'distinguished maternity doctor'. It marked a greater emphasis on the nine months before birth, on the one hand, and the increasing exposure given to scientific knowledge and medical advice, on the other.[198]

[196] 'Extra Foods for the Expectant Mother', *BMJ*, 24 July 1943, 15.
[197] *Mother*, September 1941, 32.
[198] 'Preparing for motherhood', *Mother*, October 1939, 23, 83.

In July 1940, *Mother*'s maternity doctor revealed that pregnancy could be determined 'within a few days of conception' by means of 'the urine test.'[199] Far from an unqualified endorsement, however, his description of the test was accompanied by caveats that it was expensive and unnecessary:

> Your doctor could send a specimen of your urine to certain laboratories, and a report could be made in about a week's time. The urine is injected into young female mice, and after a few days the mice are killed and their ovaries examined. If the urine came from a pregnant woman, there would be definite changes in the ovaries of the mice. So if it is urgent for you to know at the earliest possible time if you are pregnant, and you can afford to have the urine test, your doctor can arrange the matter for you.[200]

This instalment of 'Preparing for motherhood' potentially introduced biological pregnancy test to tens of thousands of women for the first time, but its debut in *Mother*, possibly the earliest in any women's magazine, was lukewarm. The physiological knowledge that underpinned the test was left unexplained and readers were left uninformed about where the laboratories were located (so they were not enabled to post their own specimens). But its essence as portrayed in the magazine (mouse injections, dissections, ovary inspections) did not differ substantially from equivalent passages in medical textbooks. Animal experimentation was generally perceived as objectionable to women (Lansbury, 1985, Elston, 1987, Ferguson, 1998), so it is possible that the technically accurate but otherwise superfluous detail was included to discourage women from inquiring further about the test.

Even as *Mother*'s maternity doctor discussed the test for the first time, he endorsed self-diagnosis as 'almost certain', portrayed quickening as 'the most dramatic and conclusive sign that Baby is on the way', and advised 'anxious' women to wait patiently until a second or third period had been missed before seeing a doctor, by which time she would be less in a position to request a termination. So why bother with early diagnosis (self or otherwise) in the first place? As *Mother*'s maternity doctor explained, confirming pregnancy 'by the end of the second month' would

[199] *Mother*, July 1940, 34.
[200] Ibid.

leave ‘seven more months to get everything ready for Baby.’ In practical terms, this meant getting busy with ‘knitting needles and work basket.’[201] For the predominantly aspirant working-class and lower-middle-class readers of *Mother*, pregnancy meant hard work making ‘little garments’ from knitting patterns, the stock-in-trade of women’s magazines. An earlier diagnosis did not necessarily lead to extended medical surveillance, but it did leave more time for knitting (**figure 3.5**).


Great New Series for Mothers-in-Waiting

the wonderful promise

Our Maternity Doctor tells you the signs and wonders which will show you whether there is a baby on the way. If you are expecting a little one and need medical advice on any point, write to him at the address on page 55, enclosing a stamped, addressed envelope.

CAN it really be true? Is there a baby on the way? Many anxious wives ask themselves these questions when the period is a few days late, and some rush off to see a doctor at once to confirm their hopes.

If you are in such a position, don't waste your time and the doctor's by consulting him when your period is only a week or two overdue. It is impossible for the doctor to detect a pregnancy before the sixth week, so you should restrain your impatience until you have missed the second period and preferably until the third is nearly due. Then, on examination, your doctor will probably be able to detect an enlargement of the womb and so will be able to diagnose a pregnancy. Baby is so very tiny in the early stages of development that there is no detectable enlargement of the womb until he is at least six weeks old.

There is a means of diagnosing a pregnancy within a few days of conception—that is the urine test.

Your doctor could send a specimen of your urine to certain laboratories, and a report could be made in about a week's time. The urine is injected into young female mice, and after a few days the mice are killed and their ovaries examined. If the urine came from a pregnant woman, there would be definite changes in the ovaries of the mice. So if it is urgent for you to know at the earliest possible time if you are pregnant, and you can afford to have the urine test, your doctor can arrange the matter for you.

GENERALLY, the first sign of pregnancy is cessation of the menstrual periods. To miss a period is strongly suggestive of pregnancy in a woman in normal health who menstruates regularly.

However, there are various conditions of ill-health (glandular disorders, acute anæmia and other diseases) in which menstruation ceases for many months. Absence of the period alone is not conclusive evidence of pregnancy and although, normally, menstruation ceases throughout pregnancy, some women have monthly periods during part or sometimes the whole of their pregnancies.

Your doctor knows the combination of signs and symptoms on which a certain diagnosis can be made.

PERHAPS the next commonest sign of early pregnancy is morning sickness. Here again, there are exceptions; some women are never sick.

But if you have missed a period and at about the time when the next period is due you feel sick or actually vomit as soon as you rise from bed in the morning, pregnancy is almost a certainty.

You must bear in mind that morning sickness may be the result of dyspepsia and liverishness: it is when it occurs together with a missed period that it is so strongly suggestive of pregnancy.

Sometimes as early as the first month of pregnancy, there is a tingling sensation in the breasts, and a feeling of fullness, but many women experience these sensations before each menstrual period. It is not until the second month of pregnancy that the characteristic darkening around the nipple occurs, a brownish tinge which becomes progressively darker as pregnancy advances. In the third month of pregnancy, secretion can be squeezed from the nipples.

It is not until about the seventeenth week of pregnancy that you will experience the most dramatic and conclusive sign that Baby is on the way. This sign is known as the "quickening"; it is your first perception of baby's movements within the womb. This is indeed a wonderful moment when first you feel Baby "taking exercise."

The sensation is that of a gentle flick with a finger, low down in the abdomen. It is as if Baby were giving you a little secret message: Here I am, mother, getting along fine.

As Baby grows bigger and stronger, the movements become more vigorous: but it is the *first* faint movement that you definitely feel that constitutes "quickening." Some mothers-to-be feel a little faint at this wonderful moment, or may actually faint, but this is of no consequence. Anyhow, you will feel terribly thrilled and happy to get this first definite sign of the separate life within you.

Of course, your doctor will have been able to assure you, long before quickening occurs, that your baby is on the way.

NATURALLY you want to know as soon as possible when to expect the birth of your baby.

You can easily calculate this for yourself. Write down the date of the first day of your last menstrual period. Now go back three months and add seven days to this date. This gives the most probable date of your baby's birthday. Let us take an example. If the first day of your last period was June 1, three months back brings you to March 1; seven days added brings you to March 8, the probable date of the confinement. So you must carefully note the first day of your last period.

This calculated date, however, is not the certain date of your baby's birthday. It is not possible to foretell this, unless the actual date of conception is known. So when you have worked out the probable date, you should allow for Baby to arrive at any time during the week preceding or the week following this date. This is the nearest you can get to an accurate calculation.

If you know definitely that you are pregnant by the end of the second month, you have seven more months to get everything ready for Baby. But if you are wise you will aim at completing all your preparation at least two months before Baby is due to arrive, because some babies are born as much as two months before the expected date.

So when, with your doctor's help, your early doubts are settled and you know that motherhood is certain, you should begin at once to make your plans and get busy with your knitting needles and work basket. As the little garments take shape under your hands, may your heart be filled with joy at the prospect of achieving the crown of womanhood, the thrilling happiness of motherhood.

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Figure 3.5. *Mother*’s maternity doctor did not link earlier pregnancy diagnosis to earlier antenatal care or abortion, but rather to preparing the layette (*Mother*, July 1940, 34).

From 1941, after Winston Churchill had become Prime Minster and the Battle of Britain had been waged, wartime conditions of motherhood became a dependable fixture of *Mother* magazine. In January 1941, Nurse Crawford offered guidance on

[201] Ibid.

'welcoming the war-time baby', the 'little one' who was born in 'difficult times'.[202] And in February *Mother*'s maternity doctor addressed the apprehensive mother who despaired it was 'wicked to bring a child into the world today, with this dreadful war raging' (**figure 3.6**). This was 'exactly what the Nazis want you to think,' he countered: 'Hitler and his followers would doubtless rejoice at the prospect of the British race dying out'. This was no time 'to shirk motherhood'. On the contrary, mothers ought to take 'special pride' in their 'great service' to the nation.[203]

Figure 3.6. A young wife and her uniformed husband contemplate parenthood and the geopolitical future of Britain as *Mother*'s maternity doctor asks, 'Dare you have a war baby?' (*Mother*, February 1941, 12-13.)

To discourage women from considering abortion and to clarify the medical position, *Mother*'s maternity doctor recounted the story of a distressed patient whose 'husband had been called up and expected to go overseas shortly' (**figure 3.7**). With 'wartime difficulties' she did not have the courage to 'face it all' and had asked him for help. 'Many people', he explained 'have the mistaken idea that doctors are free to terminate a patient's pregnancy if they can be persuaded to do so. They do not

[202] *Mother*, January 1941, 35
[203] *Mother*, February 1941, 12-13.

appreciate that the doctor's legal powers, whatever his sympathies, are very definitely limited. Unless the pregnancy is likely to be fatal to the mother, or to cause serious injury to her health it is a criminal offence to attempt to procure an abortion.' Instead, he attempted to reverse the meaning of a wartime pregnancy; a mother whose husband was away on active duty could take great comfort from her baby, and 'the prospect of the husband going abroad' was even a 'weighty argument in favour of having a baby in wartime.'[204] Using the example of a 'young wife who was working on munitions, standing at a bench', *Mother*'s maternity doctor explained that women could carry on working and doing 'their bit in this war' up to the seventh month of pregnancy as long as they were kept 'under constant medical supervision, visiting your doctor at stated intervals.'[205]

[204] 'Motherhood ahead', *Mother*, June 1942, 71-72
[205] *Mother*, July 1942, 71-72.

Figure 3.7. The anonymous (faceless) maternity doctor imposingly leans over a young wife dressed for war work. In this carefully staged portrayal of the appropriately subordinate patient's perspective, their gaze locks as she stares up at him (*Mother*, June 1942, 71).

In April 1943 *Mother* revisited the diagnostic encounter, this time with an 'eager and excited' fictionalised patient. 'Mrs Brown' expected her husband to be sent abroad 'any day now' and wanted to 'make quite sure' they were going to have a baby before 'sending him the good news.' Her periods were, however, 'only about two weeks overdue' and like 'many other young wives', she did not appreciate 'the difficulties of making such an early diagnosis of pregnancy.' The doctor informed her about a urine test, 'which takes about a week': he could send a specimen of her urine to a laboratory, where 'a small quantity would be injected into a young female mouse. About four days later, the animal would be painlessly killed, and its ovaries examined for the definite changes which would have taken place if the urine were that of a pregnant woman.'[206] In the end the doctor 'arranged for Mrs Brown to come for a medical examination at about the time when her second missed period was due, as she did not wish to go to the expense of having the urine test.' So again a woman's magazine publicised the test only to reject it.[207]

Grantly Dick-Read's *Revelation of childbirth: the principles and practice of natural childbirth*, written 'when bananas were still available' (Dick-Read, 1942, 131), explained that if 'the menses are more than ten days overdue and accurate diagnosis difficult for any of the many reasons that may give rise to uncertainty of early diagnosis, an Aschheim-Zondek or some other similar test of the urine should be done.'[208] But in practice many doctors remained reluctant to diagnose early pregnancy and did not propose a test. On a day off from work in July 1942, Ruth Beck, a 27-year-old married secretary and Mass-Observation diarist from Earley, Berkshire, did the ironing, had tea, and went to the doctor: 'I screwed up my courage & asked if I was going to have a baby, but he wouldn't diagnose it definitely yet: he was awfully sweet about it all though.'[209]

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[206] 'What are the first signs?', *Mother*, April 1943, 79-80.
[207] Ibid.
[208] Dick-Read, 1942, 131. See also Thomas, 1997, Michaels, 2014.
[209] Diarist 5247, 'Mass Observation Diaries 1939-1945', SxMOA1/4, Special Collections, University of Sussex. On Mass Observation and histories of women: Sheridan, 1994, Langhamer, 2007. See also *The Mass-Observation diaries: an introduction* (University of Sussex, 1991), http://www.massobs.org.uk/downloads/diary_intro.pdf.

In 1945 Nurse Crawford advised that, although there was 'reason for hope when a monthly period is missed', it was 'not much use going before [a second period had been missed] because, without special tests which are not normally made, no definite opinion can be given.'[210] And Dr Edgar Hope-Simpson, a GP who began practicing in rural Gloucestershire in 1946, recalled in an interview with Ann Oakley that he 'did use' the test, but only 'if it was important to know':

> I can remember people coming and wanting to know if they were pregnant. And I would say 'I think you are' or 'I think you aren't.' Is it important that you should know before next month or whatever? And if there was some particular reason why they should know then we'd arrange an Aschheim-Zondek. It cost them a couple of quid (quoted in Oakley, 1984a, 97-98).

Conclusion

Rather than tracing a linear progression from folklore and tradition to scientific knowledge and technology, this chapter has emphasised the continuity of an ambiguous and uncertain experience: early pregnancy. Nowhere is this more apparent than in the fictionalised pregnancy realisation narratives found in novels published in the 1930s. These emphasised the anxiety and uncertainty brought on by a missed period and morning sickness as well as the evidently widespread practice of menstrual regulation, but made no mention of pregnancy testing. Newspaper articles that could not help mentioning the test skirted around it without going into detail and 'home doctor' books continued to emphasise self-diagnosis.

For most people, including most general practitioners, midwives and 'ordinary' women, laboratory testing did not replace self-diagnosis or the clinical confirmation of pregnancy. On the contrary, maternity experts consistently discouraged women from asking about the laboratory test. First, it was expensive, usually unnecessary, slow, and involved killing animals. Second, the conventional signs – a missed period, morning sickness, and sore breasts – were good enough (and cost nothing). Third, there was little medical incentive to confirm a pregnancy before the end of the first

[210] *Mother*, April 1945, 63.

trimester: antenatal care could wait. Ironically, practical information about self-diagnosis became more widely available in more formal and commercial forms after the invention of the Aschheim-Zondek test. It is significant that maternity experts' general rejection of the new test provided them with a new reason for publicizing the older signs and symptoms.

Soon after Francis Crew told the Birkett committee that pregnancy testing prevented miscarriage and should be 'democratised' by the state. Meanwhile some feminists and eugenicists began making the argument that, if properly democratised, the Aschheim-Zondek test could prevent unnecessary 'abortions'. The logic of this argument, which would become important again in the 1960s (see Chapter 6), was based on the assumption that many women who took illegal abortifacients were not in fact pregnant, but merely worried by a late menstrual period that would come sooner or later. After the start of World War II, extra ration books for pregnant women, soldiers going off to the front and improved access to the diagnostic laboratory under the Emergency Medical Services (EMS) created new incentives and opportunities for women to confirm pregnancy at an early stage. Although medical experts writing in women's magazines continued to dismiss the Aschheim-Zondek test as expensive and unnecessary, a new culture of pregnancy and its early diagnosis was under construction.

Chapter 4. National babies and 'friendly' toads

In February 1938 the *Daily Mirror* reported that if a woman in South Africa 'wants to know whether she is going to have a baby [...] she consults the common frog of the veldt' and that this animal would soon be imported in bulk 'to answer the Great Question for Englishwomen.'[211] Six months later the same paper revealed that 'huge consignments' of 'one of the world's ugliest frogs' were 'being shipped from South Africa to Britain and other countries at 4d. each' and that there were even 'fears of a shortage.'[212] The South African 'platanna' frog or 'clawed toad', *Xenopus laevis*, would become the dominant test animal in pregnancy diagnosis in postwar Britain (Gurdon & Hopwood, 2000). In 1939 Francis Crew claimed the *Xenopus* pregnancy test as a British invention by naming it after his friend, the socialist physiologist Lancelot Hogben (Crew, 1939, 767). In so doing Crew touched off a priority dispute between Hogben and his South African colleagues who had reported the use of *Xenopus* in pregnancy testing to the Royal Society of South Africa a few months before Hogben's assistant announced the test in *Nature*.

A well-networked critic of eugenics and bestselling author of *Mathematics for the million* (1936), Hogben is a colourful figure in the history and philosophy of science (Werskey, 1971, 60-67, Kevles, 1985, 122-131, Mazumdar, 1992, 146-195, Bud, 1993, 73-78, Dubow, 1995, 191-195, Sarkar, 1996, Tabery, 2008). Most historical writing about the 'Hogben test' either places Hogben centre stage or attempts to redistribute the credit to Shapiro and Zwarenstein (Wells, 1978, 205-206, Zwarenstein, 1985, Hogben & Hogben, 1998, 101, Bröer, 2004, 140-141, van Sittert, 2008, Haarburger & Pillay, 2011, Sleigh, 2012, 136). This chapter revisits the dispute, but in a way that decentres Hogben. It focuses less on who invented what first, than on how *Xenopus* was made into a practical test animal in the late 1930s and how it became institutionalised after World War II under the National Health Service (NHS). It also introduces an entrepreneurial general practitioner and 'failed' scientist, Edward Elkan, whose role in making *Xenopus* a popular laboratory animal in postwar Britain has gone largely unnoticed.

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[211] '"The frog" becomes "the squeaker"', *Daily Mirror*, 8 February 1938, 2.
[212] 'Frogs that "say mother"', *Daily Mirror*, 30 August 1938, 25.

Two final sections recover how patients encountered the Hogben test in the early years of the NHS as well as the use of the common British toad, *Bufo bufo*, in pregnancy testing. 'Following the fly' led historian Robert Kohler 'away from analyzing the diffusion of *Drosophila* production to secondary and tertiary institutions, since the limiting factors for building programs were not access to standard tools but patronage and local institutional politics' (Kohler, 1994, 14). While following *Xenopus* leads to a few large specialised pregnancy diagnosis centres, following *Bufo* leads to many smaller hospital laboratories around Britain; a pattern of 'species choice' that mirrored the distribution of mice and rabbits in the 1930s.[213] But unlike mice and rabbits, frogs and toads did not need to be killed in the course of a pregnancy test. This was their major selling point and it would have significant consequences for the public face of pregnancy testing beyond the laboratory.

4.1. *Xenopus laevis*: 'the toad that has not to be slaughtered'

Lancelot Hogben headed the Department of Zoology at the University of Cape Town from 1927 to 1930.[214] His research projects were mainly devoted to studying skin colour change in amphibians, or what he called the 'pigmentory effector system' (**figure 4.1**). In South Africa he began using *Xenopus* as experimental material, studying the pigment cells visible in its webbed feet.[215] In March 1930 he reported to the Royal Society of South Africa that the ovaries of hypophysectomised female *Xenopus* toads degenerated and injection of ox pituitary restored ovulation.[216] Hogben would later claim this 1929 finding as the basis of the pregnancy test, but at the time he made no mention of any diagnostic application (Gurdon & Hopwood, 2000, 45). Later in the same year, possibly motivated by the worsening political climate, Hogben accepted a new chair at the Department of Social Biology at the London School of Economics (LSE).[217]

[213] On the politics of species choice in embryology: Hopwood, 2011.
[214] On the department: Phillips, 1993, Brown, 2003.
[215] Hogben et al., 1931. Hogben's pigmentation work culminated in his 1942 Croonian Lecture. For a full bibliography: Wells, 1978, 216-21. For a review of the Hogben papers: Tabery, 2006.
[216] Hogben, 1930. It was standard practice in 'comparative physiology' to remove a gland from a test animal and then attempt to restore the action of the removed gland with injections of glandular extract: Schlich, 2010.
[217] For a recent analysis of 'social biology' at the LSE: Renwick, 2013.

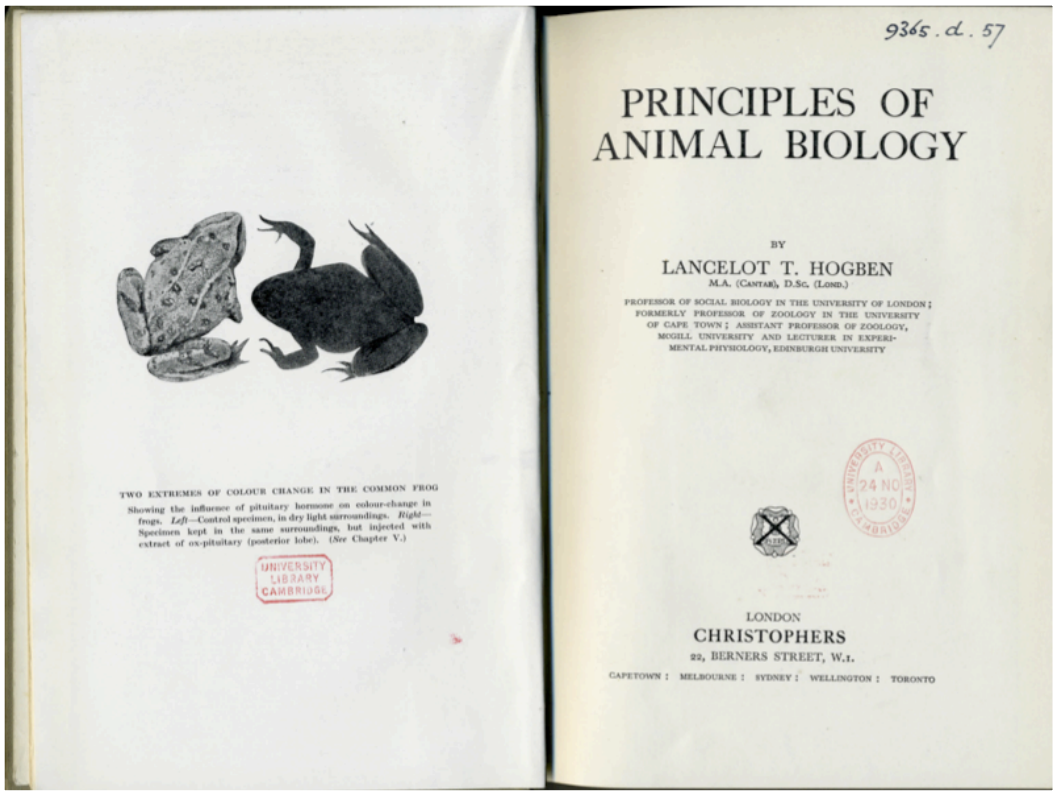


Figure 4.1. The opening pages of Hogben's popular textbook, *Principles of animal biology*, showing colour-change in frogs. The animal to the left is a control and the animal to the right has been injected with ox pituitary extract (Hogben, 1930).

Hogben returned to London with some toads to establish a small *Xenopus* colony for research and hired Charles Bellerby to continue his investigations. Bellerby performed the first experiments, funded by the Sex Hormones Committee of the Medical Research Council (MRC), on imported toads kept in 'a cold underground room'; many failed to ovulate when injected with pituitary extracts obtained from local abattoirs (Bellerby, 1933, 616). Bellerby repeated the experiment, but this time killed and examined the animals to find that unresponsive toads had atrophic ovaries. He next relocated the remaining toads to a warm, well-lit room, and established a reliability of nearly 100% in subsequent experiments. Despite the inauspicious start, Bellerby concluded that a superior dose-response relation and reusability made *Xenopus* a more practical test animal than the rabbits he was more familiar with.

In March 1934 he reported encouraging results with pregnant women's urine, which was widely known to have much the same properties as pituitary extract, in a short

letter to the prestigious journal *Nature*. For each test Bellerby injected ten toads (as so many controls) and read a positive result if five of the ten ovulated within nine hours, an arbitrarily set endpoint. Bellerby claimed that *Xenopus* could be 'obtained easily and cheaply' and maintained in colonies of several hundreds without difficulty (Bellerby, 1934, 494). In London they needed to be kept in clean water in a warm, well-lit room and fed a bit of raw meat once a week. Whereas mice and rabbits had to be dissected to reveal ovarian changes, *Xenopus* extruded numerous, large, visible eggs and so did not have to be killed. Female toads could be used repeatedly as long as they were rested for about a week between injections. The reusability of *Xenopus* was its most obvious advantage over the reigning test animals. Other amphibian species were known to spawn spontaneously in captivity, making them unsuitable. Two months later a lead article in the *BMJ* mentioned the *Xenopus* test, but concluded that there was insufficient data to assess its clinical value (Robson, 1934a, 1064). *Xenopus* was a promising but untested pregnancy test animal.

Bellerby's letter in *Nature* was not the first report of *Xenopus* in pregnancy diagnosis. In October 1933 Harry Zwarenstein and his doctoral student Hillel Abbe Shapiro, Hogben's former colleagues at the University of Cape Town Physiology Department,[218] had presented preliminary results to the Royal Society of South Africa.[219] Subsequently, in their own letter to *Nature*, the pair reported an accuracy of 100% in 97 tests undertaken in collaboration with the Cape Town gynaecologist Ariel Goldberg.[220] Shapiro and Zwarenstein injected six toads per test and read a positive result if a single toad ovulated or if a post-mortem examination revealed at least a single ovum in either or both oviducts. Their arbitrary endpoint was eighteen hours, compared to Bellerby's nine (Shapiro & Zwarenstein, 1934, 762).

In a lengthier article in the *South African medical journal*, Shapiro and Zwarenstein warned that Bellerby's definition of a positive result (five out of ten toads) would result in false negatives (Shapiro & Zwarenstein, 1935, 204). They recommended using freshly collected toads because of ovarian atrophy in captivity, which would

[218] On the physiology department: Sloan, 1979. On Zwarenstein and Shapiro see the obituaries in the *South African Medical Journal* (*SAMJ*): 'In Memoriam Hillel Abbe Shapiro', *SAMJ*, 66, 24 November 1984, 'In Memoriam H. Zwarenstein', *SAMJ*, 86, August 1996, 989, Gevers, 1998, *SAMJ*, 17 November 1973, 2198. See also Erlingsson, 2005, 2009a,b.
[219] Shapiro & Zwarenstein, 1933a.
[220] See 'In Memoriam Ariel I. Goldberg', *SAMJ*, 69, 29 March 1986, 461.

also lead to diagnostic errors. In their experience, the normal ovaries of freshly caught pond toads 'at the height of the breeding season' were filled with large ova easily seen with the naked eye. But after living for six months in a deep slate-lined tank in a dimly lit animal house at the university, the ovaries of captive females often resembled 'gelatinous masses in which individual ova were no longer discernible' (Zwarenstein & Shapiro, 1933, 372). Shapiro and Zwarenstein attributed 'ovarian retrogression' to insufficient sunlight and argued that the 'captivity effect' would make the *Xenopus* test impractical in London and elsewhere (Shapiro & Zwarenstein, 1933, 189).

Because of these doubts the test languished and Bellerby went back to the drawing board to examine the 'captivity effect'. He performed a series of injection and dissection experiments on freshly imported toads, toads that had lived in the London Zoological Gardens for years, toads that he irradiated with a 100-watt lamp at close-range, and toads that had been kept in a cold, dark basement for several months. In the end, Bellerby failed to replicate the effect observed in Cape Town and concluded that reproductive activity was probably influenced, not by light or temperature, but by food supply. He speculated that, in the wild, female toads reabsorbed their ovaries seasonally (when the ponds dried up) and, in captivity, when their food ran out. Shapiro and Zwarenstein's toads, Bellerby claimed, had been overcrowded and underfed.[221]

As Crew put it in 1936 in the *BMJ* 'everyone' was still 'waiting for the discovery of a new test animal' or a technique that would simplify pregnancy testing and reduce the time spent waiting for a test result. *Xenopus* might be 'ideal' in South Africa, where 'fresh supplies' could be 'quickly secured at regular intervals,' but Crew was under the impression that the toad did not tolerate 'laboratory conditions for more than a month' and so perceived its usefulness as limited in Britain. Any animal would need to be 'bred or bought, fed, housed, and cared for' and injections required 'a Home Office licence and a degree of surgical skill', so Crew looked forward less to a new bioassay, than to a convenient and reliable *in vitro* test, which would remove 'the

[221] Alexander & Bellerby, 1935, 312. On pathologically crowded rats: Ramsden, 2011.

necessity of maintaining and slaughtering thousands of animals [and] would surely replace them' (Crew, 1936, 1093-1094). But all this changed in the following year.

Hogben, who never stayed in one place for very long, left the LSE in 1937 to start a new job as Regius Professor of Natural History at the University of Aberdeen. He had some toads transported from London to Aberdeen and hired Frank Walter Landgrebe as a research assistant to continue Bellerby's work there. The move crucially brought Hogben into closer proximity with his old friend Crew (they had worked together in Edinburgh in the early 1920s) and facilitated a productive collaboration between Hogben's research laboratory and Crew's diagnostic service. With Zwarenstein's help Crew arranged for the importation of 1,500 large female 'clawed toads' and with Landgrebe he launched a large-scale comparative study of the use of mice, rabbits and toads as test animals in pregnancy diagnosis (Crew, 1939, 766, Landgrebe, 1939, 94).

In October 1937 Louis Bosman, another Cape Town gynaecologist who collaborated with Zwarenstein, complained in the *BMJ* of the 'almost universal ignorance of the method in vogue in South Africa.'[222] Having given only six incorrect diagnoses out of 1,000 tests performed in five years, Bosman claimed that 'the frog test' was superior to all other methods reported in American and European journals. Its only drawback was that *Xenopus* did 'not flourish in the northern hemisphere' (Bosman, 1937, 939). Crew responded in his own letter that *Xenopus* was in fact well known in Britain and beyond. Laboratories in London and Aberdeen maintained a 'considerable number of claw-toed frogs' and in Edinburgh a large colony was 'being extensively used in pregnancy diagnosis tests.' The demand for *Xenopus* had lately 'become so great' that the commercial exporters Crew dealt with warned of impending 'restrictions'. Yet Crew did not expect the use of *Xenopus* to become 'at all widespread' until a 'method of breeding and raising' the toad domestically could be worked out. Setting up and maintaining a laboratory for 1,500 frogs was 'a very much more serious matter' than establishing one for the use of mice or rabbits, which were available 'locally at all times in considerable numbers' (Crew, 1937, 1044).

[222] See 'Dr. Louis Pierre Bosman', *SAMJ*, 13 December 1947, 922-923.

In 1939 adult rabbits cost about five shillings and young mice at least sixpence each. *Xenopus*, when imported in bulk, cost eightpence per toad. Setting up a large colony also involved extraordinary overhead and maintenance costs. Crew kept his toads in galvanised metal tanks arranged in tiers on staging around the walls of a brightly lit room fitted with roof lights. A metal rim overhanging the water on all sides of a tank prevented escape. Each tank received one or two 'heaping handfuls' of finely minced meat or liver per week and electrical tubular heaters maintained the temperature of the toad room at a sweltering (for Scotland) 21ºC (Crew, 1939, 768). Ideally, these investments in specialised equipment and maintenance costs would be offset by the reusability of a test animal that did not have to be killed. Beyond the clear economic advantage of reusability, Crew also factored in the emotional cost of killing laboratory animals, the brunt of which was born by his all-female staff.[223]

Although Crew denied any compunction about 'killing of a 3-weeks-old mouse,' he admitted that breaking the neck of an adult rabbit, even one anesthetised with Nembutal beforehand, was 'not a pleasant task' and his laboratory workers preferred to 'deal with the toad that has not to be slaughtered.'[224] Their knowledge of *Xenopus* was 'still imperfect and incomplete', but they were getting to know the exotic animal and its needs 'under artificial conditions'. The reliability of the test depended on the 'power of observation' of 'human personnel'. Laboratory workers did not simply grab toads 'at random', but 'carefully selected' those 'being to the eye and to the hand such as give the impression of possessing an ovary that will respond'. They learned to avoid 'flat' toads, which they removed from the reservoir for a period of extra rest and rations (Crew, 1939, 766-68).

After eighteen months of testing, Crew was ready to replace rabbits, though not yet mice (which were still used to produce graded results in differential diagnosis, see Chapter 2), with toads (Crew, 1939, 770). And in a prominent article in the *BMJ* he proposed renaming the *Xenopus* test 'the Hogben test' to bring it into line with the Aschheim-Zondek and Friedman tests (Crew, 1939, 767). John Gunn, the acting head

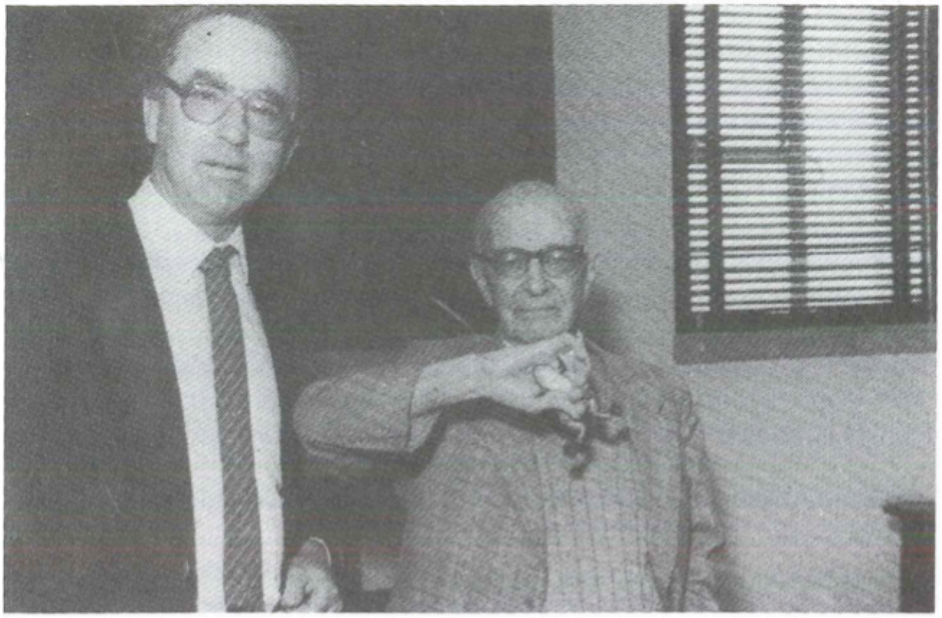
[223] The contributions of laboratory workers, many of whom were young, unmarried women, to the enterprise of medical research has often been concealed, but Crew acknowledged by name the assistance of Miss Mairi Mackay and Miss Janet Meikle. On 'invisible' technicians: Shapin, 1989. See also Tansey, 2008.
[224] Crew, 1939, 768.

of the University of Cape Town Physiology Department, responded that there was 'no justification whatever' for naming the pregnancy test after Hogben. If the test was to be named after anyone, it should be called the 'Shapiro-Zwarenstein test' (Gunn, 1939, 1258). Hogben countered that Zwarenstein and Shapiro's mistaken insistence on the 'captivity effect' nullified their claim to priority and credited Bellerby and Landgrebe with working out the ideal 'conditions of diet, density, pollution, temperature, and illumination' needed to maintain *Xenopus* for routine use (Hogben, 1939, 38-39). In a final letter Gunn explained that Shapiro and Zwarenstein had regarded themselves as merely extending the work of Aschheim and Zondek and so had modestly refrained from attaching their names to the test. In a conciliatory gesture, Gunn proposed crediting 'the humble batrachian, which seems to give an invariably correct diagnosis, by calling this the "xenopus test"' (Gunn, 1939, 580).

In Britain, where *Xenopus* would become the dominant pregnancy test animal after World War II, Crew's proposal mostly stuck. In February 1946 the recently launched 'Any Questions?' column of the *BMJ* fielded a question about the 'Hogben test for pregnancy'.[225] And the priority dispute flared up for the second and final time when Hogben took issue with a London chemist's account of the '*Xenopus* pregnancy test' (Milton, 1946, 328). Hogben, now at the University of Birmingham, responded with his own 'History of the Hogben test' to set the record straight (Hogben, 1946, 553). Shapiro and Zwarenstein responded to what they saw as 'several gross misrepresentations of the true facts' and maintained their preference 'to call the test the *Xenopus* or frog test' (Shapiro & Zwarenstein, 1946, 752). Hogben, in turn, blamed the 'South African Press' for stirring up the controversy by boosting the test 'as an indigenous South African discovery' and prompting 'zeal for the credit of South African science' (Hogben, 1946, 962). And in a final response before the *BMJ* editors formally closed the correspondence, Landgrebe, still in Aberdeen, insisted it was 'beyond question that the test arose from Hogben's discovery in 1929' and that Crew had 'very properly termed it the Hogben test' (Landgrebe, 1946, 963) (**figure 4.2**).

[225] 'Letters, notes, and answers', *BMJ*, 1, 16 February 1946, 262-264, 262. 'Any Questions' was founded in February 1943, 'at the mercy of the Paper Controller', to help the busy practicing GP: 'Any questions?', *BMJ*, 1, 20 February 1943, 226.

TUITION ON THE MOUNT



The proof is in the being. On Harry Zwarenstein's 85th birthday in 1985, he was confronted by the 51 year-old Julian Mirvish (on the left) who, 52 years earlier, in 1933, was the elderly foetus who was responsible for the first positive pregnancy test using the platanna frog. In the picture Zwarenstein holds a 1985 vintage platanna. (Courtesy of H.J. Zwarenstein)

Figure 4.2. Though better known in Britain as the Hogben test, Zwarenstein remained proud of his achievement, as did the University of Cape Town; this portrait is taken from the official history of the university's formative years (Phillips, 1993, 326).

4.2. 'Edward Elkan and the 'foreign scientific refugee element'

At around the same time that Crew was installing his massive *Xenopus* colony in Edinburgh, a refugee doctor from Germany independently established his own more modest colony in central London. Born into a comfortably middle-class Jewish family in Hamburg in 1895, Rudolf Eduard Elkan studied medicine in Berlin, Freiburg and Hamburg, served as a medic during World War I and practiced in British Palestine before setting up a general practice back in Hamburg (**figure 4.3**).[226] The Hamburg Nazis harassed Elkan early on not only because he was Jewish, but also because of his leftwing political leanings and activities in the birth control movement, which brought him into contact with the controversial socialist doctor and sex educator Max Hodann.[227] In 1933 some 'hooligans' broke into Elkan's flat, stole his typewriter, arrested him, beat him and dragged him into the street draped in red flags. Elkan found himself in a 'rat-infested cellar' and then at a local hospital before being discharged. After some days recuperating at his in-laws, the police summoned him, gave him a passport and escorted him to the SS *Manhattan*. His uncle Hans Elkan slipped him a ten-mark note to tuck under his hatband and he departed for Le Havre and Southampton, where his ticket expired.[228]

[226] See 'E. Elkan MD, *BMJ*, 287, October, 1983, 1071, Elkan, 1983, Proctor, 1988, 271-272, Cooper, 1989, Williams, 1994, Adler, 2007, 193-194, von Villiez, 2009, 258-259.
[227] Elkan, 1983, 51-52. See also Grossmann, 1995, 24, 119, 134-135, 153, 180, 186. On Hodan: Lennerhed, 2009, 60-61, Sauerteig, 2009, 133-136.
[228] Elkan, 1983, 51. On medical refugees in Britain: Weindling, 2009a,b.

Figure 4.3. Elkan as a young man in military uniform, posing with his prized microscope, a gift from his South African uncle (photograph courtesy of Naomi Hull).

Elkan planned to join his friend and fellow birth control activist Elise Ottesen-Jensen in Stockholm, but the refugee support committee that received him at Russell Square insisted that he was to spend 'every penny' they gave him in Britain.[229] So Elkan contacted Dr Helena Rosa Wright (née Lowenfeld), whom he had met at a Zürich birth control conference in 1929.[230] She took him to the headquarters of the recently formed National Birth Control Association (NBCA) and introduced him to the association's treasurer Mrs Gerda Guy who 'whisked' him off to her estate near Beaconsfield to recuperate. Elkan needed a British degree to practice medicine in London, but English medical schools were not accepting refugees. So he attended lectures in Glasgow, learned English from the radio and passed an examination in Edinburgh on subjects he 'had practiced for years.'[231]

[229] On Ottesen-Jensen: Lennerhed, 2009, 59-62.
[230] On Wright: Evans, 1984. On the Zurich conference: Grossmann, 1995, 41-43.
[231] Elkan, 1983, 52-53. On refugee physicians in Scotland: Collins, 2009.

After re-qualifying Elkan returned to London, where Wright put him in touch with Dr Edgar Obermer, an endocrinologist from a wealthy family who drove an American car 'as big as St Paul's' and ran a 'large, peculiar but flourishing practice at Manchester Square' (Elkan, 1983, 54-55). Obermer had studied medicine in Lausanne and practiced at Papworth Village Settlement in Cambridgeshire, a 'socio-medical experiment' in the treatment of tuberculosis, before settling in London. In 1933 he had applied for Ministry of Health funds to research the '"individual's neuro-endocrine-circulatory-metabolic-adaptational mechanism" but was rejected perhaps because of his "somewhat unorthodox scientific views"'.[232] Obermer promoted his individualistic approach to 'preventive' medicine in numerous articles and two books: *Health and a changing civilisation* and *Individual health* (Obermer, 1935a,b). Elkan cynically recalled that Obermer's 'main cure consisted in bleeding the patients, subjecting the sample to procedures only known to himself and then re-injecting the product into any part of the patient's anatomy' (Elkan, 1983, 54). After working as Obermer's assistant for some time, he decided to set up his own somewhat more conventional practice.

With help from his third wife, Lotte 'Maya' Lask, Elkan, who had by now changed his name to 'Edward', set up a practice 'in a house overlooking Regent's Park.' In 1937 he decided to try the Hogben test because the Aschheim-Zondek test, 'then en vogue, was cumbersome, expensive and needed hecatombs of young mice.' Despite having to explain his cryptic telegraphic order, 'Send 100 Xenopus', to suspicious authorities ('What kind of secret and probably dangerous war material was I ordering to the detriment of Old England?'), the first shipment reached him safely. In the summer they lived in outdoor tanks on a balcony, where they became 'comparatively tame'. The female of the species did not croak, so keeping them by the hundreds was 'not a nuisance to the neighbourhood' (Elkan, 1938b, 1253). The rest of the year Elkan kept them in a specially constructed tank (**figure 4.4**) and used 'one of the practical aquarium heaters now on the market' to maintain the water temperature at around 25ºC (Elkan, 1938a, 313).

[232] Jackson, 2013, 115-116. On the Papworth experiment: Bryder, 1984.

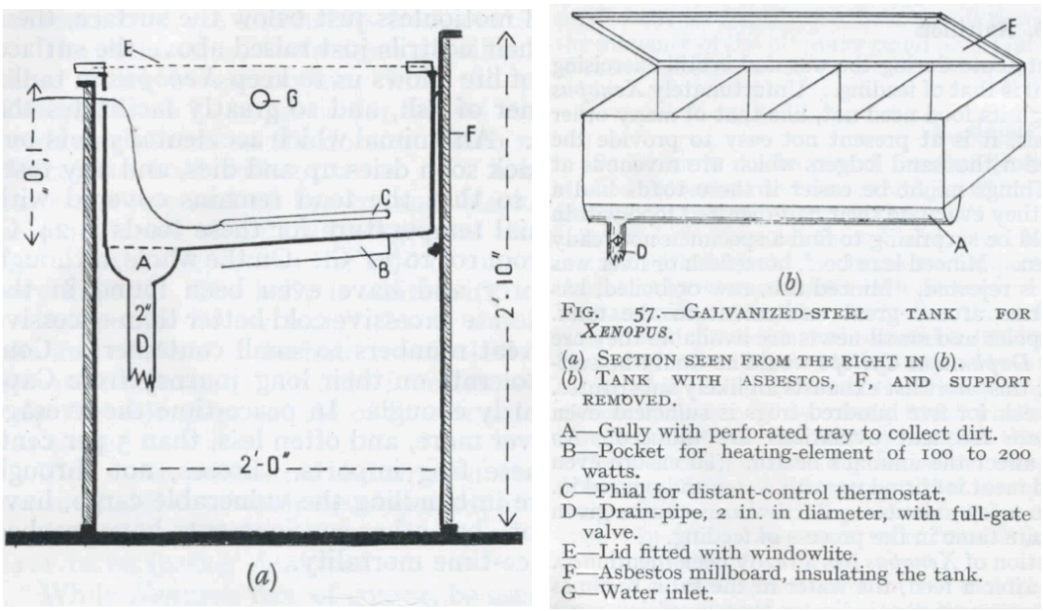


Figure 4.4. In 1938, Elkan constructed a galvanized steel tank with a sloping bottom and removable trays to facilitate cleaning. This diagram was published a decade later in the Universities Federation for Animal Welfare *Handbook on the care and management of laboratory animals*. After World War II, Elkan obtained electrical heaters from the General Electric Company and thermostats from the British Thermostat Company (Elkan, 1947, 254).

Prior to widespread electrification, aquarium heaters had been rare and expensive. The Central Electricity Board had been established with monopoly powers in 1926 and by 1933 the national grid of high-voltage transmission lines, one of the most advanced in the world, was nearly complete. By 1939 the first wave of electrical domestic appliances (vacuum cleaners, cookers, radios, gramophones and irons) had entered many homes, two-thirds of which were wired for electricity.[233] Most pet shops stocked goldfish only, but fanciers could purchase 'tropicals' from London dealers who imported and bred them in large numbers (Hodge, 1927, 11). Tropical fish fancying had been pioneered in the US in the 1910s (Hamera, 2012, 193, Klee, 2003, 152-160) and by the early 1930s American companies were making thermostatically-controlled aquarium heaters that incorporated small electrical heating coils, the same technology found in increasingly familiar domestic appliances such as irons, toasters and immersion heaters for warming soup or beverages (Grier, 2006, 255). So, by the late 1930s, Elkan would have been able to choose from several

[233] Stevenson & Cook, 2010, 18. On the electrification of Britain: Luckin, 1990.

efficient and inexpensive electrical heaters and thermostats on the market (**figure 4.5**).[234]

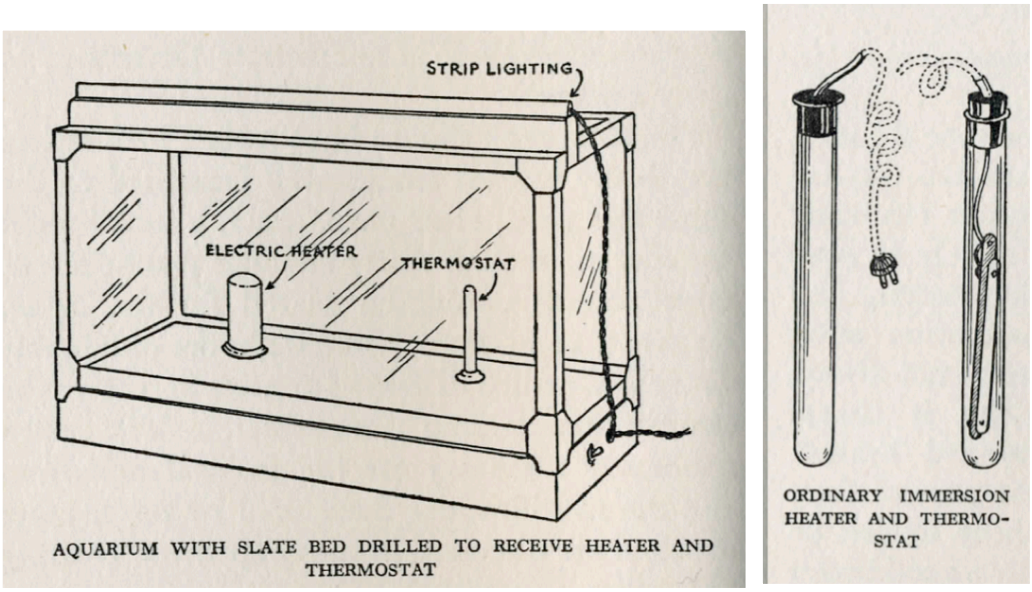


Figure 4.5. Whereas earlier manuals on tropical aquariums recommended using a Bunsen burner or an electrical bulb lamp to improvise a heating source (Hodge, 1927, 25-26), by the late 1930s, a slate-bottom aquarium (left) could be purchased already drilled to receive a commercial immersion heater and thermostat (right) (Wells, 1937, 20, 44).

Elkan, an amateur herpetologist with a passion for exotic reptiles and amphibians honed in the Palestine desert, saw himself later in life as 'an obscure and very largely failed potential scientist' with 'too many secondary interests' (**figure 4.6**).[235] He benefited from links to the birth control movement in London, but he had no connections to Hogben's network of physiologists. This may have been disadvantageous in some ways, but it also liberated him from concerns about the 'captivity effect', which turned out to be baseless. In the late 1930s he energetically experimented with *Xenopus* husbandry and published several influential articles in British, French and American medical journals.[236]

[234] In some districts, where electricity was expensive, a tropical aquarium of any size was 'an expensive luxury.' Where electricity was out of the question, leading dealers stocked immersion gas heaters and tropical fish fanciers continued to rely on a Bunsen burner placed beneath the aquarium: Wells, 1937, 44-45. In the early 1900s the zoologist Edward Bles kept *Xenopus* toads in a bell jar over a Bunsen burner in the Department of Zoology at Glasgow University: Gurdon & Hopwood, 2000, 44.
[235] Letter from Elkan to his daughter Naomi Hull, April 1980, quoted in an email from Naomi Hull, 9 March 2014.
[236] See Elkan, 1938a,b, 1939a,b,c, 1940, 1946a,b, 1947a,b.

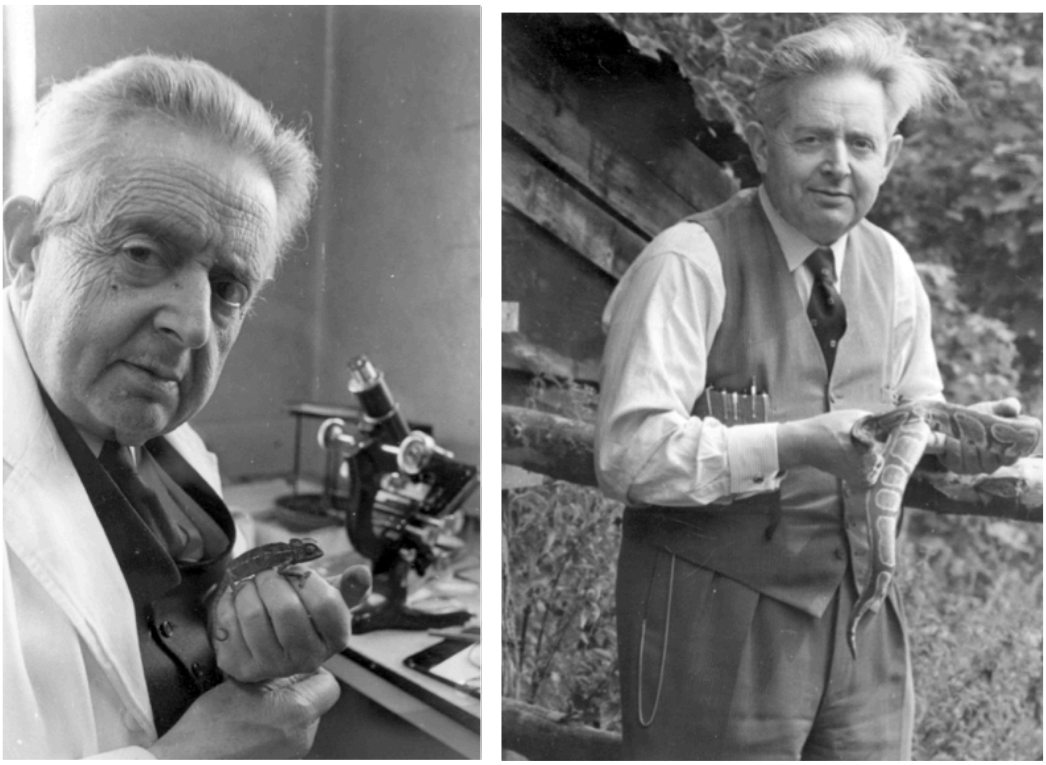
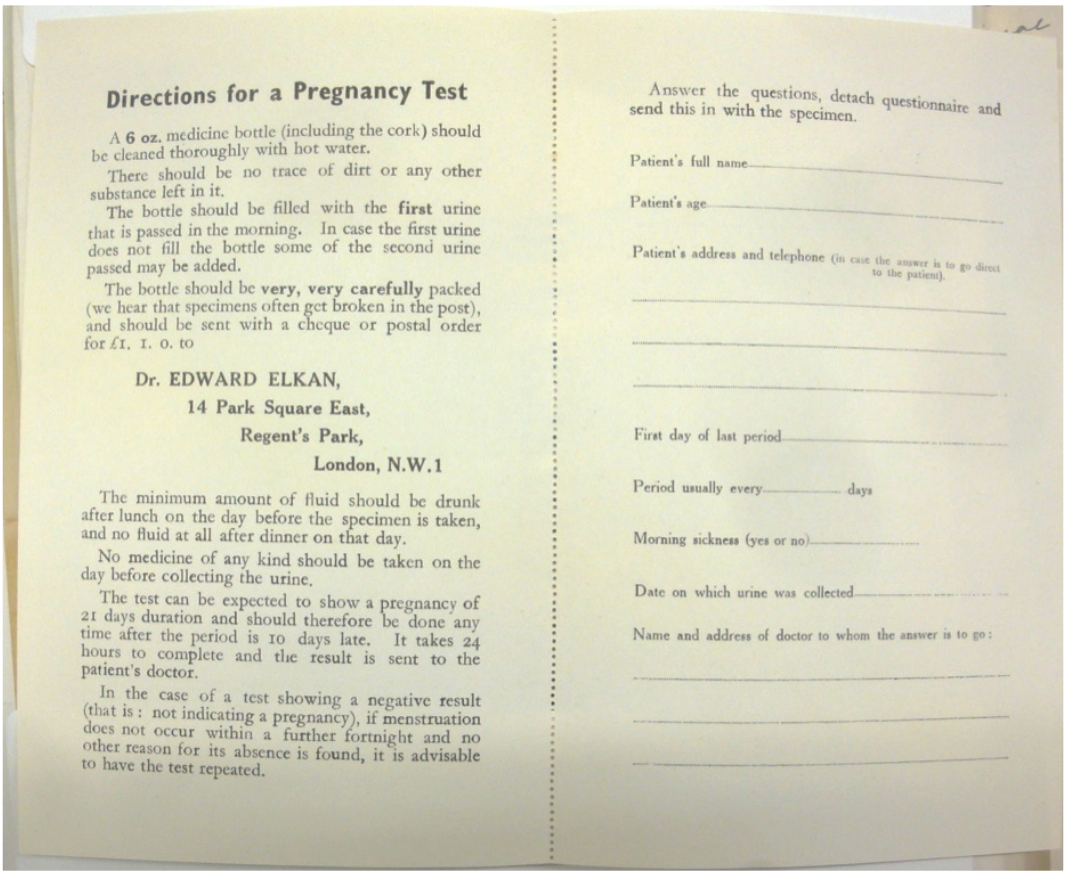


Figure 4.6. An aging Elkan posing with his beloved reptiles (photographs courtesy of Kraig Adler).

Elkan performed the Hogben test for his own patients and for other doctors. Regent's Park served a wealthy clientele, so he was able to charge one guinea per test, rather more expensive than the 'modest fee' of five shillings set by Crew in 1929. Unlike the Edinburgh station, Elkan sometimes posted and telephoned test results directly to patients, a practice that the BMA would later strongly object to (see Chapters 5 and 6) (**figure 4.7**). Most of the tests he performed were for women who had already missed one menstrual period (Elkan, 1938a, 315). Elkan's patients often drank tea or carbonated 'Vichy' mineral water,[237] in the evening, which diluted the specimen of morning urine, making it worthless (Elkan, 1939b, 899). He later recalled that pregnancy tests were 'required by three groups of people: those who *hope* they are going to have a child, those who *fear* they are going to have a child, and finally doctors who, faced with an arrangement of signs and symptoms that might, among others, be explained by pregnancy, do not feel that playing for time is what the patient expects of them.' Elkan often received bottles labelled 'URGENT', which he

[237] On the export of Vichy mineral water: Gordon, 2012.

took to mean that ‘the senders, whichever group they may belong to, do not think they are having a luxury test done’ (Elkan, 1947, 104).



Directions for a Pregnancy Test

A **6 oz.** medicine bottle (including the cork) should be cleaned thoroughly with hot water.

There should be no trace of dirt or any other substance left in it.

The bottle should be filled with the **first** urine that is passed in the morning. In case the first urine does not fill the bottle some of the second urine passed may be added.

The bottle should be **very, very carefully** packed (we hear that specimens often get broken in the post), and should be sent with a cheque or postal order for £1. 1. 0. to

Dr. EDWARD ELKAN,
14 Park Square East,
Regent's Park,
London, N.W.1

The minimum amount of fluid should be drunk after lunch on the day before the specimen is taken, and no fluid at all after dinner on that day.

No medicine of any kind should be taken on the day before collecting the urine.

The test can be expected to show a pregnancy of 21 days duration and should therefore be done any time after the period is 10 days late. It takes 24 hours to complete and the result is sent to the patient's doctor.

In the case of a test showing a negative result (that is: not indicating a pregnancy), if menstruation does not occur within a further fortnight and no other reason for its absence is found, it is advisable to have the test repeated.

Answer the questions, detach questionnaire and send this in with the specimen.

Patient's full name.....

Patient's age.....

Patient's address and telephone (in case the answer is to go direct to the patient).

.....

.....

.....

First day of last period.....

Period usually every..... days

Morning sickness (yes or no).....

Date on which urine was collected.....

Name and address of doctor to whom the answer is to go:

.....

.....

.....

Figure 4.7. ‘Directions for a pregnancy test’ instructs doctors on packing urine specimens ‘very, very carefully’ and includes space for the patient’s address and telephone ‘in case the answer is to go direct to the patient’ (PP/EPR/A.1/1, Wellcome Library).

In the first year Elkan performed nearly 300 tests using over 2,000 toads (counting the same ones multiple times), or about seven toads per test (Elkan, 1938b, 1255). He set up eight tests in one hour, 'including the time needed for injecting', and read the results the next morning. 'The whole test, therefore, took less than 24 hours to complete, a fact usually appreciated by patients and doctors' (Elkan, 1946b). Elkan preferred to work with medium-sized animals: the smallest toads did not tolerate injections very well and larger ones did not fit into an ordinary two-pound glass canning jar (Elkan, 1938b, 1253).

Dissatisfied with his reliance on imported stock, Elkan also attempted to breed *Xenopus* in captivity. After 'many unsuccessful attempts,' he managed to hatch about two hundred tadpoles.[238] These resembled 'young fish' standing vertically, head-down, to filter-feed on aquatic microorganisms in 'the manner of whales' (Elkan, 1947, 255). Not knowing what to feed them, he first rather transgressively offered them emulsion of human blood, obtained from his patients' routine tests. 'This method worked perfectly but there were not always sufficient numbers of "donors" at hand, so [he] tried emulsified butcher's liver instead' (Elkan, 1983, 56). This worked and although only one in five tadpoles survived to adulthood (Elkan, 1938b, 1253), Elkan predicted that 'frog-farming' could become 'as remunerative as mouse-farming' was already (Elkan, 1939b, 900); he called on 'the reptile specialist' to attempt the 'difficult task' of breeding the 'pathologist's pet' (Elkan, 1939c, 95).

When, at the start of World War II, the Ministry of Food promoted rabbits for human consumption (Zweiniger-Bargielowska, 2000, 2011, Martin, 2010), Elkan argued that instead of discontinuing pregnancy testing altogether, pathologists should instead use *Xenopus*, which required only 'a little scrap of meat once a week' (Elkan, 1940, 697). Elkan had performed over 800 tests on 5,000 toads by the time he was imprisoned as an 'enemy alien', first at Huyton Alien Internment Camp, near Liverpool, and then on the Isle of Man.[239] Although later released into duty, caring for civilians and wounded soldiers at an EMS hospital ('a sort of Poor Law Institution') in Bishop Auckland, County Durham (Elkan, 1983, 58), Elkan did not resume pregnancy testing until after

[238] Elkan, 1938b, 1255.
[239] On the internment of 'enemy aliens', of whom many were Jews fleeing Nazi persecution: Cesarani & Kushner, 1993.

the war. During the war, however, Elkan's former boss, Edgar Obermer came to the attention of the Home Office for allegedly performing Aschheim-Zondek tests without licence or registration.

In December 1943 the Ministry of Labour asked the Ministry of Health 'to adjudicate on a call-up question' in relation to Obermer's Institute for Medical Diagnosis. The Ministry of Labour accused Obermer of undertaking 'biochemical diagnostic procedures' and also carrying out 'a large scale survey of pregnancy'.[240] Dr Walter Phillips Kennedy, the medical intelligence officer in charge of the case, could 'only interpret this as indicating that he does Zondek-Aschheim tests and would therefore, require to be licensed under the 1876 Act, and also to have an A certificate.'[241] Obermer's survey was in fact on 'wartime rationing and nutrition in pregnancy'. Carried out on pregnant women in the outpatient department of the City of London Lying-In Hospital, the results were not published until after the war, by which time Obermer had relocated to Italy.[242] Although Obermer was not actually performing pregnancy tests, Major James Alfred Giles, chief inspector under the 1876 Act, was convinced that pregnancy testing was generally attracting 'a proportion of the foreign scientific refugee element'.[243]

Ordinarily, Giles would have called on the local police to make inquiries, but in the case of pregnancy testing his inspectors had long doubted whether an animal injection was 'really an experiment within the meaning of the Act' and considered it unwise to 'put legal machinery into motion and risk an adverse decision' in court until the question was settled. So, instead of pursuing Obermer, Giles decided to draft a memorandum on the 'position of pregnancy tests under the Cruelty to Animals Act'.[244] In it, he explained that a re-qualified medical refugee could apply for a licence under the Act and that there was 'no obvious reason' to refuse registering premises where pregnancy testing was one of several diagnostic services provided.

[240] Ministry of Health vivisection minutes, 1 February 1944, HO 45/25145.
[241] W. P. Kennedy to J. A. Giles, 31 December 1943, HO 45/25145. See 'W P Kennedy', *BMJ*, 284, 1 May 1982, 1339-1340.
[242] See, for example, Obermer, 1947, 1948.
[243] 'The position of pregnancy tests under the Cruelty to Animals Act, 1876', 2 February 1944, 2, HO 45/25145. On Giles: 'J. A. Giles, M.B., B.S., D.P.H.', *BMJ*, 22 July 1961, 248. See also Lawrence, 1987, 305-306.
[244] Ministry of Health vivisection minutes, 7 February 1944, HO 45/25145.

Yet he also admitted that 'the standard of these premises' varied 'considerably' and contrasted Queen Charlotte's Hospital, where pregnancy tests were performed under a general registration, with 'a small laboratory staffed entirely by foreigners and doing only pregnancy work'. It was this second kind of establishment that troubled inspectors, even if there was 'no direct evidence of irregularity or illegality.'[245]

Giles was particularly concerned that 'in the event of any criminal prosecution for abortion being launched, it might well come out in Court, and presumably the counsel for the defence would have every interest in bringing it out, that the premises in which the initial pregnancy test had been carried out had been premises registered by the Home Secretary under the 1876 Act.' Although 'any such publicity could be met with the perfectly reasonable argument that it is not for the Secretary of State to trace the origin of specimens tested on any particular registered premises, and that his responsibility is fulfilled if those premises are conducted according to the requirements of the Act', it was 'equally obvious that there would be a public outcry and the position of the Home Office in this matter could be greatly misrepresented were it to be revealed that the Home Secretary had, however unwittingly, registered a laboratory where material supplied by abortionists is regularly examined.' Under the circumstances, Giles decided to examine whether pregnancy diagnosis, 'if conducted by means of the Zondek-Aschheim or Xenopus tests, comes within the Act at all.'[246]

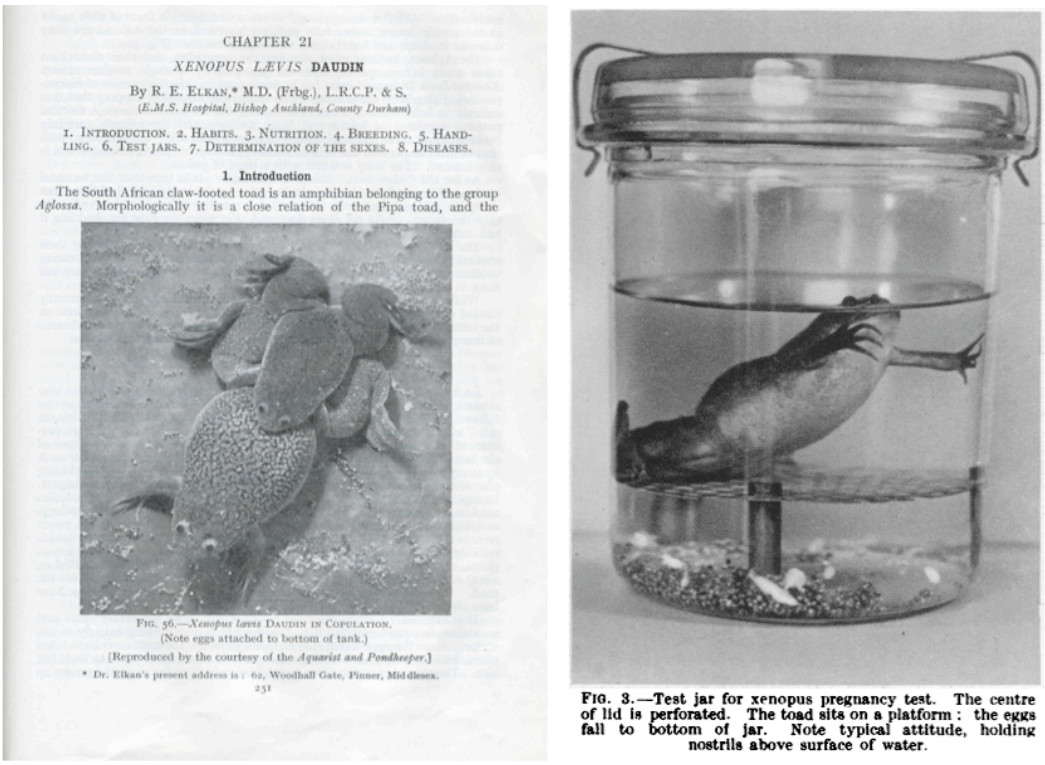
Giles recalled that 'pregnancy tests as undertaken [in 1944] were quite unknown in 1882, and therefore this aspect of inoculation work could not have been in the minds either of the Home Office or of the [legal officers] at this time.'[247] After reviewing the meaning of 'experiments calculated to cause pain' within Section 2 of the Act, he decided that there could 'be no question at all that these tests do not, cannot, and are not intended to cause pain or disease.' On the contrary, they seemed to 'create a perfectly normal physiological reaction in the ovary,' even 'a sense of well-being.' Giles recommended that pregnancy tests 'be taken outside the Act'. Not only would this remove 'all danger […] of the Home Office being placed in a position where it can be extensively criticised with no sure means of disarming such criticism', but it

[245] 'The position of pregnancy tests under the Cruelty to Animals Act, 1876', 2 February 1944, 2, HO 45/25145.
[246] Ibid.
[247] Ministry of Health vivisection minutes, 1 February 1944, HO 45/25145.

would also relieve inspectors 'of work which at present takes up a great deal of their time.'[248]

The successful *UFAW handbook on the care and management of laboratory animals*, first published in 1947, reported that the Home Secretary had recently 'removed certain pregnancy tests from the ambit' of Section 2 of the Act.[249] By this time Elkan had moved his practice and 'laboratory' to Pinner, Middlesex, and his chapter in the successful *UFAW handbook* helped establish *Xenopus* as a standard laboratory animal in postwar Britain, not only in pregnancy diagnosis but also in embryology (Gurdon & Hopwood, 2000, 47) (**figure 4.8**). Although it had been 'exceedingly difficult' to import the toad 'during the war years', the Hogben test had 'been extensively used by the Canadian military […] and by the Royal Navy' and by 1947 stocks were growing in London, Edinburgh and Aberdeen.[250] Elkan recalled of the immediate postwar years that the test had become 'quite accepted by the medical profession' and he was able to assemble 'quite a clientele' (Elkan, 1983, 58). Some 'enterprising medical students' at University College London ran 'a private service' using *Xenopus* (Bangham, 1999, 57) and the biologist Alan Parkes, who had established a colony at the National Institute of Medical Research, recommended *Xenopus* as a substitute for British frogs in schools (Parkes, 1947), and by the early 1950s, hobbyists were enjoying the 'strange and weird performances' of the 'interesting species' in aquaria and garden pools (Bury, 1953, 145). The Hogben test was also adopted on a large scale by the NHS, to which I now turn.

[248] Ibid., 3.
[249] Hume, 1947, 7. Founded by Major Charles Hume in 1926 as the University of London Animal Welfare Society, the name was changed to UFAW in 1938. The *UFAW handbook* was 'immensely successful as a "standard" reference work': Kirk, 2009, 528-529. As late as the early 1960s, Major Hume and the Home Office were still clarifying to pathologists that pregnancy tests were no longer covered by the 1876 Act. See Hume, 1962, 2 and Beedle to Calman, 'Cruelty to Animals Act, 1876,' 11 July 1963, HO 45/25145.
[250] 'Letters, notes, and answers', *BMJ*, 1, 16 February 1947, 262-264, 262. On the Canadian Army's *Xenopus* colony and pregnancy testing laboratory at McGill University's Institute of Parasitology: Cameron, 1945, Snell, 1963, 154. On civilian pregnancy testing in postwar Canada: Pollack, 1949



CHAPTER 21

XENOPUS LÆVIS DAUDIN

By R. E. Elkan,* M.D. (Frbg.), L.R.C.P. & S.
(E.M.S. Hospital, Bishop Auckland, County Durham)

1. Introduction. 2. Habits. 3. Nutrition. 4. Breeding. 5. Handling. 6. Test jars. 7. Determination of the sexes. 8. Diseases.

1. Introduction

The South African claw-footed toad is an amphibian belonging to the group *Aglossa*. Morphologically it is a close relation of the Pipa toad, and the

Fig. 56.—*Xenopus laevis* Daudin in Copulation.
(Note eggs attached to bottom of tank.)
[Reproduced by the courtesy of the *Aquarist and Pondkeeper*.]

* Dr. Elkan's present address is: 62, Woodhall Gate, Pinner, Middlesex.

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Fig. 3.—Test jar for xenopus pregnancy test. The centre of lid is perforated. The toad sits on a platform: the eggs fall to bottom of jar. Note typical attitude, holding nostrils above surface of water.

Figure 4.8. Left: Elkan's chapter in the *UFAW handbook* helped to establish *Xenopus* as a standard laboratory animal in postwar Britain (Elkan, 1947a, 251). Right: the iconic *Xenopus* pregnancy test jar in profile. Naturalists and children have long kept frogs and toads in ordinary glass jam or canning jars (Elkan, 1938, unpaginated plate).

4.3. Anxiety-driven demand and 'curiosity cases'

It is significant for pregnancy testing that on Monday 5 July 1948, not one, but two national health services came into being. The 1946 National Health Service Act created one service in England and Wales, administered from the Ministry of Health, Whitehall, London. It consolidated the wartime Emergency Laboratory Service in England and Wales as the Public Health Laboratory Service (PHLS) with administrative headquarters at Westminster to coordinate a central laboratory at Colindale, four regional laboratories at Oxford, Cambridge, Cardiff and Newcastle, several smaller 'area' laboratories, and a few reference laboratories for specialised examinations (Wilson, 1948) (**figure 4.9**). In Scotland a separate piece of legislation, the 1947 National Health Service (Scotland) Act, set the terms for an autonomous organisation administered by the Secretary of State for Scotland, St. Andrew's House, Edinburgh. This act conserved the 'general pattern' of Scotland's Emergency Bacteriological Service, administered by the Secretary of State in Edinburgh.[251]

[251] DHS Circular No. 97/1947, Graham, 'Bacteriological service', 6 October 1947, HH102/858.

Figure 4.9. A map of the PHLS in England and Wales in the *British medical bulletin* (Wilson, 1951, 146).

Although Francis Crew was poised to begin using *Xenopus* routinely in 1939, his plans were scuppered by the war. He was recalled to the Royal Army Medical Corps and had handed over control of his institute to Alan W. Greenwood, a zoologist from Melbourne who was running an autonomous sub-department on poultry genetics (Crew, 1971, 293). Greenwood not only maintained the pregnancy diagnosis station

in Crew's absence, but also invested in 'new animal cages and general replacements'.[252] It was 'exceedingly difficult' to import *Xenopus* 'during the war years'[253] and mice 'reigned supreme'.[254] Crew returned to the University of Edinburgh in 1944 to take up a chair in 'social medicine' and, when Conrad H. Waddington took over the Animal Genetics Institute in 1947,[255] Crew transferred the station from 'the suburban science departments of the King's buildings' to the Usher Institute of Public Health in the more central area of Marchmont, where his chair was located (Maclean, 2004, 59). Crew hired Hogben's former assistant Landgrebe for one year to reestablish the *Xenopus* colony (Wells, 1975, 206) and by 1948 the new laboratory was 'equipped to carry out the Hogben test' (Hobson, 1952, 352). The number of tests had more than doubled from some 10,000 in 1939 to over 21,000 in 1948 and, after three years of coexistence, the Hogben test was used exclusively from 1951. The two decades-long reign of mice had ended. By 1952 the stock of *Xenopus* had reached some 6,000 toads, four times as many as had been kept at the King's buildings' before the war (Hobson, 1952, 352) (**figure 4.10**).

[252] Crew's draft letter to Davidson, undated, 7pp. (No. 11), p. 1, HH102/858.
[253] 'Letters, notes, and answers', *BMJ*, 1, 16 February 1946, 262-264, 262.
[254] B. M. Hobson to R. W. Johnstone, 13 November 1953, GD11, Lothian Health Services Archive. See also Johnstone, 1954, 92.
[255] On Waddington: Robertson, 1977, Yoxen, 1986, Hall, 1992, Stern, 2000, Slack, 2002.

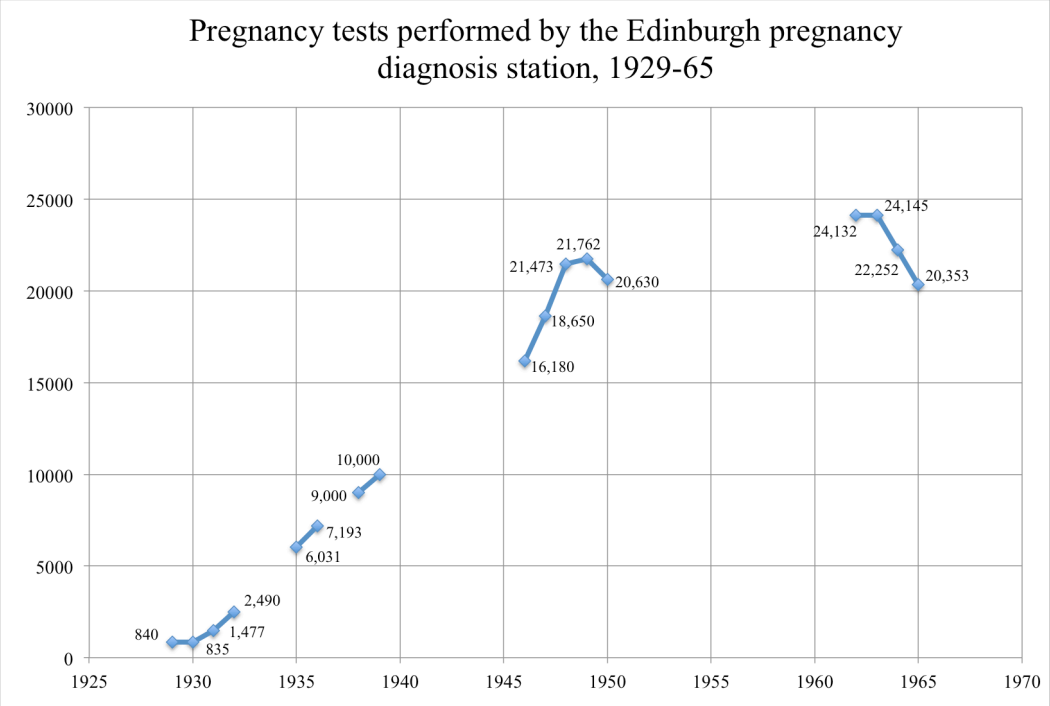

Figure 4.10. Though there are notable gaps in the record during the war and in the 1950s, the volume of work performed at Crew's station steadily increased and then levelled off at 20,000+ tests a year until the early 1960s when the proliferation of private labs using immunoassays caused decline (see Chapter 6) (HH102/858). In the 1950s the Watford and Sheffield centres (see below) would have contributed perhaps a further 20,000 tests each, but it is unlikely the grand total (including numerous smaller pathology labs) would have surpassed 80,000 or so per year. For perspective, married women in England and Wales the 1930s produced 600,000 livebirths each year, though the number of pregnancies (including those ending in miscarriage, abortion or stillbirth) was undoubtedly higher (Szreter, 1996, 428). This means that, in the 1930s, there was approximately one test per sixty livebirths (1.7%).

During the war Greenwood had employed one secretary at £7 a week, to handle the large sums of money, three office clerks and six laboratory technicians and animal attendants. Crew's enlarged station at the Usher employed Bruce Morris Hobson, BSc Aberdeen, as its new scientific director, a university assistant, three secretaries, nine laboratory technicians, one part-time laboratory worker and a part-time animal attendant. Half of all specimens received in Edinburgh came from England and half of those from south of Birmingham, with a 'heavy concentrations' in London and the Midlands. A pregnancy test cost fifteen shillings for private clinics and seven shillings for hospitals and, in a ten-month period, the station had received £6,700 in fees and spent £4,575 on wages, mice, laboratory supplies, telephone bills, stationary, stamps and sundry to show a surplus of £2,125. The 'rapidly increasing […] volume'

of the 'stream of urine', especially from south of the border, surpassed Crew's expectations and placed him in 'something of a dilemma. He was faced with the ruinous prospect of expanding his service at 'considerable expense' to keep up with southern demand until the NHS in England and Wales began offering a free service of its own, at which point he would be left with 'an organisation out of harmony with future needs.' Crew's only option was 'to steer a very careful course' in the next year or so, continuing to serve English and Welsh doctors while preparing 'for the time when the whole of this custom will collapse.'[256]

Before the war Crew had promoted the 'democratisation' of pregnancy testing. Postwar plans for a Scottish health service presented him with the irresistible opportunity to secure a place for his station within a nationalised system of laboratory services. All he needed was a block grant of £4,500 per year to cover equipment, staffing and running costs.[257] In January 1946 he proposed 'a scheme for the provision of pregnancy diagnosis facilities' to Sir Andrew Davidson, the Chief Medical Officer of the Department of Health.[258] Centralisation, Crew argued, would save the Scottish service money. As he knew from his wartime experience, when a pathologist performed the occasional test in a clinical laboratory, the cost soared from five shillings to the 'absurd heights' of two guineas. Picking up from where he had left off in 1939, he also argued that a centralised service could provide facilities and material for research in human infertility, a vital aspect of social medicine. But, he admitted, there was 'no point in [...] developing such a scheme' if it was 'not to be used as the basis of a national pregnancy diagnosis service'.[259]

But the five regional boards in Scotland had 'considerable authority',[260] and not all accepted Crew's 'proposal that all pregnancy diagnosis work be referred to Edinburgh.' Wary of the 'various defects of "postal pathology"', the Western Board decided that it was 'more convenient' to continue to rely on an 'experienced

[256] Crew to Davidson, 20 June 1947, Crew's draft letter to Davidson, 1947, Crew to Davidson, 20 June 1947, HH102/858.
[257] Crew to Davidson, 25 March 1947, NAS HH102/858.
[258] See 'Sir Andrew Davidson', *BMJ*, 25 March 1962, 880-881. For Davidson's views on the NHS Acts: Davidson, 1948.
[259] Crew to Davidson, 21 January 1946, Crew to Sir Andrew, 25 November 1946 , NAS HH102/858.
[260] Stewart, 2003, 399-400. See also McTavish, 2000, 2005, Nottingham, 2000, Jenkinson, 2002, Dingwall, 2003, Hamilton, 2003, McCrae, 2003, Stewart, 2010, Gorsky, 2004, Merrick, 2008.

pathologist' at the Glasgow Royal Maternity and Women's Hospital, who performed a steadily increasing number of Aschheim-Zondek tests every month, though Dumfries and other outlying areas continued to post specimens to Edinburgh.[261] When Landgrebe returned to Aberdeen University in 1948, he continued to perform Hogben tests for the Northeastern Region,[262] and from 1951, so too did Dr John Smith's regional laboratory at the Aberdeen City Hospital. The Southeastern Board, responsible for Edinburgh, decided not to act on the block grant until it could be established with more certainty 'how many tests would remain with the Edinburgh centre.'[263]

Scotland's health department considered Crew's proposal, but Dr Charlotte Ann Douglas, the department's adviser on maternity services,[264] was 'not too happy about' the prospect of a 'central laboratory in Edinburgh [that] would have to be fed by postal services for about 90% of the population of Scotland'. As with the specimens Elkan received in London, those sent to the Edinburgh station were 'usually accompanied by a note stating that it is a matter of urgency', but Douglas wondered whether the urgency was medical or 'emotional'. The departmental committee on laboratory services concluded that those Scottish regions that did not 'send all their work to the Usher Institute [were] quite happy about their alternative arrangements'. And the treasurer of Edinburgh University decided that not to support Crew's proposal 'as it was known that […] centres would be opened up in England'.[265]

During the war, pregnancy tests had been provided under the ELS and Sir Philip Panton, the recently knighted consultant in pathology to the Ministry of Health,[266] expected the status quo to continue 'under the aegis of Regional Hospital Boards.' He favoured the Hogben test, but saw no need to make a special arrangement for postal references to Crew's laboratory. In 1948 the Ministry began making plans to

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[261] Hobson to Callan Wilson, 17 August 1949, Notes of meeting with Dr. Bowman, 25 December 1949, 'Pregnancy diagnosis', 30 December 1949, HH102/858.
[262] See Dr Bruce Morris Hobson, FRCP Edin, http://www.rcpe.ac.uk/obituary/dr-bruce-morris-hobson-frcp-edin.
[263] 'Pregnancy diagnosis service', 7 June 1951, Pringle to Callan Wilson, 1 June 1950, HH102/858.
[264] See 'Charlotte A Douglas', *BMJ*, 29 March 1980, 948, Douglas & McKinlay, 1935.
[265] DHS Minutes, 16 June 1947, Hughes to Taylor, 28 May 1951, Pringle to Callan Wilson, 1 June 1950, HH102/858.
[266] 'Sir Philip Panton H. B. M.', *Journal of Clinical Pathology*, 4, February 1951, 109-111. See also Panton, 1951.

'distribute some fifty [toads] to each of the major hospitals throughout England and Wales.' But after discussing the matter with Landgrebe, the leading *Xenopus* expert on both sides of the border, Panton instead decided to follow the Scottish model by setting up a few large, specialised centres.[267] In 1949 Dr Herta Schwabacher, a London-trained pathologist,[268] was placed in charge of the NHS pregnancy diagnosis centre at Shrodells Hospital in the London suburb of Watford and Elkan enlisted to help set up and maintain the *Xenopus* colony (Elkan, 1983, 58).

After building the stock up to 200 toads, the Watford centre began testing the first specimens, collected locally in Hertfordshire. As the size of the colony grew, Schwabacher began accepting specimens from London and the South of England. February 1949 saw a total of 40 tests and October, over 500. After one year in operation, nearly 4,000 tests had been performed and the *Xenopus* colony had reached its full capacity of 3,000 toads. Doctors submitted urine specimens to Watford for all the usual medical reasons: threatened miscarriage, hormonal imbalance, hydatidiform mole, menopause, tuberculosis, heart disease, fibroids, tumours and (rarely) testicular cancer in men. But Schwabacher also recognised a smaller portion of requests (around 4%) for unmarried girls and women, or what she called 'anxiety' cases.

Though not strictly medical, Schwabacher accepted that early diagnosis in such cases would enable patients 'to make readjustments in social and domestic life' (Schwabacher, 1951, 84). This might involve preparations for marriage or, if marriage was out of the question, adoption.[269] But a staggering 40% of doctors' requests were for married patients with no apparent pathology. Schwabacher feared these 'curiosity cases' would eventually 'swamp' the *Xenopus* colony 'to the detriment' of legitimate 'pathological' and 'social' cases and formally discouraged 'tests from *married women who are likely to have a normal pregnancy*' (Schwabacher, 1951, 84). A circular sent to London hospitals in 1950 clarified that the Watford centre carried out tests within 'the hospital pathological service where clinical or social conditions exist' and did 'not accept specimens from a [married]

[267] Beek to Watson, 10 June 1947, Crew to Davidson, 9 December 1947, HH102/858.
[268] 'Herta Schwabacher', *BMJ*, 289, 10 November 1984, 1319.
[269] In the 1950s parents continued to send pregnant daughters to workhouses until childbirth, at which point newborns would be put up for adoption: Spensky, 1992, Keating, 2009, 31. See also Homrighaus, 2010, Gallwey 2011, Thane & Evans, 2012.

woman who is likely to have a normal pregnancy.'[270] Yet in practice, the proportion of 'curiosity' cases increased slightly to 45% as the total number of specimens increased to 6,148 in 1950 (the proportion of 'social' cases also increased to 6.2%).

In February 1951 the Ministry of Health set up a second centre at Sheffield City General Hospital to serve the Midlands and the North of England. In 1954 the Sheffield centre had to 'severely restrict its output as a result of difficulties in obtaining toads' (Shea & Warrack, 1963, 581). When the *Guardian* reported that the Edinburgh station was also affected and that it 'only dealt with special cases of women with abnormal conditions',[271] Hobson contacted the paper to clarify that the station was a 'university venture' not affiliated with the NHS: it had not 'suspended operations' and accepted specimens not only for 'complications arising from pregnancy', but also 'for the early diagnosis of pregnancy'.[272] Sheffield again suspended its service in 1958 when a bacterial epidemic 'almost destroyed the entire toad colony' (Shea & Warrack, 1963, 581). Aside from these hiccups, the Sheffield centre maintained a stock of 4,000 toads and performed some 20,000 tests a year. In 1952 Landgrebe moved to the Pharmacology Department of the Welsh National School of Medicine in Cardiff, where he established another *Xenopus* colony and diagnostic service. And by 1960 Landgrebe was performing 2,039 tests for 134 Cardiff general practitioners (**figure 4.11**). Second only to blood tests for anaemia, the Hogben test accounted for an impressive 22% of all laboratory investigations for 310,961 NHS patients in the Cardiff area (Hitchens & Lowe, 1966, 144). Crew's prewar vision of state-supported pregnancy diagnosis centres in cities around Britain was coming true.

[270] N. E. Metropolitan Regional Hospital Board Circulars 1950-1951. Circular No. (50) 150, HA/NT/117/000702, London Metropolitan Archives.
[271] 'Toad supply gives out: Hospital centre closed', *Manchester Guardian*, 6 November 1954, 1.
[272] 'Toads still at work: Edinburgh aids Sheffield', *Manchester Guardian*, 10 November 1954, 8. Hobson also sent a letter to the *BMJ* and *Lancet* to reassure practitioners, clinics, and hospitals that, contrary to the 'completely untrue' statement made in the *Guardian*, the Edinburgh laboratory had not closed down. See 'Pregnancy diagnosis', *Lancet*, 13 November 1954, 1025 and 'Toad supply', *BMJ*, 20 November 1954, 1229.

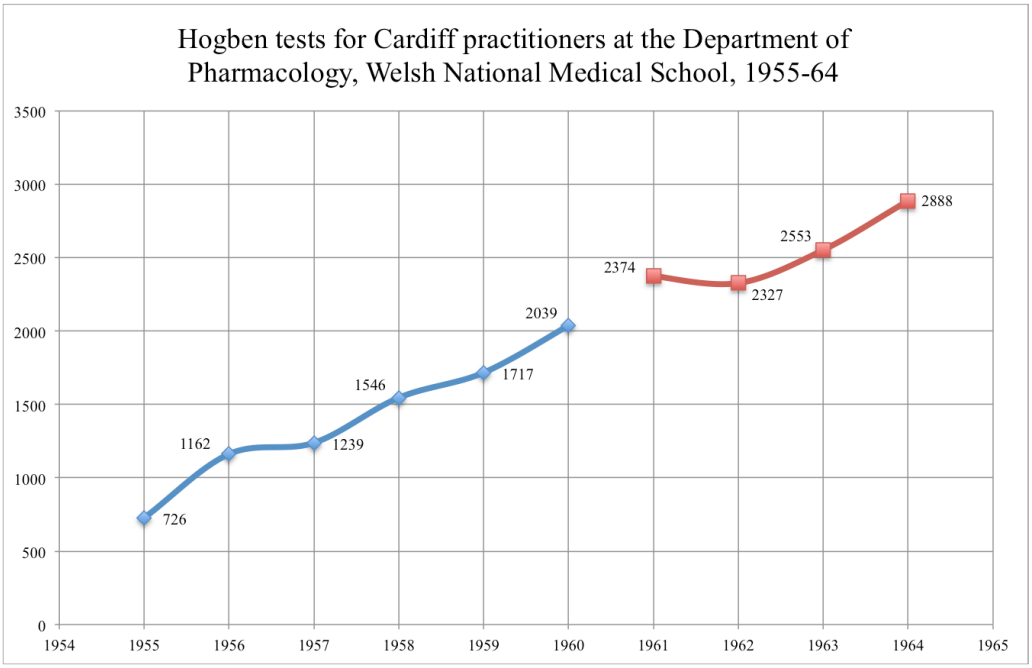


Figure 4.11. Although the method of recording information changed in 1961 from number of investigations to number of request forms, this probably made no difference for how pregnancy tests were counted: Hitchens & Lowe, 1966, 144.

4.4. 'Why don't you have a frog-test?'

On Saturday 10 July 1948 the novelist Mary Rose Alpers, née Coulton, and her husband, Anthony Alpers, began another day of work in the British Museum Reading Room by 'reminding one another [to] telephone Dr. W.'s secretary at noon.' When Mary Rose had telephoned the day before, the secretary had made no promises but suggested that 'the results of the pregnancy test' might come in the next morning's post, in which case she would be able to tell the couple 'whether they [were] positive or negative before [going] off for the week-end.' The pair worked 'till noon under the stifling dome' and then, on their way to lunch, Mary Rose telephoned 'from the booth in the desolated entrance hall.' The secretary answered in 'a nice warm voice' that the post had 'just this moment come in', that it contained the letter and, upon opening it, that the test result was 'positive.' '"I do hope that's what you want,"' said the secretary in a 'pleasant voice'. It was and the Alperses walked out into the 'brilliant summer sunshine' to lunch under the plane tree and to 'happily' discuss 'ways and means' (Campion, 1950, 7).

The brief telephone conversation between Mary Rose Alpers and her doctor's secretary, documented in the book *National baby* (1950), was the beginning, but not the end, of her protracted diagnostic experience. Endorsed in the *Guardian* as a 'highly entertaining account' of antenatal care from the 'consumer's end',[273] *National baby* was Alpers's 'personal chronicle of what it is like to have a first baby under the National Health Scheme.'[274] Although pregnancy testing was by no means routine in the late 1940s, Alpers, who wrote under the pseudonym of Sarah Campion, qualified for a pregnancy test under the new system because she was over forty and 'Philip' was her first child. Her unusually detailed account is particularly revealing, not only of one woman's diagnostic experience, but also of the broader culture of pregnancy testing in the early years of the NHS, and so worth dwelling on here.

On Monday morning, Alpers trekked to a suburban hospital (she does not say which one) bearing a doctor's letter 'in one hand' and the test result 'in the other,' only to be told to return 'at the end of next month' for a booking. She returned home

[273] A. P. M., 'Consumer's end', *The Manchester guardian*, 17 November 1950, 4.
[274] Campion, 1950, 5. See Hanson, 2004, 132.

'fulminating against the official mind, feeling like that grotesque old Viscountess in [William Makepeace Thackeray's 1852 novel *The history of Henry*] *Esmond* who was always thinking herself pregnant and never had anything to show for it in the end.' Although worried that she might be 'undergoing only a hysterical pregnancy',[275] morning sickness soon restored her self-confidence: she welcomed the 'butterflies' in her stomach as evidence of the hospital authorities' overcautiousness. Perhaps, she speculated, they were 'cautious only because miscarriages [were] so common in the early months, and they themselves so desperately busy.'[276] Only some weeks later, when her first antenatal clinic was finally booked for August and a maternity bed for the following March, did she feel 'as if the words "Now officially pregnant" were blazoned on [her] bosom.'[277]

In August, when a hospital nurse finally offered her a chit entitling her to an expectant mother's ration book (rationing continued well into the 1950s), Alpers declined because she already had been given one by her Health Visitor friend and had been 'drawing the correct rations' for the past six weeks. Reflecting on her protracted diagnostic experience, Alpers found it 'odd' that the hospital authorities expected her 'to wait one and a half months from the declaration of pregnancy, and some two and a half form its inception, for the rations which are supposed to support the infant's growing demands on the body.' But in the end she charitably rationalised, as before, that 'there are so many falls by the wayside in the first three months that they have found this the better way.'[278]

Perhaps the most relevant aspect of Alpers's account here is the irrelevance of the pregnancy test from the perspective of the hospital authorities. Made by arrangement between Alpers, her GP, and a diagnostic laboratory, probably the Edinburgh station, the positive result, initially so meaningful to Alpers and her husband, was utterly disregarded when it came to hospital protocols regarding antenatal care, maternity bed and ration book. This disconnect between the patient-doctor-laboratory relationship, on the one hand, and maternity care within hospital system, on the other,

[275] Campion, 1950, 8.
[276] Ibid., 10-11.
[277] Ibid., 20.
[278] Ibid., 23.

sheds light on the marginal place of pregnancy testing in the earliest days of the NHS.[279]

Although first hand accounts are scarce, the evidence suggests that women's diagnostic experiences varied significantly in the 1950s and early 1960s. For a young unmarried girl, the choice was not necessarily hers to make. In her memoir, *Bad Blood*, novelist Lorna Sage recalled her obstinate denial of pregnancy at the age of sixteen in 1959:

> It was so unthinkable that when I felt ill, bloated, headachy, nauseous and, oh yes, my period hadn't come, I stayed in bed and called out our new doctor, a pale, prim man in his thirties, Dr Clayton. After taking my temperature, asking about bowel movements and looking at my tongue, he looked out of the window at the copper beach tree, cleared his throat and asked could I be – um – pregnant? No, I said, feeling hot suddenly, No. He recommended a urine test anyway.

Sage was kept home from school for days and took aspirins for her persistent aches until the 'embarrassed and puzzled' doctor returned to confront her about the positive test result, at which point she 'knew it was true, just as absolutely as until that moment I knew it couldn't be' (Sage, 2000, 236).

Sheila Walker, an Edinburgh-born woman interviewed for the Millennium Memory Bank oral history project,[280] was living in the Surrey countryside and expected to marry her boyfriend when she 'got pregnant' also in 1959, but at the somewhat older age of nineteen. She 'went to the doctor's and of course in those days you didn't get early pregnancy tests. You waited till you missed your second period. And it was then that you might start worrying. And I went to the doctor and of course the doctor would take a test and it would take a week before you got, you know, the result. So that's what it was like in those days.' When she told her boyfriend she had 'missed [her] second period' and the doctor had had 'confirmed' she 'was having a child', her

[279] Histories of the NHS do not mention pregnancy testing and barely touch on laboratory services. An important exception is Loudon & Drury, 1988, 108-111. For classic accounts see Webster, 1988, 1996, 2002, Pater, 1981, Honigsbaum,1989, Rivett, 1998, Klein, 2010. For a recent review of the literature: Gorsky, 2008.
[280] See Gallwey, 2013.

boyfriend, who had been cheating on her, 'just went completely cold' and refused to marry her; her father convinced her to give up the child for adoption.[281]

There was less at stake for married women, for whom a pregnancy test could still be seen as expensive luxury. Hope, a London-born woman who had worked as a lab technician for British Drugs Houses before getting married and moving to Oxford, recollected visiting her doctor at the age of 25 in 1955:

> I went to the doctors. Erm, and we hadn't actually planned to have one quite that soon, so I was moderately upset erm, and pregnancy testing was only just starting then, and I went and you know until the doctor could actually feel something you couldn't be certain that you were pregnant. I said 'What about a pregnancy test?' which in those days I think they injected some of your urine into a frog and it ovulated or something, and he said, 'Well yes, we can arrange that but it would cost I don't know how much', and I said, 'Oh we can't afford that we need that money for the baby', so erm anyway I was pregnant and it duly arrived at the appropriate time. [282]

Ovulating toads occasionally featured in women's diagnostic narratives, including that of Claire Rayner, a prolific broadcaster, agony aunt and novelist.[283] In the early 1960s Rayner's doctor broke the news by telephone: '"Claire," she said, in as delighted a voice as I had ever heard her use, "that specimen you left with me – I have to tell you I was right and there are, as I've just heard from the laboratory, a couple of toads there are in a state of *great* excitement. You are pregnant, my dear, most definitely pregnant. You did say you were planning another baby, didn't you? How lovely for you!"'[284] And, as 'a young wife' in Manchester in the 1960s, Maureen Symons was 'desperate for a family.' But she would 'miscarry and then be told a few days later that indeed [she] had been pregnant, [her] toad had laid eggs.' She eventually gave birth to 'a beautiful daughter, Kate, and then a son, Daniel.'

[281] Interview by Amanda Kennet with Sheila Walker on April 4 1999, Millennium Memory Bank C900/16008 C1, my transcription.
[282] Interview by Angela Davis with Hope, Ref: CO11, Disc no: 1. For details: Davis, 2012, 219.
[283] Rayner's began her journalistic career writing scripts for BBC Radio 4's *Women's Hour*, which were later published as educational leaflets: Loughlin, 2005, 306. See also Rayner, 2003.
[284] Rayner, 2003, 311-312.

Today she still smiles whenever she sees a toad in her garden, remembering 'the efforts they made on [her] behalf (even if they aren't the right species!).'[285]

Audrey Peattie, a laboratory technician I interviewed in 2011, remembered 'quite a few' specimens from 'unmarried mothers' at Watford centre in the 1950s (**figure 4.12**). But otherwise she did not know 'anything much' about the lives of the women whose urine specimens she centrifuged and injected into toads. Although 'quite scared' of Schwabacher, 'a formidable lady', she fondly recalled Elkan as 'a funny old boy that came down a couple of times a week and just fiddled about in the lab.' She expressed an interest in his work and he often called her over 'to look at things' and 'explain a bit', which is why she also remembered *Bufo bufo*, 'quite little ordinary toads like the kind you see in the garden'.[286] The final section of this chapter turns to a second toad test, less well known than Hogben's, which enlisted the male of the commonest British species in the service of the diagnostic laboratory.

[285] Maureen Symons, email, 16 April 2013.
[286] Interview by Jesse Olszynko-Gryn with Audrey Peattie, 1 August 2011.

Figure 4.12. A snapshot, probably taken by Elkan, an avid amateur photographer, of Audrey (front) injecting a *Xenopus* toad with urine while her colleague Marion (back) prepares the next syringe. Note the prominent test jar on the work surface and the holding tanks on the shelving units in the background of the warehouse-like room (photograph courtesy of Audrey Peattie).

4.5. 'The friendly *Bufo bufo* and his chums' (2,392)

In December 1948 a *Lancet* editorial surveyed twenty years of pregnancy diagnosis since the invention of the Aschheim-Zondek test. 'The day has not yet arrived', it concluded, 'when the doctor can tell his patient that she is pregnant by pouring her urine into a tank of fish and watching their bellies become red; though this was the great expectation which the male bitterling at one time held out.'[287] The editorial was, however, cautiously optimistic about the 'Galli Mainini test', on which Dr Magnus Haines, director of pathology at the Chelsea Hospital for Women, had recently reported. In 1947 the Argentine physiologist Carlos Galli Mainini determined that pregnant women's urine injected into the lymph sac of the male South American toad, *Bufo arenarum* (today usually reclassified in the genus *Rhinella*), caused it to release spermatozoa.[288] After two or three hours its urine could be pipetted from the cloaca and inspected under a microscope for the presence or absence of sperm. If present, the actively motile slender slightly curved rods, pointed at their anterior ends, constituted a positive test result (**figure 4.13**).

[287] 'Twenty years of pregnancy tests', *Lancet*, 18 December 1948, 977-979, 979.
[288] Galli Mainini, 1947a,b, 1948a,b,c, Bröer, 2004, 141, Haarburger & Pillay, 2011, 546. On endocrinology in Argentina in the 1930s and Galli Mainini's teacher, the Nobel Laureate Bernardo Houssay: Eraso, 2007.

Figure 4.13. Dust jacket and diagram from Galli Mainini's monograph on the male-toad pregnancy diagnosis test depicting the steps involved and the two possible outcomes (Gailli Mainini, 1948a).

Haines had been driven to the male-toad test out of a sense of dissatisfaction with the others: the supply of infant female mice, he complained, was unreliable, rabbits had become 'costly and difficult to obtain', the 'early enthusiasm' for rats had waned, and *Xenopus* had 'not been adopted generally.'[289] He had written to Galli Mainini in Buenos Aires, who had arranged for the transport of 136 toads to London as part of a traveller's luggage (Haines, 1948, 926). Haines praised the male-toad test on the grounds that it only required three hours to complete, reading the result did not require any 'special skill', and the 'whole operation of pipetting off the urine and its microscopical examination' lasted only a few seconds. The toads required 'no special tanks' (Haines, 1948, 924), but importing them was inconvenient. Researchers in Paris had recently reported 'equally good results' with 'one of the common frogs found in France,' the edible *Rana esculenta*.[290] So, with help from the Keeper of

[289] Haines, 1948, 923. On the Chelsea Hospital for Women: Blaikley & Chamberlain, 1971. On Haines: Young, 2009, 151.
[290] 'Twenty years of pregnancy tests', *Lancet*, 18 December 1948, 977-979, 979.

Zoology at the British Museum and the Curator of Reptiles at the London Zoological Gardens, Haines began using the locally abundant 'English' or 'British' toad, *Bufo bufo*.

In the 1950s it was still 'more convenient and economical' to collect dogs, cats, monkeys and amphibians 'from the wild' than to breed these 'slowly maturing' species in captivity (Lane-Petter, 1961, 24-25). *Bufo bufo* could be purchased from a dealer for anything from a few pence to one shilling depending on the season (Haines, 1948, 926). Haines and others rapidly determined that British toads worked just as well as their South American counterparts in the Galli Mainini test (ironically, *Xenopus* was one of the only species found to be unsuitable). Clinical pathologists soon began using *Bufo bufo* at St Mary's Hospital Medical School, London (Frazer, 1950, Frazer & Wohlzogen, 1949, 1950). As pathologists at Chase Farm Hospital, Enfield, became familiar with the 'fascinating variety of protozoal life to be found in a toad's cloaca, a cursory low-power examination became sufficient to establish a diagnosis' (Klopper & Frank, 1949, 9-10). In the second edition of his pocket-sized handbook, *Gynaecological endocrinology for the practitioner* (1951), Peter Bishop predicted that the male-toad test would 'in time supersede the other tests' (Bishop, 1951, 101). Dr Gwen Barton, a pathologist at the Salisbury Infirmary, praised the test for making pregnancy diagnosis available to even 'the smallest laboratory' (Barton, 1953, 868). Grace Jeffree of Bristol predicted that the 'cheapness, simplicity, and speed of the toad test are such that it may be expected to replace the Friedman test in many laboratories' (Jeffree, 1953, 151). And a review of pregnancy tests in the *Postgraduate medical journal* recommended *Bufo bufo* over *Xenopus* for smaller laboratories (Ferreira, 1954) (**figure 4.14**).

FIG. 3.—Spermatozoa of B. bufo. Positive reaction. × 300.

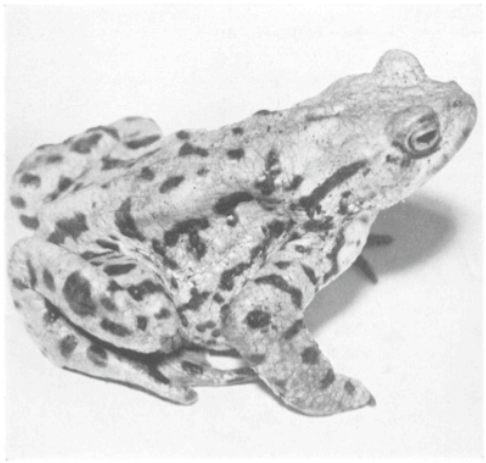


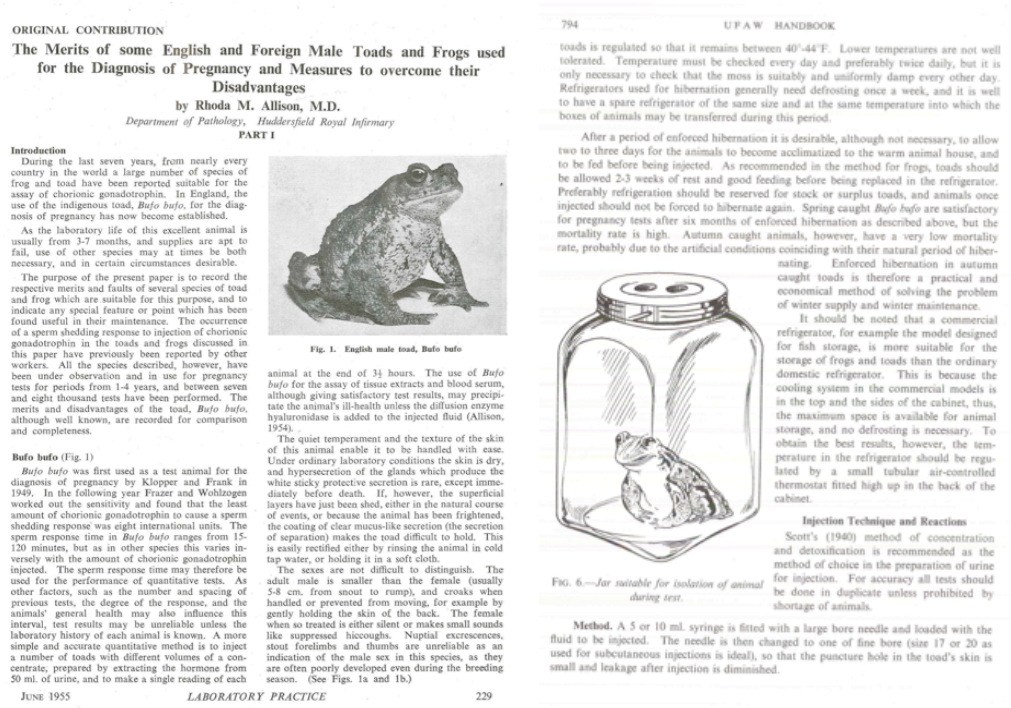
FIG. 4.—Male toad, B. bufo.

anterior pituitary in the testis of the male toad resulted in the release of spermatozoa. These pass through the renal tubules and are voided in the urine (Fig. 3).

Using male toads of 100 gm. or over Galli Mainini (1947) showed that 10 ml. untreated urine was sufficient to induce this response. Urine

Figure 4.14. Photographs of the male British toad, *Bufo bufo*, and his magnified sperm (Ferreira, 1954, 358).

By the mid 1950s Galli Mainini's test had been 'carried out all over the world using nearly every species of male toad and frog with almost universal success' (Fereirra, 1954, 358). At the end of the decade, a UFAW report ascribed the 3,802 Friedman tests performed in 1952 to 'inertia' and the 'rise in the number of amphibian used' to 'their increasing popularity for pregnancy diagnosis, in which they are tending to displace mice and rabbits' (Russell & Burch, 1959, 53). Although hospitals were unaccustomed to housing toads, pathologists were able to improvise with available materials. Rhoda Allison of Huddersfield Royal Infirmary, Yorkshire, converted standard metal guinea pig trays into residential boxes for toads, ordinary fish tanks into feeding tanks, photographic developing dishes and enamel surgical trays into water pots and pathology specimen jars into test jars (Allison, 1957, 786) (**figure 4.15**). Although *Bufo bufo* was 'adequate and satisfactory for routine work,' she preferred to rely on 'a number of foreign toads and frogs' during the winter months (Allison, 1955, 282).



ORIGINAL CONTRIBUTION

The Merits of some English and Foreign Male Toads and Frogs used for the Diagnosis of Pregnancy and Measures to overcome their Disadvantages

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PART I

Introduction

During the last seven years, from nearly every country in the world a large number of species of frog and toad have been reported suitable for the assay of chorionic gonadotrophin. In England, the use of the indigenous toad, *Bufo bufo*, for the diagnosis of pregnancy has now become established.

As the laboratory life of this excellent animal is usually from 3-7 months, and supplies are apt to fail, use of other species may at times be both necessary, and in certain circumstances desirable.

The purpose of the present paper is to record the respective merits and faults of several species of toad and frog which are suitable for this purpose, and to indicate any special feature or point which has been found useful in their maintenance. The occurrence of a sperm shedding response to injection of chorionic gonadotrophin in the toads and frogs discussed in this paper have previously been reported by other workers. All the species described, however, have been under observation and in use for pregnancy tests for periods from 1-4 years, and between seven and eight thousand tests have been performed. The merits and disadvantages of the toad, *Bufo bufo*, although well known, are recorded for comparison and completeness.

Bufo bufo (Fig. 1)

Bufo bufo was first used as a test animal for the diagnosis of pregnancy by Klopper and Frank in 1949. In the following year Frazer and Wohlzogen worked out the sensitivity and found that the least amount of chorionic gonadotrophin to cause a sperm shedding response was eight international units. The sperm response time in *Bufo bufo* ranges from 15-120 minutes, but as in other species this varies inversely with the amount of chorionic gonadotrophin injected. The sperm response time may therefore be used for the performance of quantitative tests. As other factors, such as the number and spacing of previous tests, the degree of the response, and the animals' general health may also influence this interval, test results may be unreliable unless the laboratory history of each animal is known. A more simple and accurate quantitative method is to inject a number of toads with different volumes of a concentrate, prepared by extracting the hormone from 50 ml. of urine, and to make a single reading of each

Fig. 1. English male toad, Bufo bufo

animal at the end of 3½ hours. The use of *Bufo bufo* for the assay of tissue extracts and blood serum, although giving satisfactory test results, may precipitate the animal's ill-health unless the diffusion enzyme hyaluronidase is added to the injected fluid (Allison, 1954).

The quiet temperament and the texture of the skin of this animal enable it to be handled with ease. Under ordinary laboratory conditions the skin is dry, and hypersecretion of the glands which produce the white sticky protective secretion is rare, except immediately before death. If, however, the superficial layers have just been shed, either in the natural course of events, or because the animal has been frightened, the coating of clear mucus-like secretion (the secretion of separation) makes the toad difficult to hold. This is easily rectified either by rinsing the animal in cold tap water, or holding it in a soft cloth.

The sexes are not difficult to distinguish. The adult male is smaller than the female (usually 5-8 cm. from snout to rump), and croaks when handled or prevented from moving, for example by gently holding the skin of the back. The female when so treated is either silent or makes small sounds like suppressed hiccoughs. Nuptial excrescences, stout forelimbs and thumbs are unreliable as an indication of the male sex in this species, as they are often poorly developed even during the breeding season. (See Figs. 1a and 1b.)

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toads is regulated so that it remains between 40°-44°F. Lower temperatures are not well tolerated. Temperature must be checked every day and preferably twice daily, but it is only necessary to check that the moss is suitably and uniformly damp every other day. Refrigerators used for hibernation generally need defrosting once a week, and it is well to have a spare refrigerator of the same size and at the same temperature into which the boxes of animals may be transferred during this period.

After a period of enforced hibernation it is desirable, although not necessary, to allow two to three days for the animals to become acclimatized to the warm animal house, and to be fed before being injected. As recommended in the method for frogs, toads should be allowed 2-3 weeks of rest and good feeding before being replaced in the refrigerator. Preferably refrigeration should be reserved for stock or surplus toads, and animals once injected should not be forced to hibernate again. Spring caught *Bufo bufo* are satisfactory for pregnancy tests after six months of enforced hibernation as described above, but the mortality rate is high. Autumn caught animals, however, have a very low mortality rate, probably due to the artificial conditions coinciding with their natural period of hibernating. Enforced hibernation in autumn caught toads is therefore a practical and economical method of solving the problem of winter supply and winter maintenance.

It should be noted that a commercial refrigerator, for example the model designed for fish storage, is more suitable for the storage of frogs and toads than the ordinary domestic refrigerator. This is because the cooling system in the commercial models is in the top and the sides of the cabinet, thus, the maximum space is available for animal storage, and no defrosting is necessary. To obtain the best results, however, the temperature in the refrigerator should be regulated by a small tubular air-controlled thermostat fitted high up in the back of the cabinet.

FIG. 6.—*Jar suitable for isolation of animal during test.*

Injection Technique and Reactions

Scott's (1940) method of concentration and detoxification is recommended as the method of choice in the preparation of urine for injection. For accuracy all tests should be done in duplicate unless prohibited by shortage of animals.

Method. A 5 or 10 ml. syringe is fitted with a large bore needle and loaded with the fluid to be injected. The needle is then changed to one of fine bore (size 17 or 20 as used for subcutaneous injections is ideal), so that the puncture hole in the toad's skin is small and leakage after injection is diminished.

Figure 4.15. Allinson's lengthy and detailed reviews of the male-toad test in the journal *Laboratory Practice* (1955) and in the second edition of the *UFAW Handbook* (1957) established standard guidelines for the use of the male-toad test, much as Elkan's articles had done for *Xenopus* a decade earlier (Allison 1955, 1957).

Ironically, though generally considered more convenient than *Xenopus* for small-scale laboratories, *Bufo* stubbornly resisted scaling up. Elkan lost about half his experimental stock at Watford from unknown causes every year. The situation was paradoxical. Imported toads thrived in captivity while native ones starved to death in the presence of abundant flies and mealworms. In solitary confinement, a British toad could survive in captivity for many years, but it faired less well when kept in a larger group, even when provided with moss for shelter, water and as much food as it could eat. *Bufo* evidently lost its appetite in the presence of 'competitors' and, unable to overcome its inhibitions, starved to death. Elkan concluded that British toads 'were rigidly conditioned animals and even if it costs them their life they cannot learn. The whole picture might change if we could adjust our laboratories so that each toad had its own cage', but that suggestion was 'too uneconomical to deserve much consideration' (Elkan, 1960).

Pat Fincham, who began using the Aschheim-Zondek test as a junior technician at the pathology laboratory of the Royal Northern Hospital at Holloway Road, London, in

1949, soon switched to male toads, 'which produced sperm if the test was positive.' At eighty years she still remembered 'being shocked at the thought of killing 3 mice to do a pregnancy test and much happier to see the toads sitting in their jars and knowing they would survive the ordeal.'[291] The Group Laboratory at St Stephens' Hospital, Chelsea, used male toads in the early 1960s,[292] and a technician at Chester city hospital remembered bringing them 'outside to play on the grass' as late as 1966.[293] The use of toads made diagnostic work less unpleasant for technicians and the decision by the Home Office to exempt pregnancy tests from its definition of 'experiments calculated to cause pain' made it possible for medical writers to promote the Hogben and Galli Mainini tests as a benign, even pleasurable experience for the animal.

'After the establishment of the NHS, local authorities carried the responsibility for health education, and health reporting in the 1950s was largely concentrated in the pages of women's magazines' (Nathoo, 2009, 38-48). Inspired by the success of the AMA's mass-market magazine *Today's Health*, the BMA launched *Family Doctor* in 1951. Available 'on bookstalls and newsagents' counters throughout Britain',[294] *Family Doctor* was 'written for the lay public to promote health, prevent disease and explain the workings of the body' (Nathoo, 2009, 207n26). Before the end of the decade it had provided the Liverpool physician and medical writer Robert Kemp with a forum to promote toads as 'friendly creatures' 'doing a most valuable job in pregnancy diagnosis.'[295]

In lively, humorous prose, worth dwelling on here, Kemp argued that it was 'most unfair' to think of toads as 'ugly, slimy, and repulsive' even if they 'could never […] turn into a handsome young prince as the frog does in the fairly tale.' The toad was 'actually a creature of deep thoughtful character who might be quite friendly if only he could express himself.' Kemp told the story of how his 'obviously upset' pathologist friend had recently led him 'rather tragically to his animal house', where the previous day a 'small consignment' of 'eagerly awaited' female *Xenopus* toads

[291] Pat Fincham, email, 19 April 2013.
[292] David Petts, email, 7 March 2013.
[293] Linda Brice, email, 1 May 2013.
[294] 'Family Doctor', *BMJ*, 17 March 1951, 571-572, 571. See also Bartrip, 1996, 285.
[295] Kemp, 1959, 280. See 'R. P. Kemp', *BMJ*, 300, 10 March 1990, 673-674.

had been ‘carefully’ placed ‘in warmed water in a deep porcelain basin’. At night ‘they jumped very easily out of their white pond and wandered off in all directions, possibly in search of male company. They made for all the grids of the neighbourhood and several never came back.’[296]

Kemp was also shown some dry tanks containing ‘English toads’ with the ‘lovely name’, *Bufo bufo*, and skin ‘the colour of autumn leaves.’ He returned to his friend’s laboratory the next day with a sample of blood serum taken from one of his hospital patients (most likely without her knowledge), a girl he ‘thought might be pregnant.’[297] She was and Kemp witnessed the positive endpoint of both the Hogben and Galli Mainini tests. In a ‘glass specimen jar’ assigned to Kemp’s patient, one of the remaining female *Xenopus* toads ‘was busy laying long streams of black dotted eggs.’[298] And a laboratory assistant showed Kemp the ‘swarms’ of sperm ‘put out by the male toad in response to some mysterious message given by the pregnancy hormones circulated in [his] patient’s blood.’ Although there were ‘many occasions when it is really important [for a gynaecologist] to know at the earliest possible moment whether someone is pregnant or not’, as a generalist, Kemp ‘did not use this sort of test much.’[299] So why did he welcome these ‘simple’ and ‘convincing’ tests with so much verve?

One new reason that had not been available in the 1930s or 1940s had to do with concerns over a possible link between diagnostic radiology *in utero* and childhood leukaemia and other cancers. In 1956 Dr Alice Stewart, the assistant director of the Institute of Social Medicine at Oxford, had published her preliminary report in the *Lancet* that mothers of dead children were twice as likely to have been X-rayed while pregnant than mothers of living children. A full report, published in the *BMJ* in 1958, confirmed her preliminary findings (Greene, 1999, Dry, 2006). In 1959, while the medical profession debated ‘the possible harm’ of *x*-rays in early pregnancy, Kemp preferred ‘to keep mothers away from any *x*-rays that [were] not absolutely essential’. Although ‘not very new’, the value of pregnancy testing was ‘now becoming more

[296] Kemp, 1959, 280.
[297] Some American gynaecologists used blood serum for the *Xenopus* test when they wanted to conceal the true nature of the test: Rosenfeld & Rosenfeld, 1944, 529.
[298] Kemp, 1959, 280.
[299] Ibid.

widely recognised and many more laboratories [were] providing the service.'[300] He also disavowed 'the "let nature take its course" school':

> There are so many social and medical reasons for knowing whether the first missed period does mean a pregnancy. It might even be said that a woman has the inherent right to know where she stands on this very important matter. I am sure that most mothers would find plenty of reasons for supporting me on this vital point.[301]

Kemp's appeal to a woman's 'inherent right to know' was precocious: it would gain ground only in the mid-1960s, when direct-to-consumer pregnancy testing became widespread and was openly debated in newspapers and magazines (see Chapter 6). The toads, he concluded, were 'certainly doing a very useful friendly job.' But what did the toads 'think of it all?'[302] His pathologist friend had 'every reason to believe that it is a very pleasurable sensation and occasion for both male and female toads. They really seem to enjoy it, and they certainly seem quite happy living here in these tanks.' Kemp ended his article with the fanciful image of 'a delegation of toads seeking admission to his [friend's] animal house because they had heard that what Nature had decreed to be an irregular event was there taking place under the plushiest conditions every month in a toad's life' (**figure 4.16**).[303]

[300] Ibid., 281.
[301] Ibid.
[302] Ibid.
[303] Ibid.

Toads have been given a bad
name for too long and with no reason.
Some families of toads are friendly creatures
doing a most valuable job in pregnancy diagnosis

The friendly bufo bufo and his chums

by ROBERT KEMP, M.D., M.R.C.P.

PERHAPS you feel that a toad could never be friendly and never likely to turn into a handsome young prince as the frog does in the fairy tale. In reality, however, we are the unfriendly ones, when we think of a toad as ugly, slimy, and repulsive, which is most unfair.

A toad is actually a creature of deep thoughtful character who might be quite friendly if only he could express himself. In this story, anyhow, toads are certainly willing to be helpful to humans. My new respect for toads grew in this way.

My friend the Pathologist was obviously upset when he met me. He led me rather tragically to his animal house to tell me about it. It seemed that after several weeks' work and organisation he had but yesterday had a small consignment of eagerly awaited toads from South Africa. By name they were *Xenopus laevis*, and they were all female. They had been put carefully in warmed water in a deep porcelain basin and offered suitable food after their journey, and then they were left in peace.

Flighty

But their habits were as yet not known and in the night they jumped very easily out of their white pond and wandered off in all directions, possibly in search of male company. They made for all the grids in the neighbourhood and several never came back. Those who remained looked very solid and unimaginative and difficult to make friends with. As usual I was asked to try to pick one up and failed because of the slimy evasiveness of this particular breed, so I didn't get much chance of getting to know them.

In another set of dry tanks were English toads of quite a different kind. They had the lovely name of *Bufo bufo*. Their skin was dry, the colour of autumn leaves. To keep them happy, they were fed on a few blow-fly maggots or on the flies themselves. A separate minor industry in the laboratory was devoted to breeding the flies. From the point of view of the assistants who looked after the toads they could be regarded as attractive, but not responsive to care and attention. Keeping the toads was not just scientific backroom eccentricity. They were, I was told, for the biological diagnosis of early pregnancy. There are, of course, many occasions when it is really important to know at the earliest possible moment whether someone is pregnant or not. When it is essential to be absolutely sure.

Being more of a general physician than a gynaecologist, I did not use this sort of test much. The one that I used took a fortnight and seemed rather difficult so I was interested in trying something else. Particularly as I had a girl in my hospital whom we thought might be pregnant. I took a sample of her blood serum to my friend and invited myself round the next day at noon to see the results.

The friendly toads were giving a public performance that day in a secluded part of the laboratory. Three of the South African *Xenopus* toads were working on the Hogben test. A sample of serum from each patient to be tested had been injected with a fine needle just under the skin into the toad's dorsal sac.

Then each toad had been placed in a glass specimen jar with water up to their necks in just the way they like it. Half way up each jar was a perforated glass tray on which they sat. They sat there quite happily gazing out at the busy world around them, or so it seemed.

A few hours after the injection it was obvious that two of the toads had merely sat happily doing nothing. The third female toad was busy laying long streams of black dotted eggs very like frog spawn. On the jar of this toad was written my patient's name and there was little doubt that her serum had caused the toad to ovulate. The toad had made it very plain that my patient was pregnant.

The male *Bufo bufo* toads were working on the Galli-Mainini test in separate dry glass jars and they had been similarly injected two hours previously. Before this, their urine had been examined under the microscope for male sperms, but none had been seen.

Now the laboratory assistant picked up the toad allocated to my patient and drew off more urine for examination. The toad wrapped his forelegs round the assistant's finger quite automatically. Then a fine glass pipette was passed gently into the lower bowel which acts also as a bladder for the toad. A few drops of clear urine were drawn off and the specimen was then put under the microscope.

There I could see swarms of male sperms put out by the male toad in response to some mysterious message given by the pregnancy hormones circulating in my patient's blood. The sperms were swimming about vigorously in the drop of urine, looking around hopefully for a female egg waiting to be fertilised.

It would need a biologist to explain in detail exactly what was going on. And a zoologist to tell us why these particular types of toad were chosen for the test. All that matters to us, however, is that the glands of the mother-to-be are putting out into her blood some substance which stimulates the toads to start their own quite different but also quite unmistakeable method of reproduction.

Speedy

Nothing could have been more simple or more convincing. After many years, perhaps centuries, of research it is now possible to give a positive diagnosis within a few days or weeks of the actual start of pregnancy. This, on a simple blood or urine sample from the mother, by a test which only requires a few hours and is somewhere near a hundred per cent. accurate as well as speedy.

I don't agree with the "let nature take its course" school, nor do many mothers and potential mothers. There are so many social and medical reasons for knowing whether the first missed period does mean a pregnancy. It might even be said that a woman has an inherent right to know where she stands on this very important matter. I am sure that most mothers would find plenty of reasons for supporting me on this vital point.

There are, of course, special diagnostic reasons which make the test very helpful to the gynaecologist. It helps him to know, among other things, where there has been a miscarriage, whether a baby has died in the womb or whether pregnancy is taking place outside the womb. Apart from this, doctors can often be very much indebted for an early diagnosis.

Just at the moment the profession is concerned at the possible harm that x-ray investigations may do to the early pregnancy. Nothing definite has been decided yet. But while the matter is under discussion I personally want to keep mothers away from any x-rays that are not absolutely essential until after they have had their confinements.

In my patient's case, the test made me cancel all x-ray examination below the diaphragm. In other instances it isn't unknown for a young woman to come to her doctor or to hospital complaining of vomiting and it never strikes the patient or the doctor it may be morning sickness. The toads have sent me a positive message in four such cases recently and made it clear that an x-ray was unnecessary, as were several other investigations.

Of course these tests are not very new and they have been described before but their value is now becoming more widely recognised and many more laboratories are providing the service. Perhaps I have made it sound too simple. Its simplicity is merely due to the expert way in which it is carried out in the laboratory.

The toads are certainly doing a very useful friendly job. "What do the toads think of it all?" I asked the Pathologist who was working with them.

"Well," he said, "we have difficulty in tuning in to the toads' exact wave-length to ask, but we have every reason to believe that it is a very pleasurable sensation and occasion for both male and female toads. They really seem to enjoy it, and they certainly seem quite happy living here in these tanks."

His words made me picture a delegation of toads seeking admission to his animal house because they had heard that what Nature had decreed to be an irregular event was there taking place under the plushiest conditions every month in a toad's life.

Hard at work on a pregnancy test. This lady comes from South Africa and sits on an elegant glass tray with water right up to her neck

This gentleman is not suffering. He has been injected with the serum of a woman thought to be pregnant and now samples of his water are being taken through a glass tube to be examined. In this particular case the test was positive

And here is what Bufo bufo was producing. A swarm of male sperms are seen under the microscope, looking exactly like baby tadpoles

We are indebted to Colonel Basil Blewitt, M.D., for all the photographs shown here

Figure 4.16. Kemp's article in *Family Doctor*, May 1959, 280-281, including photographs of *Xenopus* and *Bufo* by Colonel Basel Blewitt, MD. The captions, from left to right, read: 'Hard at work on a pregnancy test. This lady comes from South Africa and sits on an elegant glass tray with water right up to her neck.' 'This gentleman is not suffering. He was injected with the serum of a woman throught to be pregnant and now samples of his water are being taken through a glass tube to be examined. In this particular case the test was positive.' 'And here is what *Bufo bufo* was producing. A swarm of male sperms are seen under the microscope, looking exactly like baby tadpoles.'

Conclusion

In 1954 Robert W. Johnstone rated pregnancy tests as second only to X-rays in the 'sweeping advances' in obstetrics in the first half of the twentieth century. Pregnancy tests had become 'so generally adopted' as to have 'largely replaced the skilled clinical methods that [had been] the pride of all previous generations of obstetricians' (Johnstone, 1954, 92). Some laboratories may have insisted on 'important clinical reasons to know, as soon as possible, whether the lady was pregnant,'[304] but Edinburgh was not among them and neither was Watford. Despite having been nationalised, diagnostic services in the 1950s were provided by a heterogeneous collection of semi-autonomous laboratories. Schwabacher continued to maintain that although no laboratory would be able 'to satisfy the natural desire of every woman to know the truth as soon as possible', unmarried mothers 'should have the advantage of laboratory diagnosis […] in making re-adjustments in social and domestic life' (Schwabacher, 1956, 392). Despite statements to the contrary, the NHS accepted pregnancy testing for 'social' reasons, a liberal approach that would be extended to contraception and abortion in the 1960s.

Schwabacher's concern that the Watford centre would be 'swamped' by less deserving 'curiosity' cases to the detriment of legitimately 'pathological' ones was consistent with the general perception that, in the early years of the NHS in England and Wales, the demand 'from people previously unable to afford care', most famously for dentures and spectacles, but also for X-rays and diagnostic tests, was far greater than anticipated (Webster, 2002, 42, Harrison & McDonald, 2008, 9-10). Many radiologists and clinical pathologists 'feared that they would be swamped with unnecessary and inappropriate requests' (Loudon & Drury, 1988, 108-110). But pregnancy testing was also a special case. And the Home Office viewed the proliferation of pregnancy diagnosis services during the war as linked to the 'foreign scientific refugee element'. Significantly, and perhaps surprisingly, this led to the exception of pregnancy tests under the 1876 Act. This, and the increasing popularity of *Xenopus* and other toads that had 'not to be slaughtered', softened the public face of pregnancy testing in the 1950s. Freed from its association of the slaughter of

[304] David Petts, email, 7 March 2013.

countless mice and rabbits, medical writers could even present pregnancy testing to lay readers as a ‘pleasurable’ experience for the laboratory animal.

Chapter 5. 'Primodos will decide!' Chemists, advertising and drugs

In 1949, Margaret, a twenty-eight-year-old newlywed from Birmingham, wrote to the Family Planning Association (FPA): 'I am very irregular with my periods. They vary from four to six weeks, but never have I been beyond the six week mark. I am now well on into my 7th week and I do not know whether I am extremely late or pregnant […] I had always been under the impression that a water test could be taken within a few days after conception […] Could you please enlighten me on these points.' Margaret, who was looking forward to becoming a mother for the first time, also asked for 'the names of one or two reliable books on the subject of pregnancy and motherhood' and enclosed a postal order of two pounds. Although the FPA did not have any relevant books, it did have 'a special Centre in London for the diagnosis of pregnancy' and the association's general secretary, Stephanie Robinson, enclosed 'instructions as to the way in which a specimen can be sent'.[305]

In the 1960s, Naomi, a student at Chelsea Art School, was given Amenorone Forte on two separate occasions by her family doctor, 'a refugee from Germany. He was also a dirty old man, but didn't let on to [her] parents about [her] wayward behaviour.' Naomi took the tablets, which 'had to be dissolved under the tongue', on the bus to school 'and for weeks afterwards every time [she] got on the bus [she] could taste them - a Pavlovian response!'[306] A promotional pamphlet distributed by the French pharmaceutical company Roussel explained that one tablet of Amenorone Forte, which contained a combination of progesterone and estrogen, taken daily for three days could be used as 'a simple and safe test for pregnancy, since the course results in bleeding in amenorrhoea, but not in pregnancy' (Roussel Laboratories, 1957). This chapter investigates two new sources of commercialisation that reshaped the market for pregnancy testing in postwar Britain: the FPA and pharmaceutical companies.

[305] Margaret to FPA, 28 June 1949, FPA to Margaret, 30 June 1949, SA/FPA/A3/11.
[306] Naomi Pfeffer, email, 1 November 2011.

5.1. The 'famous toads' of Sloane Street

Birth control was not championed in the 'reforming zeal' to create the NHS and negotiations leading up to the 1946 Act made no mention of family planning and left underlying contraceptive legislation unamended (Leathard, 1980, 73-74). In 1949 the Royal Commission of Population recommended the NHS take charge of clinics providing infertility services and contraceptive advice, but the Chancellor of the Exchequer rejected the proposal as too costly for the taxpayers (Pfeffer, 1993, 109). Politicians generally shied away from reproductive policies in peacetime. The NHS enabled local health authorities to contribute to voluntary organisations like the FPA, but it was unclear whether GPs could charge a fee for contraceptive advice (Brookes, 1988, 136). For guidance local authorities looked to a 1930 Ministry of Health circular (153/MCW) that permitted antenatal clinics to dispense contraceptive advice to a married woman, but only if her health was seriously threatened by pregnancy. In 1946 the FPA's sixty clinics could not keep up with demand and by 1950, just over a third of some 145 local health authorities in England and Wales dispensed contraceptive advice (often liberally interpreted as medically indicated) at special clinics for married women. Other authorities referred patients to a local FPA clinic or hired premises to an FPA branch, while still others provided their own services (Leathard, 1980, 79-80).

Towards the end of World War II the FPA extended its range of activities to include infertility treatment. With money donated by Gerda Guy, Dr Hans A. Davidson set up a seminological laboratory in 1945 at 33 Wimpole Street near Harley Street.[307] Some seventy patients attended the clinic each month for semen analysis, a post-coital test, or testicular biopsy in the first year and the number more than doubled in the second.[308] Hospitals, infertility clinics, private consultants and general practitioners referred men, mostly husbands of wives who had failed to conceive in the first two years of marriage, to Davidson's laboratory for testing (Davidson, 1949, 1953). And by June 1948 he was struggling to 'keep up with the demand for microscopic investigation' (Robertson, 1948, 13). In January 1949, while the FPA was in the

[307] Leathard, 1980, 73, Pfeffer, 1993, 59-60. See also 'H A Davidson', *BMJ*, 280, 657-658.
[308] Pfeffer, 1993, 105. For the earlier history of male infertility and sperm analysis: Benninghaus, 2012.

process of planning to move the laboratory into newly acquired and larger premises at 64 Sloane Street, just south of Hyde Park, Helena Wright's son, Dr Beric Wright, suggested that the association should also establish its own pregnancy diagnosis laboratory.

The only book-length history of the FPA merely notes that 'the Association bought bigger premises at 64, Sloane Street' and opened 'a pregnancy diagnosis centre' there in 1949 (Leathard, 1980, 81). Ann Oakley adds that South African toads 'were kept in the basement [of the Sloane Street clinic] 'and were regarded as a much-prized asset' (Oakley, 1984a, 97). Oakley's source for the Sloane Street toads is a personal communication from the Cambridge child psychologist Martin P. M. Richards, whose mother had been 'very involved in the FPA' and who, as a schoolboy in London in the mid 1950s, had been shown 'a low room with racks with tanks of *Xenopus*'.[309] And Helen Knewstub (Lady Brook), who joined the FPA in 1952, later told the TV interviewer and writer Mavis Nicholson: 'I was allowed to go down to Sloane Street, where I saw the famous toads' (Nicholson, 1995, 98).

Wright had learned to perform Hogben tests during the war while working with Herta Schwabacher in the EMS.[310] He expected the initial investment to be quickly offset if the service were adequately promoted and argued that the FPA would benefit financially from the income generated by pregnancy testing.[311] In his letters to potential benefactors and clients, he anticipated 'a steady profit' for the association even after taking 'a small fee' for his own time and involvement. The FPA was in a 'desperate financial situation',[312] and Wright promised that pregnancy testing would 'balance the Association's budget' and make it financially independent so that it would no longer have to rely on 'private subscriptions and the usual methods by which voluntary organizations are always fighting to balance their overdrafts.'[313]

[309] Martin Richards, email, 14 February 2013.
[310] Wright to Schwabacher, 15 February 1949, Pregnancy Diagnosis Laboratory, SA/FPA/A3/11-13.
[311] Wright to Medical and Sub-fertility Committee, 20 January 1949, SA/FPA/A3/11-13.
[312] Wright to Guy, 21 January 1949, SA/FPA/A3/11-13.
[313] Wright to Crew, 1 July 1949, SA/FPA/A3/11-13.

The FPA agreed to provide Wright with £100 to cover the cost of setting up and Wright planned to open the laboratory in March 1949.[314] He proposed two rates: twenty-five shillings for private patients and twelve shillings and sixpence for hospital patients. This was more expensive than the Edinburgh station, but Wright claimed that there was a 'shortage of laboratory animals and […] difficulties in getting a pregnancy test done rapidly'.[315] Londoners, especially Harley street doctors, who used the Sloane Street laboratory would no longer have to wait an entire week for a urine specimen and test result to work its way through the postal service. And he anticipated setting up monthly accounts for regular users. When Wright spent twice as much as planned on equipment, including glass bottles and a bespoke galvanised steel 'frog tank', Gerta Guy agreed to donate a further £100.[316]

Wright first approached his wartime supervisor Schwabacher about whether she might be able to refer cases to his laboratory or if anyone else at the NHS was in a position to discuss the matter and arrange fees. Schwabacher informed Wright that, unfortunately for him, the Ministry of Health was already in the process of establishing its own centre in Watford to serve the South of England and offered him the use of her toads when his were 'overworked'. Wright next consulted Robert Forbes, secretary of the Medical Defence Union, to find out whether he would be within his rights to distribute a promotional leaflet about the laboratory. Forbes explained that Wright's leaflet would not be 'objectionable' because a BMA resolution adopted in 1932 stipulated that a 'practitioner who wishes to draw the attention of his colleagues in the profession to the fact that he has recently commenced or intends to practise any particular branch of medical or surgical work, may do so [...] by calling upon practitioners already established in the area & giving a personal explanation of his arrangements'.[317]

Wright sent his leaflet to doctors and pathologists in and around London who were already known to the FPA. And Stephanie Robinson contacted the Ministry of Health to request the names and addresses of the Group Pathological Laboratories around

[314] Executive minutes, 12 March 1949, SA/FPA/A3/11-13. On Helena and Beric Wright: Evans, 1984.
[315] Wright, 13 April 1949, SA/FPA/A3/11-13.
[316] E. K. Bowman Ltd., to Wright, 23 February 1949, Wright to Guy, 21 January 1949, SA/FPA/A3/11-13.
[317] Wright to Schwabacher, 15 February 1949, Schwabacher to Wright, 18 February 1949, Forbes to Wright, 1 March 1948, SA/FPA/A3/11-13.

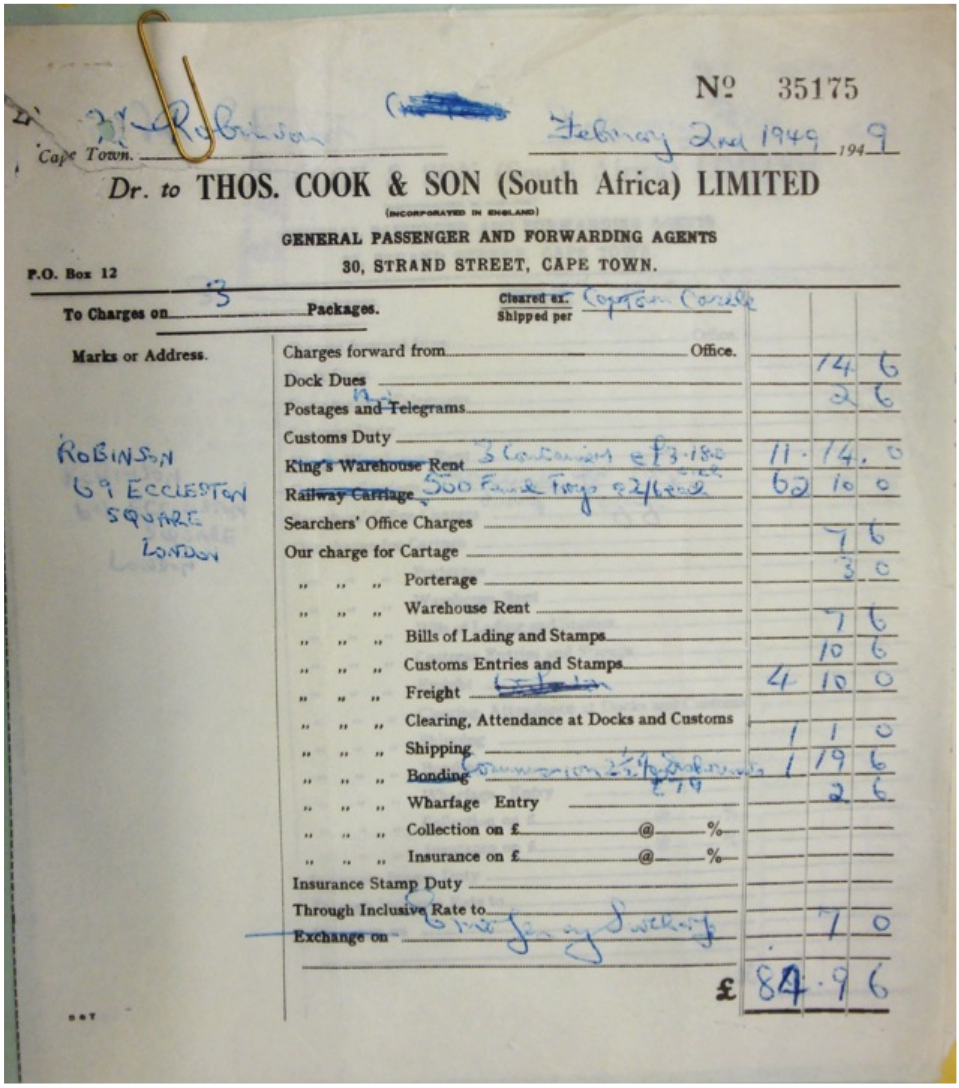
Britain in order to inform them about the Sloane Street laboratory. Dr George Godber responded that the Ministry was in the process of establishing its own pregnancy diagnosis service at Watford and would soon be opening a second one at Sheffield. He clarified, however, that these centres would provide 'an essentially medical service within the hospital scheme' and would not be available 'in any early pregnancy but only when this is really necessary on medical grounds.' The Watford centre was 'not yet able to cope with all requirements', so it was possible that Sloane Street would have 'a valuable supplementary function'. But information about the Watford and Sheffield centres had already been circulated within the hospital service, so Godber doubted the Ministry would also be able to publicise the FPA service.[318]

Robinson pressed Godber for a list of addresses. She suggested that group pathology laboratory directors might be 'grateful for [the FPA] to do some tests for them' until the NHS centres were able to meet the demand. Furthermore, although laboratories within the health service were 'unable to perform [tests] from doctors for their private patients', they might still be able to refer such cases to the association. But after consulting with Philip Panton, Godber informed Robinson that the Ministry would not be able to encourage the FPA's 'redundant' laboratory. There might be plenty of demand 'outside the scope of the Health Service,' but the association would not be able to 'look to the Health Service' for support.[319]

Wright nevertheless managed to secure contracts with hospitals, not only in London, but also in East Surrey and as far north as Hull, Salford and Newcastle. He finally turned to Francis Crew, his principal competitor, with whom he had become acquainted during the war. Wright had heard from a colleague that the Edinburgh station was 'overworked' and 'anxious to try and reduce the number of tests coming in.' Furthermore, hospitals in the South of England had to 'wait ten days or so' for a test result from Edinburgh. Because of this delay and because Wright was 'anxious to build up' the Sloane Street laboratory he cautiously asked if Crew would be willing 'to pass some of the work from the South' on to the FPA. But, as we have seen in the previous chapter, Crew was in fact worried about losing his clients from England to

[318] Unsigned letter to Mr R. Christie Brown, unsigned letter to Dr James Carrie, 29 March 1949, unsigned letter to Dr Greta Graff, unsigned letter to H. I. Winner, 29 March 1949, Robinson to Godber, 1 April 1949, Godber to Robinson, 2 April 1949, SA/FPA/A3/11-1. On Godber: Craft, 1975.
[319] Robinson to Godber, 6 April 1949, Godber to Robinson, 6 April 1949, SA/FPA/A3/11-1.

the NHS centres and so he rejected Wright's offer.[320] Wright's first shipment of *Xenopus* arrived in April 1949. The toads were supplied by the travel agent Thomas Cook, which in turn obtained them from the Department of Inland Fisheries of the Provincial Administration of the Cape of Good Hope (**figure 5.1**).[321]



Nº 35175

Cape Town. February 2nd 1949

Dr. to THOS. COOK & SON (South Africa) LIMITED

(INCORPORATED IN ENGLAND)

GENERAL PASSENGER AND FORWARDING AGENTS

P.O. Box 12 — 30, STRAND STREET, CAPE TOWN.

To Charges on 3 Packages. Cleared ex. Shipped per Captain Cowie

Marks or Address.

ROBINSON
69 ECCLESTON
SQUARE
LONDON

Charges forward from Office.		
Dock Dues		14 6
Postages and Telegrams		2 6
Customs Duty		
King's Warehouse Rent 3 Containers @ £3.18.0	11 14 0	
Railway Carriage 500 Fauna Frogs @ 2/6 each	62 10 0	
Searchers' Office Charges		7 6
Our charge for Cartage		3 0
" " " Porterage		
" " " Warehouse Rent		7 6
" " " Bills of Lading and Stamps		10 6
" " " Customs Entries and Stamps		
" " " Freight	4 10 0	
" " " Clearing, Attendance at Docks and Customs	1 1 0	
" " " Shipping		
" " " Bonding Commission 2½% on £76	1 19 6	
" " " Wharfage Entry		2 6
" " " Collection on £ @ %		
" " " Insurance on £ @ %		
Insurance Stamp Duty		
Through Inclusive Rate to		
Exchange on		7 0
	£ 84 9 6	

Figure 5.1. Documentation for 3 packages of 500 toads shipped by Cook & Son from Cape Town to the FPA headquarters in London in 1949 (SA/FPA/A3/13).

Until 1941, *Xenopus* was 'obtained from coloured collectors, who caught them mainly in small waters on the Cape Flats, or from one or more European dealers who

[320] Wright to Crew, 1 July 1949, Letter to Wright, 5 July 1949, SA/FPA/A3/11-1.
[321] On the history of Thomas Cook see, for example, Brendon, 1991.

also did a small amount of export before the war.'[322] Supplies were 'intermittent,' and it was not always easy to obtain the mature females needed for pregnancy testing. Some collectors reported that 'former haunts of platannas had been drained and reclaimed, or that their numbers had been reduced by the introduction of largemouth bass.'[323] High losses resulted from exposure to 'sun and salt spray' as the consignments were usually carried in metal tanks on deck and under wartime conditions ships were often delayed for weeks or even months 'in some tropical African port' (Hey, 1977, 108).

Dr Louis Bosman, a colleague of Zwarenstein and enthusiast of the *Xenopus* test, successfully petitioned the Cape Provincial Administration to introduce a protective legislation and to investigate the possibility of artificial cultivation at the provincial trout hatchery in Jonkershoek (Hey, 1949, 45). In August 1941, the Jonkershoek Hatchery was authorised to breed *Xenopus* for medical and scientific purposes and provisions were made for the construction of concrete holding tanks and 'for the use of Hatchery labour and transport in collecting them from farm dams and for payment of owners.' The 1941 draft of the Inland Fisheries Ordinance, No. 15 was amended to include 'aquatic fauna generally' in order to cover *Xenopus*.[324]

Douglas Hey would set off with thee assistants in 'an ex-army three-ton Chevrolet truck loaded with containers, nets and traps.' They visited a large number of farms and learned how to 'assess the potential of a dam almost at a glance.' At first they collected toads in the vicinity of Stellenbosch, but were gradually forced to 'forage further afield to Paarl, Caledon, Malmesbury and even Piketberg'. They paid regular visits to one farm that employed a team of Italian prisoners of war who 'objected strongly' when they started catching toads. The prisoners had recently identified these animals as 'a delicacy and were catching them regularly for food.' The head and feet were cut off, the skin removed, the body eviscerated, salted, peppered, rolled in flour, 'fried to a crisp brown in boiling oil' and served 'with bread and a glass of cold white wine'. *Xenopus* was 'a meal for a gourmet' (Hey, 1977, 109).

[322] *Inland Fisheries Department Report*, 1, 1944, 31. The term 'coloured' is a now contested colonial and then apartheid racial category that refers to a heterogeneous group of people with mixed European, African and Asian ancestry: Adhikari, 2005.
[323] *Inland Fisheries Department Report*, 1, 1944, 32.
[324] Ibid.

The hatchery supplied domestic hospitals and doctors by rail, sending toads in batches of 300 in standard five-gallon carboys insulated against temperature fluctuation and painted inside to prevent metal poisoning. The toads were starved for up to three days before embarking on rail journeys of up to five days. For overseas shipments 125 toads were placed in a flatter type of container with a larger surface area for the toads. Double the number could survive if the shipment was accompanied by a technical officer who looked after the consignment by removing any dead specimens daily, changing the water at least once a week and feeding the toads twice a week (Hey, 1949, 52). The hatchery supplied 350 toads in 1941, 2,700 in 1942 and 4,300 in 1943. In that year the Inland Fisheries Department was established with Hey as its director, consolidating the government control of the *Xenopus* trade, which would structure and stabilise the postwar supply of toads.

In 1949 the hatchery distributed 10,866 toads, of which 3,803 (35%) were exported (Weldon et al., 2004, 2013). The harvest, however, was 'unreliable and erratic' and Hey looked forward to the day when universities and hospitals would be able to order disease-free hatchery-cultured toads of any size and quantity (Hey, 1949, 54-5). Despite the optimistic prediction that *Xenopus* would soon be 'cultured as easily as fish' (Hey, 1949, 53), the hatchery did not become a breeding centre, but rather a 'clearing house' for the easily and inexpensively harvested farm toads (van Sittert, 2008, 17). Toads collected from farmers (in exchange for token payment to the landlord) were brought to Jonkershoek, where they were sorted by sex and size before shipping. The hatchery charged slightly above cost on a sliding scale from local to international delivery and only supplied teaching, research and medical institutions. This effectively allowed consumers to reliably purchase somewhat standardised toads directly from a wholesaler, stabilising the market (van Sittert, 2008).

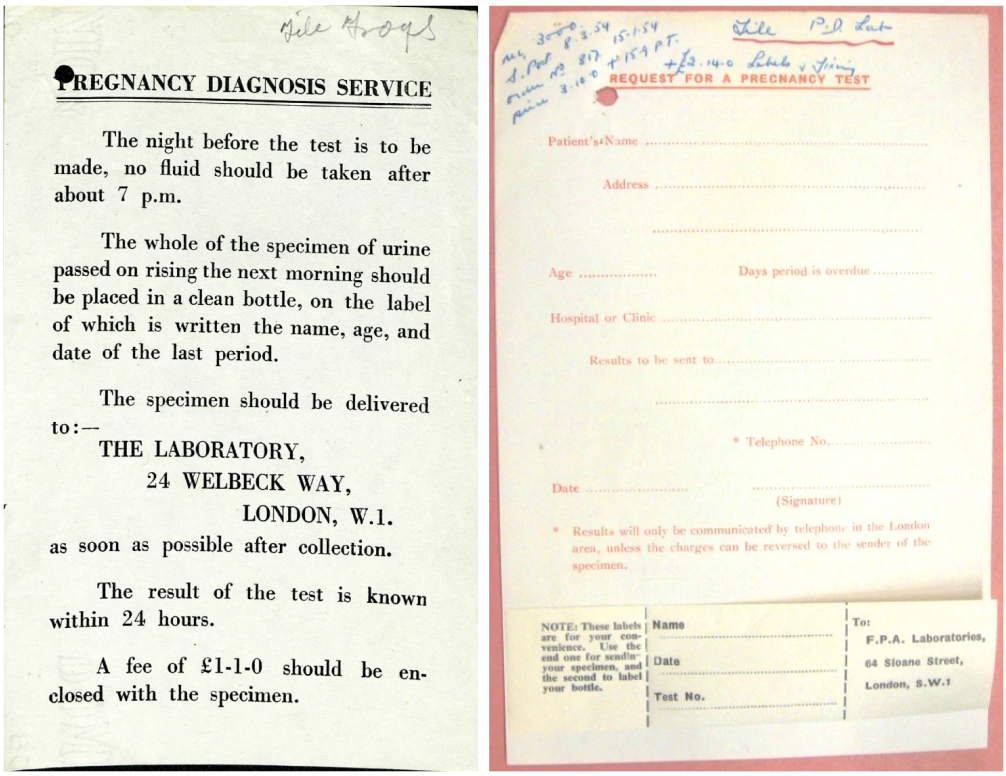
By mid-summer the toads were 'booming' and Wright, who kept long hours performing the tests himself, was struggling to keep up with demand. Wright's secretary, Mrs Northgate, agreed to become 'a full-time frog queen' and Wright began training her to perform tests. Although Margaret Pyke agreed that 'the splendid rise in the number of P.D. tests' meant that Wright could not 'go on coping' without a technician, she reminded him that he would have to wait for the FPA to approve his

budgetary requirements. Frustrated with bureaucratic constraints, Wright complained that the association would not become 'really energetic' unless it was 'prepared to delegate' certain responsibilities. Publicity was a 'case in point'. The FPA had already lost about three months worth of trade while committees 'gently wrangled over' the advertising question. Meanwhile, the toads continued to 'flourish' and Wright had 'already banked about £80 to £90.' In September 1949 the financial subcommittee agreed that Wright should receive 25% of the gross taking up to the end of the year and approved a fulltime technician as well as the necessary expenditure for advertisements in the *BMJ*.[325]

5.2. Chemists and the 'advertising angle'

In April 1949 the *BMJ* and *Lancet* reported that the FPA's seminological centre had relocated to Sloane Street and now included a 24-hours pregnancy diagnosis service.[326] In July a notice in the *Chemist & Druggist* alerted retail pharmacists that they would receive a discount on pregnancy testing and invited them to contact the FPA for details.[327] Two weeks later the *Pharmaceutical Journal* published a letter by Wright, which explained that the association would charge pharmacists a reduced rate of twenty-five shillings per test and suggested that they could turn a profit by charging customers thirty (Wright, 1949a, 59). Wright claimed that as a voluntary organisation, the FPA was 'not primarily interested in profits' and so was 'able to do pregnancy tests at a somewhat lower rate than the majority of commercial laboratories' (**figure 5.2**).[328] These short notes marked a major departure from Francis Crew's policy of dealing exclusively with the medical profession. The *BMJ* and *Lancet* publicised the Edinburgh station to doctors, but Crew rejected urine specimens sent in by chemists. Now, for the first time, Beric Wright actively attempted to recruit chemists as clients of his service.

[325] Wright to Pyke, 20 August 1949, Pyke to Wright, 24 August 1949, Wright to Pyke, 28 August 1949, General Secretary to Wright, 19 September 1949, SA/FPA/A3/11-1.
[326] 'Seminological centre', *Lancet*, 16 April 1949, 676, 'Family Planning Association', *BMJ*, 30 April 1949, 790.
[327] 'Diagnosis of pregnancy', *Chemist & Druggist*, 2 July 1949.
[328] Commercial laboratories have left little trace and it is difficult to recover the scale. Welbeck Laboratories and Camden Chemical Co. are occasionally mentioned in passing, but not discussed at any length.



PREGNANCY DIAGNOSIS SERVICE

The night before the test is to be made, no fluid should be taken after about 7 p.m.

The whole of the specimen of urine passed on rising the next morning should be placed in a clean bottle, on the label of which is written the name, age, and date of the last period.

The specimen should be delivered to:—

THE LABORATORY,
24 WELBECK WAY,
LONDON, W.1.

as soon as possible after collection.

The result of the test is known within 24 hours.

A fee of £1-1-0 should be enclosed with the specimen.

REQUEST FOR A PREGNANCY TEST

Patient's Name .....

Address .....

Age ..... Days period is overdue .....

Hospital or Clinic .....

Results to be sent to .....

* Telephone No. .....

Date ..... (Signature)

* Results will only be communicated by telephone in the London area, unless the charges can be reversed to the sender of the specimen.

NOTE: These labels are for your convenience. Use the end one for sending your specimen, and the second to label your bottle.

Name .....

Date .....

Test No. .....

To:
F.P.A. Laboratories,
64 Sloane Street,
London, S.W.1

Figure 5.2. Left: a flyer for Welbeck laboratory, one of the more prominent commercial pregnancy diagnosis services in the postwar years. Right: a request form an FPA pregnancy test including labels (SA/FPA/A3/11).

Wright's letter in the *Pharmaceutical journal* provoked Norman Jones van Abbé, a chemist of Muswell Hill, Middlesex, to 'question the desirability' of placing pregnancy tests in chemists' hands. In his own letter van Abbé suggested that a test was justified only in cases of 'real urgency': 'to indicate the clinical necessity for the interruption of pregnancy or special ante-natal care, or to establish legal evidence'. But a test might also be requested 'to satisfy ordinary curiosity or to establish grounds for illegal interference with pregnancy.' In these cases, van Abbé argued, it was 'undesirable even to give encouragement to this practice unwittingly, especially as the pharmacist is then likely to be pestered by these people with undesirable intentions.' Finally, van Abbé objected to the 'uncivilised' use of animals 'to gratify the curious or the person with illicit designs'. Though he acknowledged the necessity of vivisection for 'instructional purposes or genuine research', he regarded pregnancy tests as an 'abuse of the Home Office licence' (van Abbé, 1949, 78).

Chemists had long discretely dispensed sex education advice, condoms and materials that could be used to perform an illegal abortion including slippery elm and pennyroyal. Before the NHS, retail chemists had provided dental care, first aid and postpartum care for mothers and babies. These activities diminished with free access to general practitioners, hospital accident and emergency services and child welfare clinics under the NHS. Overnight, the significant increase in the number of prescriptions written by doctors, from 70 million in 1947 to 241 million in 1948, pushed chemists from behind the counter to the back of the shop as they struggled to keep up with demand (Anderson & Berridge, 2000, 64-68). The professional relationship between doctors and chemists, or pharmacists, as they were increasingly called after World War II, was in flux when Wright inadvertently provoked a debate about the non-medical provision of pregnancy testing.

In a second letter, Wright defended the desirability of a diagnostic service available to 'those who want it' without a doctor's permission. He repeated his invitation to like-minded pharmacists to use the Sloane Street laboratory. He further maintained that 'every woman should, if she wishes, be able to make use of the methods of early confirmation of pregnancy which recent scientific advances have made available.' Women should not have to wait six to eight weeks as van Abbé suggested. Drawing on the rhetoric of austerity,[329] Wright suggested that a positive test result could be 'a considerable help in making the necessary arrangements for the confinement and care of the baby', particularly in 'these days of hard work and shortages'. He argued that moral concerns about women who might attempt an illegal abortion should not prevent the 'possibilities for good which the service offers.' According to Wright, women had been able to obtain pregnancy tests 'through pharmacists for a number of years with [...] no undesirable results.' As for allegations of 'vivisection', Wright countered that his toads were 'merely subjected to a subcutaneous injection, isolated for a short period and then returned to the aquarium', a simple procedure that no longer required a Home Office licence (Wright, 1949b, 115).

At around the same time, fellows of the Royal College of Obstetricians and Gynaecologists (RCOG) met to discuss their own misgivings about Wright's

[329] On 'austerity Britain': Zweiniger-Bargielowska, 2000, Kynaston, 2010.

initiative, which they objected to on 'ethical grounds' and also because his first letter in the *Pharmaceutical Journal* possibly constituted medical advertising, which was prohibited. Several fellows sat on FPA committees and others had been appointed vice-presidents, so the association could not afford to offend such a prestigious and politically powerful group of supporters. For reasons of political allegiance, if not legal obligation, the FPA decided to act in accordance with the wishes of the Royal College.

In a conciliatory letter, the FPA defended Wright on the grounds that the NHS only offered pregnancy tests when they were 'necessary for strictly medical reasons, and therefore the woman who has domestic reasons for wishing to know as soon as possible whether or not she is pregnant may prefer to get a test done through a pharmaceutical chemist.' The letter claimed that such work had been 'undertaken on a large scale by a number of commercial firms for some time.' Wright communicated results directly to the 'patient' and if the result was positive, advised her to 'consult her doctor immediately.' Finally, the letter explained that the demand from FPA clinics and affiliated doctors was not large enough to sustain the running cost of Wright's laboratory, the association's 'smallest and newest venture'. This was why a medical subcommittee had approved making the service available 'to all medical practitioners, hospitals, clinics and chemists'.[330]

The FPA had 'no idea' that the way Wright was conducting his service, 'a new venture,' was 'open to any kind of criticism.' But negotiations with the BMA and RCOG eventually led to a compromise: Wright would continue accepting tests from chemists and women but would 'include on the form accompanying the test, a space for the name and address of the applicant's doctor, and communicate the result of the test only to the applicant's doctor.' That way a woman would be able to send a specimen without first 'having to obtain the permission of a medical practitioner beforehand', but it would 'not be possible for her to hear the result of the test except through her own doctor.'[331] Though Wright ceased all activities that might be interpreted as inappropriate or unethical advertising, the Sloane Street laboratory

[330] Draft letter, Wellcome Library SA/FPA/A3/11-1.
[331] Robinson to Lloyd, 15 August 1949, General Secretary to Dr Hadfield, 1 December 1949, SA/FPA/A3/11.

continued to be promoted in the professional and lay press.[332] Newspaper articles could not count as medical advertising if they did not mention Wright by name; Robinson was fair game because she had no medical qualifications. So medical journalism constituted a new and valuable source of publicity for the Sloane Street laboratory.

In August 1949 the FPA took out a classified advertisement in the *Pharmaceutical Journal* for two pounds and ten shillings and an article in *Reveille* – a small weekly tabloid that featured a mixture of cartoons, pin-ups, letters, puzzles and articles on fashion, celebrity gossip, lifestyle, music and sports – reported that the FPA's 'new' 24-hours service was available 'to any woman who wishes to apply [to her doctor] for it'.[333] The article emphasised the advantages for expectant mothers 'anxious to book a bed in a nursing home, and other married couples who want to know urgently whether a baby is on the way'. Stephanie Robinson was quoted as saying that 'many couples' had 'urgent reasons for wanting the information as quickly as possible so that they can plan their domestic arrangements accordingly,' for instance, a 'serviceman about to leave for overseas can make proper arrangements for his wife's confinement.' Finally, the article reported that the FPA was carrying out 35 tests every week for 25 shillings a test.[334]

The *South London advertiser* carried essentially the same story, this time under the headline, 'New science aids family planning: tells if baby is on the way.'[335] In December the medicine and health section of the *News review* carried a more substantial article under the heading, 'Trial by toads', by an anonymous staff reporter who had evidently visited Sloane Street to see the 'four, metal-lined tanks', where 1,000 'greyish-brown' toads were kept in 'thermostatically heated water.' This article also adopted the usual tactic of precluding the possibility of abortion by stating that the toads did 'an important job in connection with childbirth.' It described 'the Hogben test', praised its accuracy and explained that the toads did not have to be killed and could be used 'every two or three weeks for three or four years'. Wartime

[332] On the history of the tabloid press in Britain: Conboy, 2006.
[333] Secretary to Pharmaceutical Journal, 2 August 1949, SA/FPA/A3/11-1. '"Radar" for the stork', *Reveille*, 27 August 1949. Launched in 1940 and bought in 1947 by the Mirror Group, *Reveille* was originally the official newspaper of the Ex-Services' Allied Association: Hoggart, 1957, Owen, 2005.
[334] '"Radar" for the stork', *Reveille*, 27 August 1949.
[335] 'New science aids family planning', *South London Advertiser*, 16 September 1949.

meat rationing continued well into the 1950s, so this sympathetic article went out of its way to mention that the toads were fed on 'a special grade of minced liver unfit for any other use' (**figure 5.3**).

Figure 5.3. Classified adverts in the *Pharmaceutical Journal* (top-left) and headlines in tabloid newspapers (clockwise) *Reveille*, *South London advertiser*, and *News review* provided value sources of non-medical advertising for the FPA pregnancy diagnosis service and significantly increased the public visibility and acceptability of pregnancy testing (SA/FPA/A3/11).

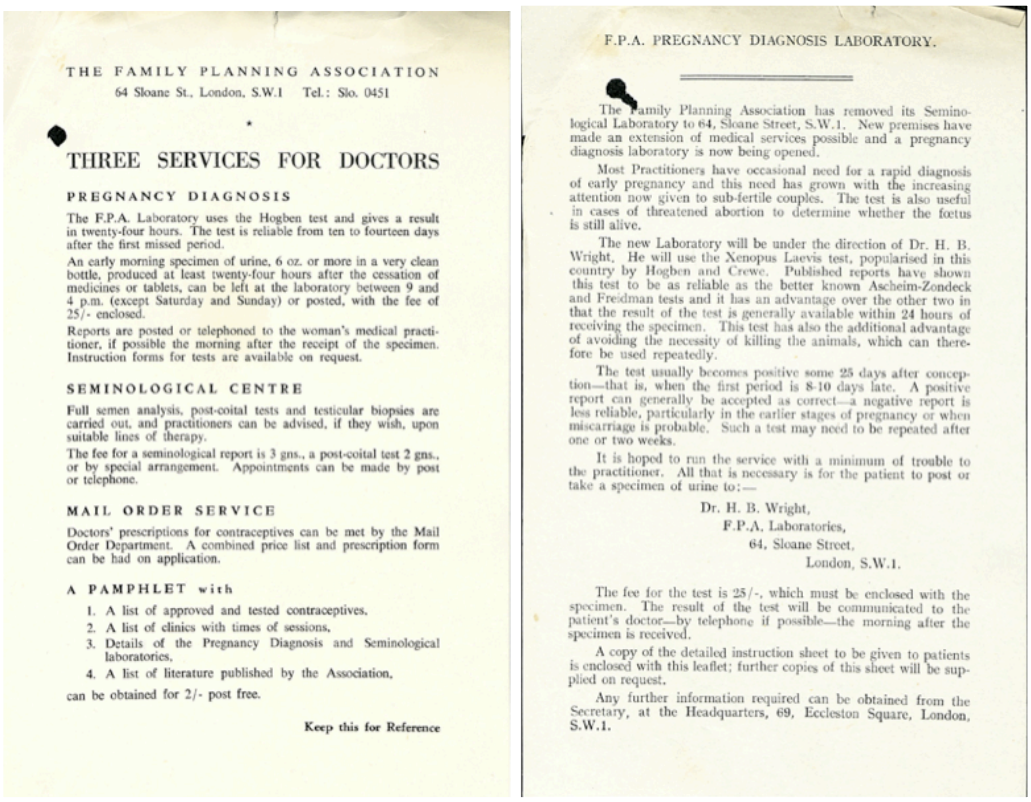
The *News Review* article reported that, although most tests were currently performed for 'hospital patients and those attending clinics', every woman would soon be able to procure a test from 'her local chemist.'[336] Within 24 hours, the result would be communicated, not to the woman or the chemist, but rather to the woman's doctor. This arrangement was reported as 'a compromise on an earlier plan for the chemist to

[336] 'Trial by toads', *News Review*, 22 December 1949.

tell the woman the result direct.' The FPA now decided that 'without the intervention of a doctor the service might be open to misuse', an oblique reference to illegal abortion. The diagnostic service was praised for its value, not only to patients booking a maternity bed, but also to businesswomen and their employers as well as women planning holidays.[337] The remainder of the article generally praised the FPA and promoted its broad range of activities beyond 'birth control', including work on male infertility. Because of the expenses incurred by these activities and the move to Sloane Street, the association was now 'some £1500 into the red'. Although its relations with the Ministry of Health were 'cordial' and many doctors were reportedly in favour of integrating contraceptive services into the NHS, the FPA had recently been rejected by the BBC's 'Good Cause' charity appeal.[338]

In January 1950 Wright had a thousand revised information sheets printed and distributed. In a letter to chemists who already used the Sloane Street service, he suggested that the new arrangement would offer 'the best chances of protecting the Pharmacist and the Laboratory' and also served 'the best interests of the patient concerned' (**figure 5.4.**). A second letter assured new customers that the method of notifying results had been 'adopted not through any lack of confidence in the Pharmacist, but because it has been recommended by medical authorities as being the only method which will protect the Pharmacist and the Laboratory from occasional abuse.' These terms were the only ones under which Wright was permitted to receive tests from 'non-medical sources.'[339]

[337] On women's leisure in postwar Britain: Langhamer, 2000.
[338] On the Sunday evening broadcast of the *Week's Good Cause*: Colpus, 2011.
[339] General Secretary to Mr Avory, 27 February 1950, letter to old chemists, 31 January 1950, letter to new chemists, 31 January 1950, SA/FPA/A3/11.



THE FAMILY PLANNING ASSOCIATION
64 Sloane St., London, S.W.1 Tel.: Slo. 0451

*

THREE SERVICES FOR DOCTORS

PREGNANCY DIAGNOSIS

The F.P.A. Laboratory uses the Hogben test and gives a result in twenty-four hours. The test is reliable from ten to fourteen days after the first missed period.

An early morning specimen of urine, 6 oz. or more in a very clean bottle, produced at least twenty-four hours after the cessation of medicines or tablets, can be left at the laboratory between 9 and 4 p.m. (except Saturday and Sunday) or posted, with the fee of 25/- enclosed.

Reports are posted or telephoned to the woman's medical practitioner, if possible the morning after the receipt of the specimen. Instruction forms for tests are available on request.

SEMINOLOGICAL CENTRE

Full semen analysis, post-coital tests and testicular biopsies are carried out, and practitioners can be advised, if they wish, upon suitable lines of therapy.

The fee for a seminological report is 3 gns., a post-coital test 2 gns., or by special arrangement. Appointments can be made by post or telephone.

MAIL ORDER SERVICE

Doctors' prescriptions for contraceptives can be met by the Mail Order Department. A combined price list and prescription form can be had on application.

A PAMPHLET with

1. A list of approved and tested contraceptives,
2. A list of clinics with times of sessions,
3. Details of the Pregnancy Diagnosis and Seminological laboratories,
4. A list of literature published by the Association,

can be obtained for 2/- post free.

Keep this for Reference

F.P.A. PREGNANCY DIAGNOSIS LABORATORY.

The Family Planning Association has removed its Seminological Laboratory to 64, Sloane Street, S.W.1. New premises have made an extension of medical services possible and a pregnancy diagnosis laboratory is now being opened.

Most Practitioners have occasional need for a rapid diagnosis of early pregnancy and this need has grown with the increasing attention now given to sub-fertile couples. The test is also useful in cases of threatened abortion to determine whether the fœtus is still alive.

The new Laboratory will be under the direction of Dr. H. B. Wright. He will use the Xenopus Laevis test, popularised in this country by Hogben and Crewe. Published reports have shown this test to be as reliable as the better known Ascheim-Zondeck and Freidman tests and it has an advantage over the other two in that the result of the test is generally available within 24 hours of receiving the specimen. This test has also the additional advantage of avoiding the necessity of killing the animals, which can therefore be used repeatedly.

The test usually becomes positive some 25 days after conception—that is, when the first period is 8-10 days late. A positive report can generally be accepted as correct—a negative report is less reliable, particularly in the earlier stages of pregnancy or when miscarriage is probable. Such a test may need to be repeated after one or two weeks.

It is hoped to run the service with a minimum of trouble to the practitioner. All that is necessary is for the patient to post or take a specimen of urine to:—

Dr. H. B. Wright,
F.P.A. Laboratories,
64, Sloane Street,
London, S.W.1.

The fee for the test is 25/-, which must be enclosed with the specimen. The result of the test will be communicated to the patient's doctor—by telephone if possible—the morning after the specimen is received.

A copy of the detailed instruction sheet to be given to patients is enclosed with this leaflet; further copies of this sheet will be supplied on request.

Any further information required can be obtained from the Secretary, at the Headquarters, 69, Eccleston Square, London, S.W.1.

Figure 5.4. An information sheet produced by the FPA publicised pregnancy diagnosis alongside semen analysis as well as mail order contraceptives and information pamphlets. It attributed the increased demand for early pregnancy diagnosis to the 'increasing attention now given to sub-fertile couples' and pointed out that the Hogben test 'avoided the necessity of killing the animals' (SA/FPA/A3/11, Wellcome Library).

By the end of March 1950, Wright had performed over 1,500 Hogben tests. He had cleared a small profit (£165) after spending around £1,200 on overhead, running costs and salaries. Wright budgeted £1,400 for the following year and anticipated a monthly income of around £160, or about £2,000 for the year. For £50 a month, an advertisement in the *BMJ* was 'still bringing in a steady flow of new doctors, at the rate of 6 to 10 a week'. Wright expected that continued expansion would make it necessary to hire a 'bottle washer' and 'general cleaner up' of equipment to assist the 'frog queen' Mrs Northgate. He also invested in a new tank with an immersion heater, thermostat and Sunvic control. Wright's frogs were becoming 'a little bit overcrowded' and he planned to order another batch come summer.[340]

[340] Wright to Finance Committee, A. Restall, Ltd., to Wright, 11 May 1950, Wright to Finance Committee, 19 May 1950, SA/FPA/A3/11.

The association approved Wright's plans for expansion and he commissioned new tanks and electrical equipment. He also ordered a further 600 toads for about 5 shillings each from Thomas Cook. Wright requested approval for cardboard bottle containers to compete with commercial firms, which were sending 'far more beautiful containers' as well as 'the Public Health and associated organisations', which also supplied containers to doctors. Wright's workload was 'still expanding and pretty fast' and with 'judicious propaganda', he expected it to stabilise at around 300 tests per month. By October 1950 five or six hundred doctors were using the laboratory. Hans Davidson's wife Victoria prepared a 'semi-humorous design,' based on the work of the seminological and pregnancy diagnosis laboratories and Wright sent out Christmas cards as a 'useful way of creating good will and reminding [his] more wayward clients of [his] continued existence and interest.'[341]

In 1951 the Post Office complained that the 'glass bottles in boxes' that Wright had ordered 'do not meet their very stringent regulations for sending specimens through the post.' So he contacted Industrial Appliances to receive samples of plastic bottles. Subject to approval by the Post Office, Wright planned to buy 250 'completely unbreakable' bottles for one shilling each. The high cost of plastic bottles was offset by what Wright called 'the advertising angle'. In other words, 'by having something which is entirely up to date we are leading the field and are likely to create a good impression by so doing.' Wright suspected that plastic would soon 'replace glassware very considerably for packing in the medical trade.' Although very self-conscious of the image projected to clients, Wright's basement laboratory was less impressive in other ways. It lacked heating and the glass roof over the frog tank leaked and made it impossible to work when it rained without getting wet. Wright had no filing cabinet and so folders were kept in a partition in a cupboard, which was 'thoroughly unsatisfactory and untidy.' But Wright's service continued to expand. The number of tests he performed in 1951-52 increased to over 3,300 and the income to over £2,500.[342]

[341] Wright to Miss Leach, 26 May 1950, Leach to Thos. Cook, 31 May 1950, Wright to Leach, 19 July 1950, Wright to Pyke, 23 July 1950, General Secretary to Wright, 20 October 1950, Wright to Finance Committee, 23 October 1950, SA/FPA/A3/11.
[342] Wright to Finance Committee, 26 January 1951, Wright, 'Report 1950/51 and budget 1951/2', 17 February 1951, SA/FPA/A3/11.

Meanwhile, women's magazines began promoting the Sloane Street service, as they had not done with the Edinburgh station. *Woman's World* published a letter attributed to a 'very worried' aunt from Glasgow whose niece, 'a single girl,' had 'made a terrible mistake.' 'How soon is a pregnancy certain?' she asked. The magazine's agony aunt, 'sorry to hear' that the girl was 'in such trouble', explained that there was 'now a urine test for pregnancy which can be performed when the period is a fortnight late' and which would 'give the answer in a few days.' 'If a doctor thinks it is necessary,' she continued, 'this test can be done for free under the National Health Service. If performed privately, through the Family Planning Association there is a fee of twenty-five shillings.'[343] And *Mother* magazine published a letter attributed to a woman who wished she 'knew whether or not [she] was going to have a baby.' She hadn't had a period 'for nearly three months' and she was certain her 'tender' bust was 'fuller'. Her doctor, however, refused to examine her because she 'already had two miscarriages' and he was 'afraid of doing anything which may start a period off, just in case [she] had conceived.' 'Would it be any good having a pregnancy test, do you think? How does one go about it?' she asked. 'By all means ask your doctor about a pregnancy test', encouraged *Mother*'s agony aunt: 'It simply involves sending a specimen of your urine to The Family Planning Association, 64 Sloane Street, London, S.W.1.'[344]

On 29 November 1955 the conservative Minister of Health Iain Macleod officially visited the FPA in public recognition of the association's Silver Jubilee. He posed for photographs outside the North Kensington clinic as well as 'at a microscope in the sub-fertility laboratory'. This was the first time a Minister for Health had publically endorsed any voluntary organisation promoting birth control, a publicity stunt that generated headlines in the national newspapers, an interview with Margaret Pyke on BBC television and a talk on *Woman's Hour* (Shepherd, 1994, 94). In June 1958, a photograph of Macleod being shown a positive Hogben test by an obliging lab technician at Sloane Street was published in a *Family Doctor* article on morning sickness (**figure 5.5**). More than the Edinburgh station or the NHS, it was Wright's

[343] 'Pregnancy test', *Woman's World*, 6 January 1951.
[344] *Mother*, February 1952, 69.

initiative and the involvement of the FPA that managed to increase the public visibility of pregnancy testing in the 1950s.

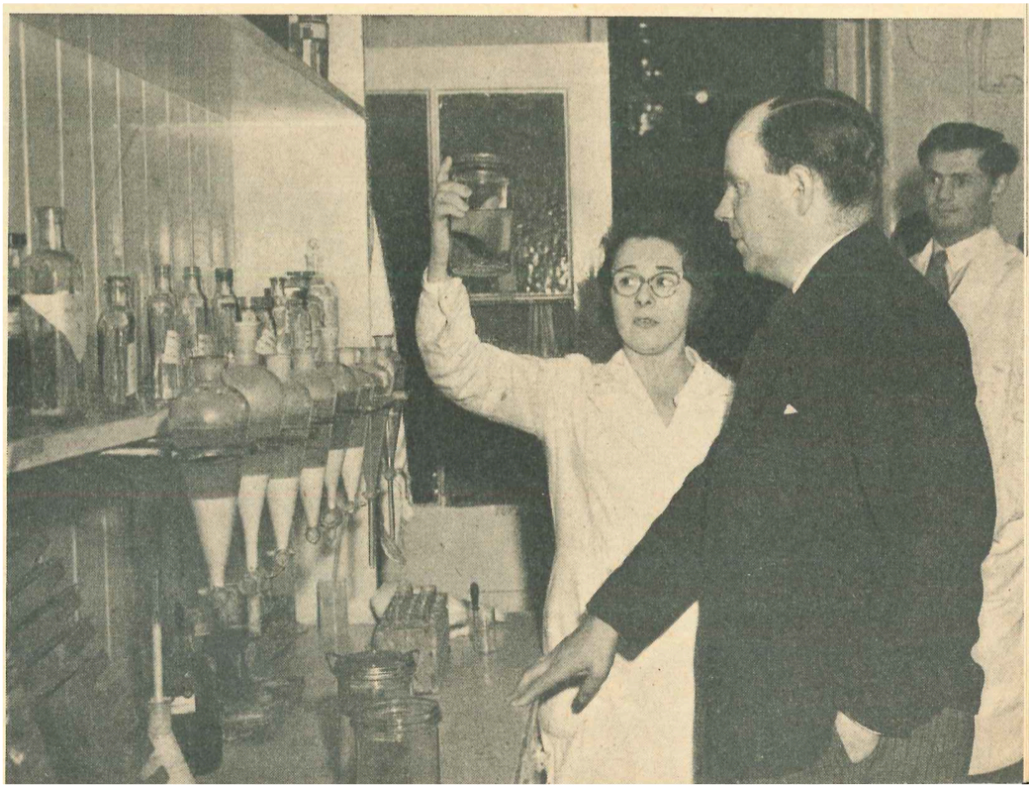


Figure 5.5. The caption reads: 'The Rt. Hon. Iain Macleod sees a positive result of the Hogben test. In the bottle is a toad and the eggs she has laid. She only lays these eggs if the urine injected into her was an "early morning specimen" from a pregnant woman. Within twenty-four hours the results are absolutely certain. Every week over a hundred couples use this service at the Family Planning Association's Pregnancy Diagnosis Laboratory at 64 Sloane Street, London, S.W.1' (Capel, 1958, 382).

5.3. 'Pregnancy, like murder, will out'

'"Doctor, my periods are late: whatever shall I do?" Every general practitioner is familiar with this question.' So began a short article in the March 1955 issue of *Medical World*, the journal of the Medical Practitioners' Union (MPU).[345] The author, Dr A. Ryle, reported that his London practice, which served over 6,000 patients, had dealt with 13 unwanted pregnancies in four months (July-October 1954). These cases did not include those 'where substances had been taken to "bring on" late periods (a very common practice) when the total duration of amenorrhoea was less than two months. Such cases may or may not have been pregnant' (Ryle, 1955, 266). As historian Emma Jones reminds us, chemists, rubber shops and herbalists continued to sell over the counter remedies to 'bring on a delayed period' or 'terminate pregnancy' well into the 1960s. In a letter to the ALRA in 1964 a nineteen-year-old woman wrote: 'I am now about six weeks pregnant having just missed my second period [...] I understand that there is a possibility of obtaining certain drugs or injections that are able to bring on the period provided that I can act fairly swiftly' (Jones, 2011, 293). Though never advertised or prescribed as abortifacients, pharmaceutical companies manufactured and marketed hormonally active tablets and ampoules in the 1960s that purported to restore menstruation.

American journals had first announced the 'treatment of delayed menstruation with prostigin' as a 'therapeutic test for early pregnancy' in 1940.[346] And in 1942 Bernhard Zondek, having become the head of a hormone research laboratory at the Hadassah Medical School in Jerusalem, Palestine, reported injections of progesterone and oestrogen as a 'simplified hormonal treatment of amenorrhea' (Zondek, 1942). Though Zondek did not propose this combination of hormones as a pregnancy test, others did. In 1950, Schering, the same company that had marketed Maturin before the war, licensed 'a compound named Duogynon' in West Germany 'as a pregnancy test and to treat secondary amenorrhea' (Tümmler et al., 2014, 14). By the time Duogynon was marketed as 'Primodos' in Britain, several other companies had already launched their own 'clinical', 'hormonal' or 'withdrawal bleeding' pregnancy

[345] The MPU was established as the Panel Medico-Political Union in 1914 to simultaneously promote the extension of state medical care and protect the autonomy of GPs: Cooter, 2004.
[346] See, for example, Soskin et al., 1940, Winkelstein, 1942.

tests, as they were variously called. For example, Roussel's Amenorone Forte was marketed both as 'Zondek's method for medical curettage for amenorrhoea and other medical disorders' and as 'simple and safe test for pregnancy' (Roussel Laboratories, 1957) (**figure 5.6**).

for rapid action

Amenorone Forte

Each tablet contains 50 mg. Ethisterone and 0·05 mg. Ethinyloestradiol

1 Tablet daily for 3 days

RECENT SECONDARY AMENORRHOEA

AMENORONE FORTE, 1 tablet daily for 3 days, results in menstrual bleeding within 3 days of the last dose.

In resistant cases, a higher dose, such as 2 or 3 tablets daily for 3 or 4 days, may be used.

PREGNANCY TEST

AMENORONE FORTE in the same dosage provides a safe and simple test for pregnancy since **withdrawal bleeding is produced in amenorrhoea but not in pregnancy.**

Rationale: When AMENORONE FORTE is stopped during pregnancy, in contrast to amenorrhoea, the high level of natural hormones is sufficient to continue supporting the endometrium. Withdrawal bleeding, therefore, does not occur.

6

ADVANTAGES

For the patient	easy treatment rapid return of menses
For the prescriber	simple dosage low cost.

Mode of administration

Sublabial (or sublingual) administration allows maximal absorption: the tablet is placed between the lip and upper gum so that its presence can be forgotten, ideally on going to bed, or after meals. The tablet is allowed to dissolve slowly, without sucking and without any food or drink being taken until after it has disappeared.

Packing and Basic N.H.S. Prices

AMENORONE . . .	Bottles of 20 tablets 8/6
AMENORONE FORTE	Boxes of 3 tablets 6/–
ANDROSTALONE . .	Bottles of 12 tablets 12/–

7

Figure 5.6. A pamphlet promoting Amenorone forte, a combination of ethisterone (50 mg) and ethinyl-oestradiol (0.05), indicated as a treatment for 'recent secondary amenorrhoea' or as a 'pregnancy test' (MH 149/1105).

Anthropologist Linda Layne has noted that the US Federal Drug Administration (FDA) banned 'a hormone withdrawal test' in 1975 (Layne, 2009, 62), but few others have commented on the forgotten use of drugs as pregnancy tests. A notable exception is the Australian feminist Germaine Greer. In *Sex and destiny: the politics of human fertility* (1984), Greer wondered if 'the marketing of high doses of sex hormones as pregnancy tests was not a disguised way of selling do-it-yourself abortion kits. The instructions for the use of Primodos are simply too good to be true.' These were to take '1 tablet on each of two consecutive days. Bleeding follows in 3-6 (rarely as long as ten) days, if there is no pregnancy. An existing pregnancy is unaffected by Primodos' (Greer, 1984, 143). In the early 1950s, some pregnancy testers evidently took the claims of Primodos and other drugs at face value, even as

others expressed doubts and concerns. GPs began prescribing the new drugs and laboratory workers began testing them against the known standard of *Xenopus*.

In 1953 George Douglas Matthew of the University of Edinburgh Obstetrics and Gynaecology Department teamed up with Bruce Hobson of the pregnancy diagnosis station to compare the Hogben test to two consecutive daily intramuscular injections of 'Disecron', a combination of progesterone and oestrogen manufactured by Schering (Matthew & Hobson, 1953). Although apparently more reliable than *Xenopus* in the early weeks of pregnancy, Matthew was put off by the invasiveness of injections as the form of administration. So, to 'overcome this element of discomfort and inconvenience to the patient', he conducted a second trial in which he administered 94 women with ten 'Orasecron' tablets for two days (**figure 5.7**). Of the 62 who did not experience any bleeding, all were confirmed with the Hogben test to be pregnant. Follow-up examinations excluded pregnancy in the remaining 32 who did bleed after a week or two. Matthew enthusiastically reported the oral administration of orasecron in the *BMJ* as 'a reliable clinical method of diagnosing early pregnancy' (Matthew, 1956, 979). Matthew specialised in infertility and had, since the end of the war, provided a service for southeast Scotland, so it is unlikely that he would have knowingly prescribed abortifacients to his patients, many of whom would have been trying to become pregnant.[347]

[347] See 'G D Matthew', *BMJ*, 292, 1678.

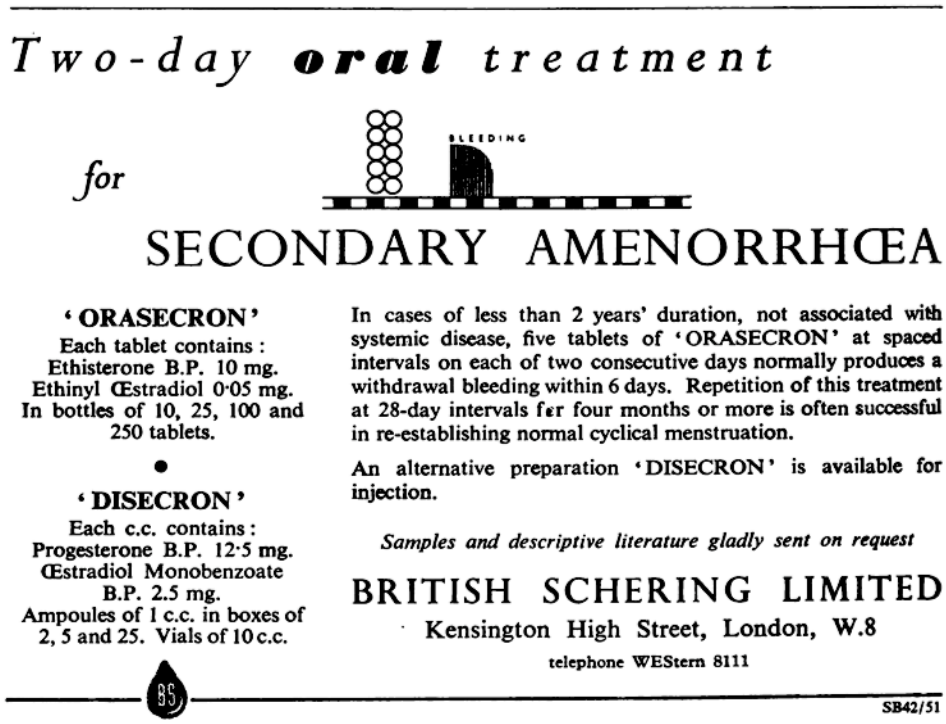


Figure 5.7. Schering's 'Disecron' and 'Orasecron' were advertised as treatments for amenorrhoea, not as pregnancy tests (*Proceedings of the Royal Society of Medicine*, 45, November 1952, Advertisements, vi).

But not all doctors shared Matthew's confidence in the new drugs. A cautious *BMJ* editorial explained that the 'technical and financial disadvantages' of biological tests had 'led to the search for a simple biochemical method.' But none 'proved reliable' and so it 'seemed rational as well as economical to use the patient herself as the test animal.' Researchers had investigated the potential of histology, the microscopic examination of vaginal smears and cervical mucus in pregnancy diagnosis. Though considered reliable, histological techniques required 'specialist interpretation' and so were not widely adopted in general practice. Because patients usually sought medical advice on account of a missed period, researchers had also investigated methods that would 'produce uterine bleeding only if the patient were not pregnant and which would not harm the pregnancy if present.' The editorial agreed that the commendable 'simplicity and relative economy' of the test would endear it to general practitioners, but also spelled out some qualifications.[348]

[348] 'Diagnosis of early pregnancy', *BMJ*, 27 October 1956, 987-989.

Although Matthew had not noted any 'untoward effects on the pregnancy', the possibility that the course of hormones had provoked miscarriages in one or more of the 32 women who experienced bleeding remained. To be absolutely sure of the benign influence of Orasecron, Matthew would have had to examine patients' menstrual blood for clots and conduct endometrial biopsies. The editorial suggested repeating Matthew's clinical trial with these added precautions. Another drawback of Matthew's test was that it was of little use in cases when differential diagnosis was 'perhaps most often sought', that of patients who presented with bleeding. For women suspected of a threatened miscarriage, the administration of hormones to induce bleeding could be of no assistance. The editorial concluded that there was 'usually no urgency for a certain diagnosis of early pregnancy, and if the family doctor cannot make a confident diagnosis, re-examination of the patient in three or four weeks' time is nearly always conclusive. Pregnancy, like murder, will out.'[349]

A few months earlier, Dr Hubert G. Britton, a London physiologist, had written: 'It is with dismay that I have received this morning a brochure from a drug firm describing a test for differentiating between pregnancy and amenorrhoea by the administration of a mixture of synthetic hormones, and the induction of withdrawal bleeding in those with amenorrhoea.' Britton worried that drugs administered 'in the first few weeks of pregnancy […] when the embryo is most susceptible to noxious influences […] will upset the delicate hormonal balance of the mother and the foetus'. He condemned clinical trials of the safety of such drugs, on the grounds that 'a continued pregnancy and an apparently normal child is no guarantee that no harm is being done' (Britton, 1956a, 419).

Britton reiterated his concerns following the *BMJ* editorial, this time drawing attention to a recent report of 'the delivery of a malformed foetus after this test had been used, although the writer was of the opinion that the association was coincidental.' He criticised the editorial, which raised the risk of miscarriage, for completely ignoring 'this side of the problem' and 'hoped that the widespread use of these tests [would] not lead to a repetition of the story of X-ray pelvimetry, for a

[349] Ibid.

procedure of no therapeutic value' (Britton, 1956b, 1118). But concerns that prescribing drugs to pregnant women would result in fetal abnormalities were not widespread in the years before thalidomide. For example, even as the chapter on 'antenatal care' in the BMA's *Refresher course for general practitioners* condemned the routine 'pelvimetry of every primigravida', warned of the 'danger' posed by 'repeated exposures of radiation […] to the fetal gonads', and remarked on 'how seldom drugs harm the foetus' (Nixon, 1956, 314, 321).

Dr David Lambert of Ruislip, Middlesex, had 'often' used Disecron 'as a test for early pregnancy', but switched to Orasecron because his patients appreciated 'not having to be injected and not having to come to the surgery twice for that purpose.' He agreed with Matthew 'that the oral administration of combined progesterone and oestrogen in the dosage prescribed would appear to constitute a reliable clinical method of diagnosing early pregnancy.' He also took issue with the *BMJ* 'annotation' that concluded 'Pregnancy, like murder, will out':

> Leaving aside those several cases seen each year in general practice where one must consider advising a therapeutic abortion, the general practitioner will at any given time in a large practice have anything up to half-a-dozen cases on his hands of patients who are terribly anxious to know early on whether they are pregnant. I have precisely six such cases in my practice at this minute. For example, recently a patient consulted me when one week overdue. She was in a terrible state of anxiety because she has four children. I believe that she is becoming menopausal. With the aid of orasecron I shall be able to advise her one way or the other within seven to fourteen days.

The *BMJ*'s 'annotator', Lambert complained, 'had little knowledge of this problem in general practice. It is a very real one, and orasecron is a very real help. Eight to twelve weeks of anxiety are harder to bear than one to two weeks. The grateful patient will tell you that it is so' (Lambert, 1956, 118). This was anxiety-driven demand.

5.4. ‘A modern scientific achievement’

An introduction to endocrinology, a handbook published by Organon Laboratories in 1957 explained that ‘Menstrogen’ provided ‘a safe, simple and effective pregnancy test which [did] not depend on laboratory animals.’ Rather, it depended on the production of ‘cyclic bleeding in cases of amenorrhoea due to endocrine dysfunction.’ The ‘failure to induce menstruation after four tablets of Menstrogen have been given daily for five days [indicated] a diagnosis of pregnancy.’ The handbook argued that the test did not endanger pregnancy ‘because the addition and withdrawal of the hormones present in Menstrogen do not interfere with the existing hormonal balance and have no effect on the pregnant uterus’ (Organon, 1957, 35). Organon’s catalogue, *Everyday treatment of endocrine disorders*, published in 1959 promoted Menstrogen, now also available in ampoules, as a safe and ‘speedy diagnostic aid early in pregnancy’ (Organon Laboratories, 1959, 83) (**figure 5.8**).

Figure 5.8. Organon advertised Menstrogen as both a treatment for amenorrhoea and a test for pregnancy (*Practitioner*, *184*, April 1960, A98, June 1960, A80).

In 1959, Dr Douglas Hogg, a Newcastle general practitioner, turned to Schering's 'Orasecron' because of the cost (23 shillings), waiting period (at least a week), and 'trouble' of collecting, packaging, and posting the urine for the Hogben test and also because overworked laboratories often requested that general practitioners 'ask for such tests only when absolutely necessary' (Hogg, 1959, 612). Hogg prescribed Orasecron, which he judged simple, cheap, rapid and reliable, to women who suspected pregnancy on the grounds of a missed period, but showed no other clinical symptoms. One of Hogg's patients made the 'veiled suggestion that the drug had produced an abortion' and so he warned the practitioner 'to be guarded in the wording of his instructions to a patient.' In addition to pregnancy diagnosis, Hogg recommended Orasecron as 'a most useful drug when it is necessary for a woman to regulate her periods to prevent menstruation at awkward times such as examinations or sporting events' (Hogg, 1959, 614). Mary Bew, a Belfast practitioner, found Orasecron 'particularly useful as an aid to diagnosis when pregnancy is possible in an unmarried girl' and did not 'suspect that it had interfered with the course of pregnancy in those women who were pregnant' (Bew, 1960, 372).

Dr D. H. Forster, a general practitioner, argued that the Hogben test was 'cumbersome, because a specimen of urine has to be collected, packed and posted, sometimes to a very considerable distance. This specimen may not reach the laboratory intact, and even if intact may be insufficient in quantity. Assuming these obstacles have been overcome, the results are not always accurate, and, in any case, may not be received until ten days or even longer after the patient's first attendance.' In the past few years, he had performed 'hormone tests for pregnancy' on 46 patients using an 'oily injection' of Disecron. In view of 'the distraught state of mind in so many' of his patients, Forster preferred 'to give two daily injections rather than risk an incorrect diagnosis through a misunderstanding by the patient over the dosage of the tablets.' He considered hormone tests to be 'at least as accurate' as the Hogben test and had not 'heard of any foetal abnormalities resulting from its use'. Finally, the basic NHS cost of Disecron, six shillings for two injections, compared 'favourably with the cost of urinary gonadotrophin tests' (Forster, 1959, 242).

Bruce Hobson, Britain's leading proponent of the Hogben test, expressed doubts that Disecron was a 'desirable' alternative to *Xenopus*. He maintained that the Edinburgh station routinely provided reliable results within 24-48 hours (except on weekends) and that urine specimens packed in polyethylene bottles were sure to arrive intact. Though Hobson conceded that Disecron 'might be more convenient for some general practitioners,' he argued that there were few women who, 'when given the alternative of collecting a specimen of urine or of receiving two intramuscular injections, would choose the discomfort of the latter.' Finally, his strongest objection to any 'pregnancy test involving the injection of steroid material when other adequate tests [were] available', was the uncertainty that 'the resulting hormonal imbalance, however small, may not itself cause an abortion in susceptible women' (Hobson, 1959, 409).

But the convenience of pills continued to appeal to GPs and perhaps also to a generation of patients increasingly at ease with prescription drugs. Dr R. J. Kenton, a Glasgow general practitioner, preferred tablets because they required 'less of the general practitioner's time than injections or urinary gonadotrophin tests.' He prescribed a course of four tablets of Primodos, 'one tablet night and morning on each of two consecutive days' to produce 'either withdrawal bleeding (no pregnancy) or no bleeding (indicating pregnancy) within 3-6 days.' As with Disecron, the cost to the NHS of Primodos compared 'favourably with that of gonadotrophin tests' (Kenton, 1959, 409-410) (**figure 5.9**).

Figure 5.9. These two Schering adverts display different marketing tactics: a direct attack ad on the 'slow' toad in fiery red (left) and a subdued blue one playing on the patient's quiet anxiety over a missed period (right). Both ads make prominent use of the question mark (*Practitioner*, 187, July 1960, A49; 184; Schering Archiv).

Dr Albert Davis compared injections of Organon's 'pregnancy test ampoule' (PTA) to the Hogben test in 100 patients from outpatient gynaecological clinics in north and south London 'thus representative of 'the Metropolitan population', including 'women of Northern Mediterranean and African genotypes' (Davis, 1963, 70). Each patient was given a routine examination, a single intramuscular injection of PTA, instructed to bring a urine specimen the next day for a Hogben test, and seen one week later to verify whether the 'presence or absence of bleeding correlated with the Hogben test', which was repeated in cases of disagreement. All patients were seen later 'either for artificial reinstitution of menstruation, or for supervision of their pregnancy if pregnant.' Davis reported in the *Practitioner* that PTA had been correct in all 100 cases, that it was 'utilizable at an earlier stage' than the Hogben test and that 'there had been no adverse effect in cases of established pregnancy' (Davis, 1963, 71).

Gabriel V. Jaffé, a Bournemouth practitioner, used pridostigmine, a cholinergic drug, as a pregnancy test in 100 women with amenorrhoea. He reported in the *Lancet* an overall accuracy of 97% for the 'simple, accurate, and inexpensive' test, which cost 3 shillings under the NHS.[350] Drs G. L. Higgins and W. R. Sadler, who provided antenatal care to 7,500 patients in Bristol, an industrial city of 500,000, considered the Hogben test 'cumbersome and lengthy' and also noted that 'the collection and transmission of the specimen represent considerable inconvenience to an already busy person.' They decided to give Primodos to 'all women' (excluding those 'who were clearly pregnant') 'who had amenorrhoea of short duration, after explaining the nature of, and the reasons for, the test (Higgins & Sadler, 1960, 677-678). Yet cautious views continued to be expressed.

The chapter by Ursula M. Lister on 'the early diagnosis of pregnancy' in *Calling the laboratory* (1962), first published as an article in the *Practitioner*, warned of the possibility that, 'at least in susceptible cases,' 'the hormone balance may be upset and bleeding occur despite a pregnancy.' Although early diagnosis 'may be desired by the patient,' Lister contended that 'a few weeks' delay and re-examination' was 'the best test of all' (Lister, 1962, 86). This view represented the cautious non-interventionist end of the spectrum. But as we have already seen, anxiety-driven demand was only increasing and many GPs felt pressured by their patients to do something. The unknown risks of tablets and injections, on the one hand, and the increasing demand for pregnancy testing, on the other, contributed to an even greater positive presence of *Xenopus laevis* and *Bufo bufo* in women's magazines. In June 1961 an article by Joan Seaward in *Woman* promoted the Hogben test, not Primodos, 'as a modern scientific achievement.' A full-page article conveyed the pros and cons of different tests in the form of a fictionalised encounter between 'Mrs Berry' and her doctor (**figure 5.10**).

[350] Jaffé, 1960, 654. For a critique Jaffé's 'thererapeutic enthusiasm': Read, 160, 158.

"WOMAN" W/E 24TH JUNE 1961

PREGNANCY TEST ★ ★ ★ a modern scientific achievement

GLANCING through the records on his desk, the doctor noted that the last time he had seen the young woman in front of him was when he had attended her for a miscarriage just three years ago.

Both she and her husband had been bitterly disappointed at the loss of what they had hoped would be their first child. And when Mrs. Berry had completely recovered, he had advised her to become pregnant again just as soon as she could.

"Doctor," she began, "once I got over my miscarriage, I never missed a single period—not even a day late. But now I'm a whole fortnight overdue. That could mean I'm pregnant again at last, couldn't it?"

"It could," he answered. "But I won't be able to give you a definite diagnosis today."

Her face fell. "Do you mean you can't tell by examining me?"

"Not yet," he replied. "In any case, it might be unwise for me to do an internal examination very early in your pregnancy. We have to remember that last time you had a miscarriage in the third month, so it's best to take no risks."

What does a pregnancy test involve?

"But doctor," she said, "how much longer must I wait before knowing for certain? It means so much to my husband and me. Couldn't I have one of those pregnancy tests I've heard about?"

"Well yes, Mrs. Berry," he answered, "as your period is two weeks overdue that could be arranged. The laboratory charges a guinea for making the test, but I take it you think it's worth that?"

"Oh yes," she said fervently. "What happens?"

"Well, in the first place, a carefully prepared specimen of your urine is needed and it's essential that your period is at least two weeks overdue, because it's the presence of what we call gonadotrophic hormones in the specimen of urine which gives proof that conception has occurred. And it takes twenty-five to thirty days from time of conception for these hormones to be first manufactured and then excreted in sufficient strength in the urine."

"Can you do the test right here in the surgery?"

The doctor shook his head. "It has to be done in a properly equipped laboratory. You see, apart from anything else, the test we use most in this country involves the co-operation of toads!"

"How perfectly extraordinary. How on earth do toads help?"

"In the test, which is called the Hogben test, the urine is injected under the skin of a female toad. If the urine contains gonadotrophic hormones, twelve to twenty-four hours later the toad will begin to produce streams of eggs.

"In another test, called the Galli-Mainini, male toads are used. If the urine injected into them is definitely from a pregnant woman, they produce sperm as the female produced eggs.

"Two other tests—the Ascheim Zondeik test for which mice were used and the Friedman test which involved rabbits—have been largely discarded nowadays as although they (like the Hogben and Galli-Mainini tests) are practically a hundred per cent reliable, they take longer to get results and also involve killing the animals concerned, whereas the toads can be used over and over again with no ill effects."

"How amazing," said Mrs. Berry. "Thank you for explaining. Could I ask just one more question? Aren't there some tablets that act like a pregnancy test?"

"The tablets you mean," the doctor answered, "are a combination of two of the ovarian hormones, oestrogen and progesterone. A woman can start taking them when her period is just one week overdue and continue for four to five days. If she is *not* pregnant, then four to five days after this her period will commence. If she *is* pregnant, there'll be no bleeding.

"A similar test can be given by means of a hormone injection when the period is one week overdue. Again it's a combination of the same two hormones. And again the period will start after a five day interval if the patient is not pregnant, while there'll be no bleeding if she is.

"But like most doctors I prefer my patients to have the Hogben test. There is still much we have to learn about hormones—although the pregnancy tests are reliable enough.

"And a hormone test wouldn't have got you the result any quicker. You see, for five days of this past week you would have been taking the necessary tablets (for it's these I would have prescribed). Then you would have to wait another five days to see if your period started. Which brings you up to the day after tomorrow.

"As it is, if you take your specimen of urine round to the laboratory tomorrow, which you can do as you live in London, we'll have the result from the Hogben test just twenty-four hours later. So you see you haven't lost time by not coming earlier!"

Hopes confirmed in forty-eight hours

"Here's the necessary pregnancy test form," he said. "I've filled in my part. When you get home, fill in your name, address, age and the number of days your period is overdue. And do adhere strictly to the instructions on the form, won't you?"

"Nothing to drink after your evening meal today so that the morning specimen of urine will be really concentrated. And no aspirin, indigestion mixture or any kind of drug, because that would contaminate the specimen and might possibly harm the toad into which it is injected.

"And finally, use the urine you pass first thing in the morning. Put at least six ounces into a clean glass bottle or jar. See your name is on the bottle. Put the filled-in form, specimen of urine and the fee together, and hand them in at the address on the front of the form. As you'll see, the laboratory is open for specimens from 9 a.m. to 4 p.m. daily except at the weekends. And luckily for you this is only Tuesday!

"Now away you go and try to possess your soul in patience!"

Forty-eight hours later, an ecstatic Mrs. Berry was able to tell her husband a telephone call from the doctor had confirmed she was pregnant.

And just seven months after that she declared herself to be the happiest woman in the world. For she had been safely delivered of a beautiful baby boy.

JOAN SEAWARD

The pregnancy test proved positive —and now the baby they wanted so much is safely in her arms

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Figure 5.10. The caption reads, 'The pregnancy test proved positive—and now the baby they wanted so much is safely in her arms' (Seaward, 1961, 27).

Three years ago Mrs Berry had miscarried in the third month of her first pregnancy. She and her husband had been 'bitterly disappointed at the loss of what they hoped would be their first child.' Subsequently, Mrs Berry's periods had been regular, but they were now a fortnight overdue. She suspected pregnancy, but her doctor would not risk an internal examination, which could provoke another miscarriage. 'But doctor,' she implored, 'how much longer must I wait before knowing for certain? It means so much to my husband and me. Couldn't I have one of those pregnancy tests I've heard about?' Mrs Berry's doctor informed her that the most popular tests in Britain cost one guinea ('but I take it you think it's worth that') and 'involved the co-operation of toads!' 'How perfectly extraordinary', Mrs Berry replied, 'How on earth do toads help?' The doctor explained how the Hogben and Galli-Mainini tests worked as well as the now 'largely discarded' Aschheim-Zondek and Friedman tests. 'How amazing', explained Mrs Berry, before asking 'just more question' about 'tablets' she had heard of that 'act like a pregnant test'.

'The tablets you mean,' explained the doctor, 'are a combination of two of the ovarian hormones, otestrogen and progesterone. A woman can start taking them when her period is just one week overdue and continue for four to five days. If she is *not* pregnant, then four to five days after this her period will commence. If she *is* pregnant, there'll be no bleeding.' 'A similar test can be given by means of a hormone injection when the period is one week overdue. Again it's a combination of the same two hormones. And again the period will start after a five day interval if the patient is not pregnant, while there'll be no bleeding if she is.' 'But like most doctors', he continued, 'I prefer my patients to have the Hogben test. There is still much we have to learn about hormones—although the pregnancy tests are reliable enough.' Furthermore, he added, 'the hormone test wouldn't have got you the result any quicker. You see, for five days of this past week you would have been taking the necessary tablets (for it's these I would have prescribed). Then you would have to wait another five days to see if your period started. Which brings us up to the day after tomorrow.' Mrs Berry would be able to take her specimen 'round to the laboratory tomorrow,' and would 'have the result from the Hogben test just twenty-four hours later. So you see you haven't lost time by not coming earlier!'

Mrs Berry's doctor handed her the 'necessary pregnancy test form' with his part already completed and instructed her to fill in her name, address, age and the number of days her period was overdue. He instructed her not to drink after her evening meal, to take no aspirin or other drugs that might harm the toad, to collect at least six ounces of concentrated morning urine in a clean glass bottle or jar with her name on it, and to deliver the specimen, completed form, and fee to the indicated address. 'Forty-eight hours later, an ecstatic Mrs. Berry was able to tell her husband a telephone call from the doctor had confirmed she was pregnant.' 'And just seven months after that she declared herself to be the happiest woman in the world. For she had been safely delivered of a beautiful baby boy' (Seaward, 1961, 27). This strong endorsement of the Hogben test in Britain's most prominent women's magazine was a direct response to concerns about hormone tablets and injections.

In the medical press, concerns about withdrawal bleeding tests intensified when Dr Victor Dubowitz, a South African-born paediatrician at the Children's Hospital, Sheffield,[351] warned of a 'possible association between the administration of "Amenorone" for the diagnosis of pregnancy and virilisation in the female infant.' The case, reported in the *Lancet* in August 1962, involved a 34-year-old woman who had become pregnant for the first time after six years of marriage. After missing a second period, she had consulted her GP, who prescribed one tablet of Amenorone daily for three consecutive days. 'This did not produce any vaginal bleeding' and after 'an uneventful pregnancy', the patient gave birth to twins: one 'apparently normal male' and one with 'ambiguous' genitalia. The latter was transferred to the Children's Hospital, where, after performing some tests (a 'buccal smear was chromatin positive' and a 'chromosome karyotype was 46 XX'), Dubowitz concluded that the infant was a 'non-adrenal female "pseudohemaphrodite"'.[352] He 'could only speculate' whether 'masculinisation' ('phallic enlargement') could 'have resulted from the small dose of amenorone' (Dubowitz, 1962, 406).

Dubowitz's speculation planted a new seed of doubt about withdrawal bleeding tests, already suspected by some of inducing miscarriage in pregnant women, that of teratogenicity. Interest in the monitoring of birth defects had 'intensified enormously'

[351] See Dubowitz, 2005.
[352] Dubowitz, 1962, 405-406. On clinical approaches to sexual ambiguity in the 1950s: Eder, 2010.

in Britain in the 1960s as the direct result of the thalidomide tragedy and German measles epidemics. In 1964 the Ministry of Health set up 'a formal system of registering congenital malformations, with the aim of establishing typical seasonal and regional variations in incidence, and of warning quickly of any unusual increases' (Al-Gailani, 2013, 4). In a review article on the 'problem of teratogenicity' published in the January 1965 issue of the *Practitioner*, Dr Richard Smithells, a Liverpool paediatrician and 'leading British expert on thalidomide diagnostics',[353] explained that

> For the first two weeks of embryonic life pregnancy is usually unsuspected and there is a natural anxiety that during this unguarded fortnight drugs may be taken, anaesthetics administered or x-ray exposures made which would have been avoided had pregnancy been recognized (Smithells, 1965, 104).

But what of withdrawal bleeding tests: drugs intended to be prescribed in the early weeks of pregnancy? Smithells surveyed 189 women who had been prescribed Amenorone Forte or Primodos in 'the first 12 weeks of pregnancies which went beyond the 28th week', but admitted that the 'small group' provided 'no evidence to support [Dubowitz's] suggestion that pregnancy-test drugs are teratogenic.' Nevertheless, he warned that a 'heavy responsibility lies on the shoulders of every practitioner who orders the administration of any drug to a woman in the first twelve weeks of pregnancy' (Smithells, 1965, 108-109).

[353] Smithells 'had set up a congenital abnormalities register and genetic counselling service in Liverpool in 1960': Al-Gailani, 2013, 5.

Conclusion

In the late 1940s and early 1950s Beric Wright's publicity campaign and efforts to commercialise the FPA's diagnostic service also contributed to the higher visibility of pregnancy testing as such. Wright later recalled that he had 'started the frog lab [...] to make money for the FPA and it would have made a lot more if they had let us report direct to the patients.'[354] Although he had been frustrated by the association's bureaucracy and compromises over the involvement of women and chemists, a 1956 'progress report on birth control' praised the Sloane Street laboratory for having 'provided a useful revenue, and […] opened up contact with medical practitioners who had hitherto been unaware of the Association's work' (Florence, 1956, 33). Wright's publicity campaigns and those of pharmaceutical companies marketing withdrawal bleeding tests did more to promote pregnancy testing to general practitioners, chemists and women in the 1950s than the Edinburgh station or the NHS.

In the same decade, concerns about drugs including Primodos, Amenorone Forte, and Menstrogen, gave doctors new reasons to promote the Hogben test. Joan Seaward's article in *Woman* portrayed the Hogben test as less risky and just as quick as hormone tablets or injections, at least for a woman living in London who was willing to pay one guinea. By the early 1960s the mixed public-private market for pregnancy testing was not only more expansive, but also more dynamic, competitive and diversified than ever.

[354] Interviews, Beric Wright (HRW's son), PP/PRE/J.1/18:Box 21, Wellcome Library, my transcription.

Chapter 6. ‘Hogben test’s last croak’

Delia was a 24-year-old PhD student at Leeds University when she began to ‘think of having a baby.’ She was married and, having successfully used contraception for eight years, ‘slightly nervous’ about having a ‘fertility problem.’ ‘Because of this’ and also to ‘fit any pregnancy in with research’ she ‘decided to spend the equivalent of a week’s rent on a commercial pregnancy test as soon as [she] noted signs of pregnancy.’ She had probably read about such tests in *New Statesman* or seen an advertisement in *Peace News* or *Private Eye*, all of which ‘were easily available in West Yorkshire’. Her result ‘came back promptly as positive’ and she ‘went at once to the Student Health Service to request ante-natal care.’ When Delia ‘began to bleed’ three weeks later she convinced the doctor who took her call that she was not just having a late period on the grounds that she ‘had had a positive test’ and he ‘immediately arranged’ to drive her to Student Health where she was ‘monitored, and nursed for several days as a result of which [she] missed the great Vietnam Solidarity Campaign demonstration in London on 26 October 1968 (Davin, 2014).

This chapter is about how the technological and social landscape of pregnancy testing rapidly and dramatically changed in a few short years of the decade variously characterised in terms of ‘permissiveness’ and the revolutionary spirit of 1968. Standard histories have it that the adoption of immunoassays obviated the need for animals in the 1960s, by which time *Xenopus* had become established in biological research (Gurdon & Hopwood, 2000, 47, Leavitt, 2006, 322, Tone, 2012, 324). Although we know that pharmaceutical companies manufactured these tests and made them commercially available to clinics and hospitals under trade names (Leavitt, 2006, 322, Haarburger & Pillay, 2011, 547), surprisingly little is known about this commercialising process or its consequences for social relations between laboratories, doctors, women and the media which had become so apparent by the time of Delia’s pregnancy.

Immunoassays were undoubtedly more convenient and efficient than animal injections, but technological progress is not the whole story. In this chapter I want to explore the contested status of commercial test kits, which some pregnancy testers rejected as unreliable even as others enthusiastically embraced them. I will show how

pharmaceutical companies, by aggressively marketing test kits, exacerbated old tensions between rival laboratories and restructured the balance of power between clinical pathologists, doctors and patients. New and productive relationships were forged between entrepreneurial researchers, pharmaceutical companies and the laboratory workers who calibrated the new test kits in commercially supported clinical trials. From 1965 commercial laboratories used these tests to offer direct-to-consumer services, which non-medical newspapers and magazines controversially advertised. New reasons for early pregnancy diagnosis including the risk of birth defects caused by thalidomide and rubella were publicly debated within broader debates over women's rights and the medical status of family planning and abortion within the NHS and British society at large.

6.1 'I see a ring, girl, get your ring'

Pregnancy, made hormonal in the 'golden age' of endocrinology, was made immunological in a brave new world of postwar biomedicine.[355] New tools and networks played an important role, but so too did older links between farm, lab and clinic. In 1950, Stephen V. Boyden, an Australian-born, London and Cambridge-trained veterinarian and immunologist, was visiting the Rockefeller Institute in New York on a Wellcome Trust animal health fellowship, when he developed a method of binding protein antigens to the surface of sheep erythrocytes (red blood cells) treated with tannic acid.[356] Using tuberculin preparations, sera from human patients and rabbit antisera, he found that antigen-coated cells formed a mat pattern when they sedimented in a test tube in the presence of antibodies and that uncoated cells formed a visible ring or dot in the centre. The addition of free antigen neutralised the antibodies and inhibited the mat pattern formation, which made it possible to detect the antigen in a solution. Immunologists first used Boyden's test to detect insulin in a buffer solution in the mid 1950s and Leif Wide, a Swedish medical student, first applied it to pregnancy testing in 1960 (Wide, 2005, 194-195) (**figure 6.1**).

[355] On postwar biomedicine and immunology, see for example, Mazumdar, 1989, 2002, Cambrosio & Keating, 1995, Löwy, 1996, Gaudillière, 2002, Quirke & Gaudillière, 2008, Kroker et al., 2008, Silverstein, 2009.
[356] Boyden, 1951. On the Institute and its flagship *Journal of Experimental Medicine*, in which Boyden reported his method: Lederer, 1992.

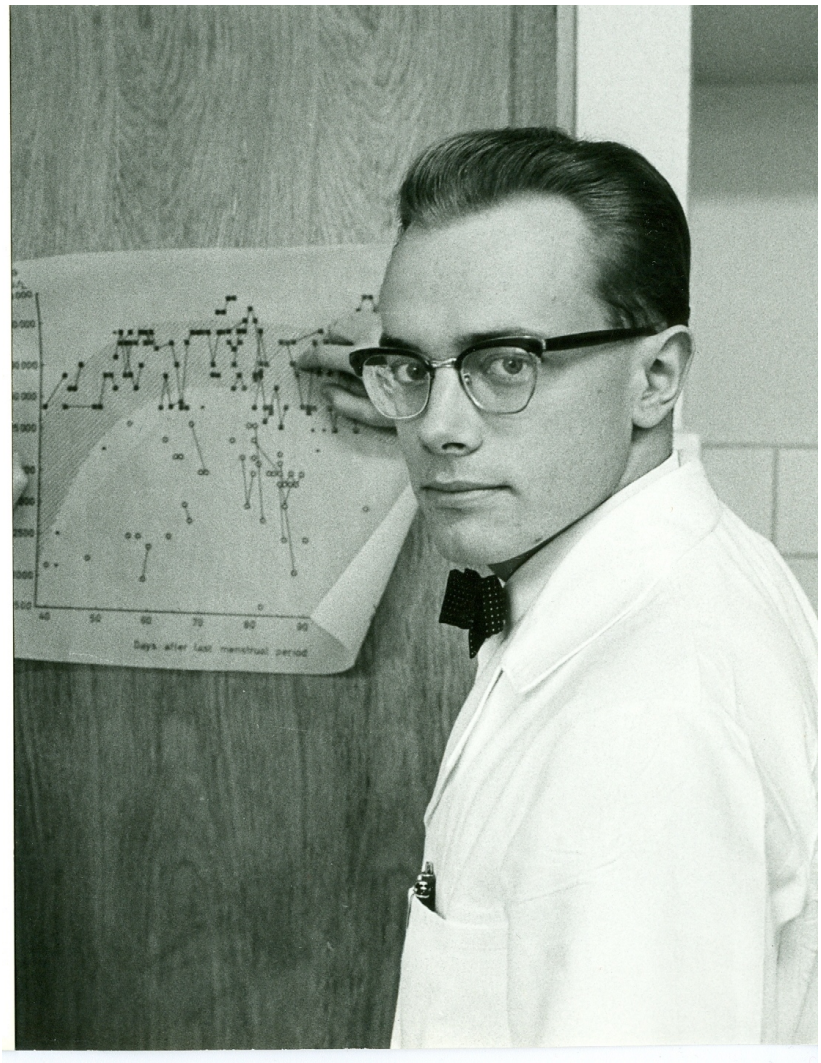
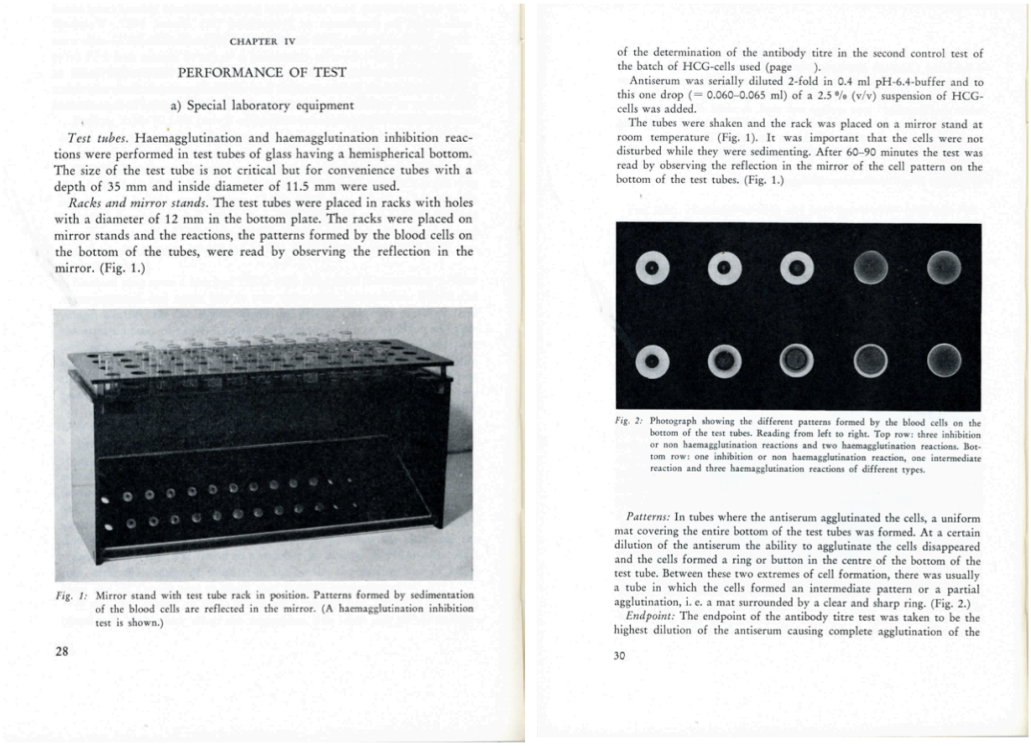


Figure 6.1. A portrait (*c.*1960) of Leif Wide looking smart as a young doctoral student in lab coat, slicked back hair, horn-rim glasses and bowtie, demonstrating a draft of a figure from his doctoral thesis; courtesy of Leif Wide.

In the autumn of 1959, Wide approached Carl Gemzell, his teacher at the Karolinska Institute in Stockholm, to start some research in parallel with his studies. Gemzell, a gynaecologist specialised in reproductive endocrinology and infertility treatment,[357] directed Wide towards an immunoassay for the human growth hormone (hGH) in blood, which had recently been reported by American researchers (Read & Stone, 1958). Wide had little success measuring the minute concentrations of hGH in serum or plasma and so in February 1960 he decided to apply the same techniques to measuring hCG, which was known to occur in large concentrations in pregnant women's urine. Gemzell arranged for specimens to be rerouted from his gynaecology ward; only pregnant women tested positive (Wide, 2005, 195).

Wide treated sheep erythrocytes with formalin and tannic acid and then coated them with 'Pregnyl', the commercial hCG product marketed by the Dutch company Organon. With a view towards a test kit that would be suitable for a doctor's surgery or pharmacy, he next attempted to freeze-dry the hCG-coated cells and the antiserum in separate bottles. Developed in the 1930s by biochemists at the University of Pennsylvania, the technique of freeze-drying or 'lyophilisation' was used to preserve human plasma and penicillin during the war, orange juice and other foodstuffs in peacetime (Greaves, 1968, Meryman, 1976, Schneider, 2003, 220, Radin, 2012, 129). After encouraging results Wide began using ampoules of the two freeze-dried reagents combined in a round-bottomed test tube. To perform a pregnancy test, he first added a single drop of woman's urine and half a millilitre of buffer solution to an ampoule containing the two freeze-dried reagents and then waited ninety minutes before inspecting a mirror beneath the test tube. In a positive reaction, the hCG in a pregnant woman's urine bound the antibodies and the hCG-coated cells slid down the glass wall to settle 'as a sharp ring or disc.' In a negative reaction, the antibodies reacted with and covered the cells, which adhered to the glass wall and formed 'a mat pattern' as they sedimented (Wide, 2005, 197) (**Figure 6.2**).

[357] Gemzell, who attempted to use pituitary hormones prepared from human cadavers to induce ovulation in infertile women, had recently announced the successful birth of twins in one of his patients: Pfeffer, 1993, 2000, Nordlund, 2011.



CHAPTER IV

PERFORMANCE OF TEST

a) Special laboratory equipment

Test tubes. Haemagglutination and haemagglutination inhibition reactions were performed in test tubes of glass having a hemispherical bottom. The size of the test tube is not critical but for convenience tubes with a depth of 35 mm and inside diameter of 11.5 mm were used.

Racks and mirror stands. The test tubes were placed in racks with holes with a diameter of 12 mm in the bottom plate. The racks were placed on mirror stands and the reactions, the patterns formed by the blood cells on the bottom of the tubes, were read by observing the reflection in the mirror. (Fig. 1.)

Fig. 1: Mirror stand with test tube rack in position. Patterns formed by sedimentation of the blood cells are reflected in the mirror. (A haemagglutination inhibition test is shown.)

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of the determination of the antibody titre in the second control test of the batch of HCG-cells used (page).

Antiserum was serially diluted 2-fold in 0.4 ml pH-6.4-buffer and to this one drop (= 0.060–0.065 ml) of a 2.5 %/s (v/v) suspension of HCG-cells was added.

The tubes were shaken and the rack was placed on a mirror stand at room temperature (Fig. 1). It was important that the cells were not disturbed while they were sedimenting. After 60–90 minutes the test was read by observing the reflection in the mirror of the cell pattern on the bottom of the test tubes. (Fig. 1.)

Fig. 2: Photograph showing the different patterns formed by the blood cells on the bottom of the test tubes. Reading from left to right. Top row: three inhibition or non haemagglutination reactions and two haemagglutination reactions. Bottom row: one inhibition or non haemagglutination reaction, one intermediate reaction and three haemagglutination reactions of different types.

Patterns: In tubes where the antiserum agglutinated the cells, a uniform mat covering the entire bottom of the test tubes was formed. At a certain dilution of the antiserum the ability to agglutinate the cells disappeared and the cells formed a ring or button in the centre of the bottom of the test tube. Between these two extremes of cell formation, there was usually a tube in which the cells formed an intermediate pattern or a partial agglutination, i. e. a mat surrounded by a clear and sharp ring. (Fig. 2.)

Endpoint: The endpoint of the antibody titre test was taken to be the highest dilution of the antiserum causing complete agglutination of the

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Figure 6.2. Pages from Wide's doctoral thesis, completed in Uppsala and published in Copenhagen in 1962 in *Acta Endocrinologica Supplementum 70*, showing photographs of a mirror stand with test tube rack (left) and the patterns formed by blood cells on the bottom of test tubes (right) (Wide, 1962, 28, 30).

By May 1960 Wide had tested over 300 urine specimens from Gemzell's ward and had not obtained a single incorrect result. But the pair needed a commercial partner to manufacture the standardised reagents on a large scale, so Gemzell approached Organon, a company he had previously dealt with. Marius Tausk, the managing director in Oss, Holland, was 'deeply impressed' and proposed the mnemonic, 'I see a ring, girl, get your ring' (Tausk, 1984, 236). On his return flight he drafted a contract, which granted Organon a few weeks to apply for a patent before the Swedes submitted their manuscript for publication.[358] Tausk expected the first test kits to be launched by Christmas, but had 'seriously underestimated' the technical difficulties of scaling up the production of freeze-dried reagents.[359] The unanticipated delay nearly provoked Organon to abandon the project.

[358] See Wide & Gemzell, 1960.

[359] Wide, 2005, 198. Wide had worked out how to freeze-dry the reagents in bottles for batches of only 20 or 100 tests.

At a meeting in July 1961 several Organon executives argued that the project 'should be abandoned' to free up company resources for more promising ventures. But Jacobus Polderman, an enthusiastic research pharmacist, and other supporters successfully pushed for the continuation of the freeze-drying work.[360] Meanwhile, Wide and Gemzell moved to Uppsala University, where the latter became professor of obstetrics and gynaecology in January 1961.[361] Wide defended his doctoral thesis in 1962, reporting an accuracy of 99.8% in some 2,230 tests.[362] And although clinicians were initially skeptical that such a simple test could actually work, the university hospital there eventually replaced the Friedman test with Wide's.[363] Several other hospitals in Sweden followed suit and Organon first marketed 'Pregnosticon' in the Netherlands in May 1962 (Tausk, 1984, 237). By then the market had already become competitive with rival pharmaceutical companies actively promoting their own test kits.

In Britain, Burroughs Wellcome & Co., a prosperous pharmaceutical company with a long tradition of laboratory research,[364] began work on its own immunoassay in 1961. Arthur James Fulthorpe and others at the Biological Division of Wellcome Research Laboratories in Beckenham, Kent, collaborated with a hospital and two group laboratories in nearby Lewisham, South London, to compare a new immunoassay to the male toad test in over 700 urine specimens, including over 200 from female staff members at the Wellcome laboratory (six turned out to be pregnant).[365] William A. Barr of the Edinburgh station worked with Fulthorpe to compare Wellcome's 'Prepuerin' to *Xenopus* in over 1,500 tests (**figure 6.3**). Although Prepuerin was 'simple and easy to perform,' the standard of Hogben testing in the Edinburgh laboratory was 'extremely high': 99.2% agreement with clinical diagnosis compared to 97.4% for Prepuerin. Most disagreements occurred when *Xenopus* was negative and Prepuerin was falsely positive, due to 'a completely non-specific' reaction or cross-reaction with pituitary luteinising hormone (Barr, 1963a, 556). False positives

[360] Tausk, 1984, 236. On Polderman: Gerritsma, 1980.
[361] On the history of Uppsala University: Lindroth, 1976.
[362] Wide, 2005, 199. See also Wide, 1962, Wide & Gemzell, 1962.
[363] Interview by Naomi Pfeffer with Gemzell, undated.
[364] On Burroughs Wellcome: Macdonald, 1980, Tansey, 1989, 1990, Church & Tansey, 2007. On the pharmaceutical industry in twentieth-century Britain: Slinn, 1996, 2005, Quirke, 2008, 2009.
[365] Fulthorpe et al., 1963. Burroughs Wellcome had the 'oldest "modern" pharmaceutical research laboratories in Britain': Quirke, 2009, 284. See also Anderson, 2005, Church & Tansey, 2007.

had not been an issue with *Xenopus* in Edinburgh and pregnancy testers debated their significance in the early 1960s.

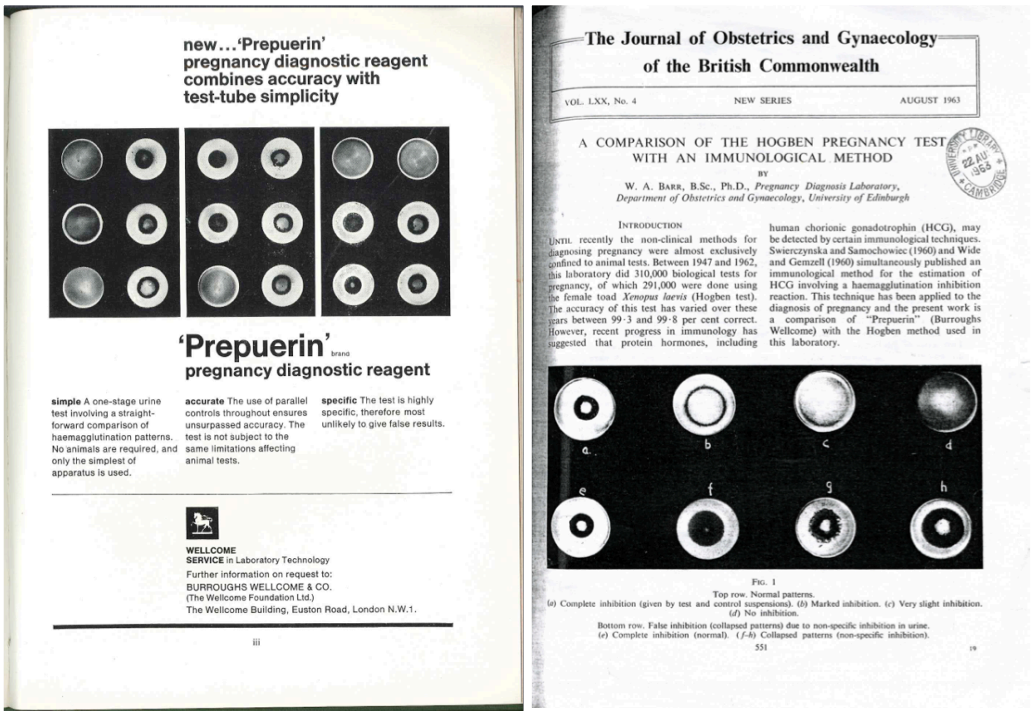


Figure 6.3. An advertisement (left) and leading article (right), both from *The Journal of Obstetrics and Gynaecology of the British Commonwealth* (previously *Empire*), showing photographs of agglutination inhibition reactions obtained with Wellcome's 'Prepuerin' (Volume 70, Issue 2, April 1963, iii; Volume 70, Issue 4, August 1963, 551).

As Wellcome made Prepuerin commercially available, Alexander Warrack and his colleagues at the Sheffield pregnancy diagnosis centre compared it with the Hogben test in randomly selected urine specimens. By May 1963 they had clinically confirmed the results in 311 of 729 tests.[366] The Sheffield centre, which covered the Midlands, the North of England and Wales, performed some 20,000 Hogben tests a year. To maintain an 'output' of at least 50 tests a day, the centre depended on a colony of some 4,000 toads. Pregnancy testing had ground to a halt in 1954 owing to 'difficulties in obtaining toads' and again in 1958, when a streptococcal epidemic nearly wiped out the colony. Unsurprisingly given this track record Warrack was

[366] Shea & Warrack, 1963, 582.

keen to emancipate his laboratory from the 'vagaries of supply' and 'a creature as temperamental in its outlook as it is difficult to obtain in regular quantities.' So despite obtaining three false positives with Prepuerin he praised the immunoassay as 'easy to perform and easy to read.'[367]

Eileen Shuttleworth, a pathologist at the Cumberland Infirmary, Carlisle, collaborated with Fulthorpe and Warrack to test Prepuerin against the Hogben test. In October, having clinically confirmed the results in 165 women, she reported in the *Lancet* that Prepuerin was easier, more economical and quicker than 'using living animals.'[368] Richard Oliver, a pathologist at the Mayday Hospital in Croydon, Surrey, had also tried Prepuerin, but preferred the 'simplicity' of Pregnosticon, which 'was performed on undiluted urine in the ampoules provided, without the need of additional glassware'. He had performed 250 Pregnosticon tests in 'the few months' since Organon had made it commercially available.[369] Organon primarily offered Pregnosticon for testing to laboratories in the Netherlands, nearby Belgium and other European countries, but its English branch in Morden, Surrey, supplied the FPA with free kits to compare against the Hogben test.[370]

An Organon promotional booklet boasted that Pregnosticon, the 'result of many years of work of a large scientific team', combined 'simplicity with great reliability' and that 'several investigators' had already reported 'good results'. After comparing Pregnosticon to the Aschheim-Zondek and rat hyperaemia tests in 453 women, Max Keller and Heinz Erb of the Universitäts-Frauenklinik in Basel, Switzerland, had testified that it was 'vastly superior' to all other pregnancy tests. For best results, the booklet recommended carrying out 'a preliminary check' when starting 'a new pack' 'with pregnancy urine and normal urine.' Each pack contained reagents sufficient for twenty tests as well as 'test samples in freeze-dried form' for checking the pack. If these samples were 'not in agreement with the indicated results', the booklet

[367] Ibid., 581.
[368] Shuttleworth, 1963, 699.
[369] Oliver, 1963, 840.
[370] The FPA had to make special arrangements to receive the consignments because the basement laboratory was not equipped with a refrigerator to store the material: Mrs A. D. Simpson to Organon Laboratories, 8 January 1963, SA/FPA/A7/90.

instructed that the material 'should not be used but returned to Organon or their representative.'[371]

A Wellcome promotional brochure boasted that the Prepuerin, which combined 'accuracy with test-tube simplicity', did not produce false positives (it did) and was 'as sensitive as the Toad Test' (it was). An accompanying 'Dear Sir' letter, intended for pathologists, announced that pregnancy diagnosis had 'been simplified.' The new Prepuerin test, which required 'no animals', was 'simple', 'sensitive', 'accurate', 'specific', 'economical' and 'labour-saving'. A 'Dear Doctor' letter proclaimed that Prepuerin had finally filled the 'need' 'for a simpler pregnancy test.' Instead of 'inconvenient' animal tests, which suffered from 'seasonal variations in accuracy', Prepuerin involved the 'straightforward comparison of haemagglutination patterns.' 'It [was] performed on urine without special apparatus under normal laboratory conditions, and the results [were] obtainable overnight.' This 'simple,' 'accurate, sensitive and highly specific' test would 'enable any hospital laboratory to provide economically a speedy local service' (**figure 6.4**).[372]

[371] *Pregnosticon*, Organon, Laboratories, Morden, Surry, *c*.1963, 'Contraceptive testing manufacturers: Organon 1962-1965', SA/FPA/A7/90.
[372] *'Prepuerin': New pregnancy test combines accuracy with test-tube simplicity*, Burroughs Wellcome, 1963, Prepuerin archive material, 1963-*c*.1968, Prepuerin 'Dear Sir' letter, Prepuerin 'Dear Doctor' letter, WF/M/PL/247.

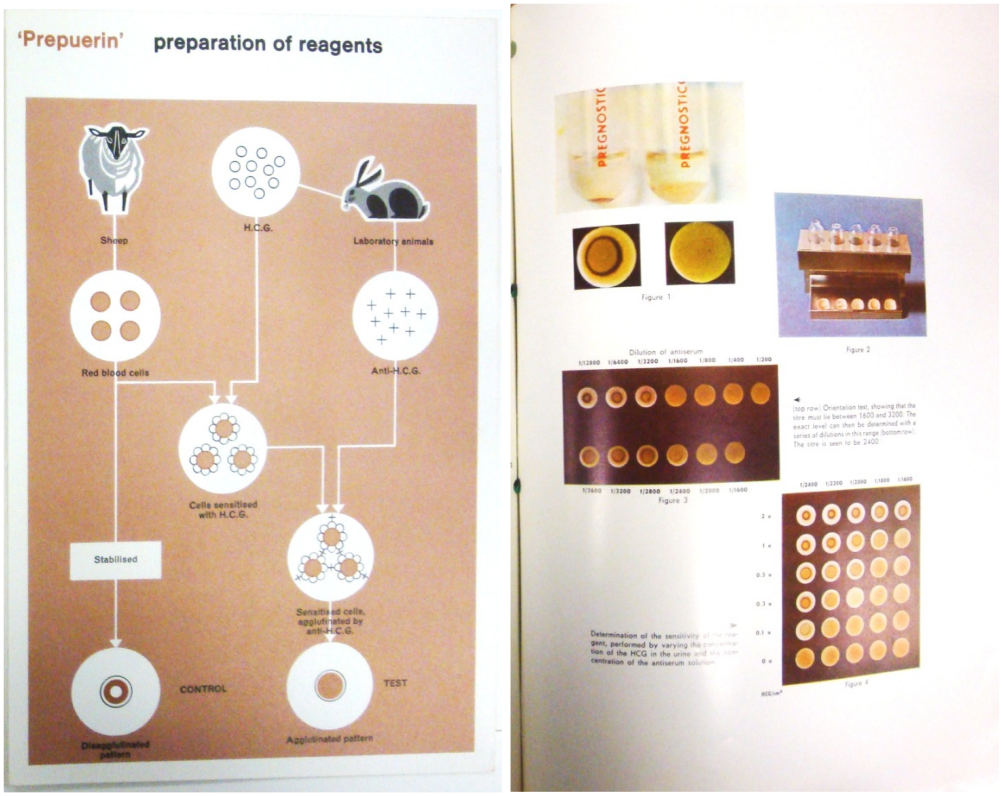


Figure 6.4. Pages from Wellcome's promotional brochure, '*Prepuerin': basic principles of the new 'Prepuerin' pregnancy test* (1963), showing the production of reagents and reaction patters from raw materials (sheep and rabbit blood) (left) and from Organon's brochure, *Pregnosticon* (*c*.1962), showing the calibration of the reaction with different concentrations of hCG and reagent (right) (Wellcome Library: 'Prepuerin', WF/M/PL/247, 'Contraceptive testing manufacturers: Organon 1962-1965', SA/FPA/A7/90).

6.2. 'The ultimate in pregnancy testing'

In 1961, the same year that Wellcome began testing Prepuerin in Britain, Ortho Pharmaceutical, a subsidiary of the American company Johnson & Johnson based in Raritan, New Jersey, launched a two-stage agglutination test using polystyrene latex particles instead of sheep erythrocytes.[373] Since the late 1940s, American electron microscopists had enthusiastically used the unusually uniform latex spheres produced in Michigan by Dow Chemicals to establish a uniform standard of magnification (Rasmussen, 1997, 204, 235-236). The inert particles presented medical workers with an attractive alternative to red blood cells, which deteriorated unless specially treated. In the mid 1950s, doctors at Mount Sinai Hospital, New York, reported the first latex fixation test, using Dow spheres, for the serological diagnosis of rheumatoid arthritis (Singer & Plotz, 1956).

Ortho first supplied reagents to two doctors in Gainesville, Florida, who reported in October 1962 in *JAMA* that the accuracy of the 'simple and rapid procedure' was 'comparable' to that of *Xenopus* (Henry & Little, 1962). In December a *BMJ* editorial predicted that, based on the Florida report, the latex test might soon replace Wide and Gemzell's 'temperamental' haemagglutination method.[374] And in January 1963, the London-based weekly *New Scientist* reported that the new latex test developed in Florida was 'better' than the Hogben test.[375] Bruce Hobson, scientific director of the Edinburgh station, leapt to the defence of *Xenopus*, which was correct, he claimed, '99 times out of 100.' Hobson conceded that immunoassays might eventually become 'the method of choice when their accuracy [was] improved', but for now he preferred the Hogben test (Hobson, 1963a, 309).

[373] Hobson, 1966. Ortho was originally created in the early 1930s to market spermicidal creams and jellies; see Marks, 2010, 36, 'Ortho: A her-story of achievement in women's health', *Women's health care*, 5, 2006, 16-20. On the landmark spermicide 'Ortho-Gynol': Löwy, 2010, 2012. On Ortho Diagnostics: Keating & Cambrosio, 2003, 133, 171.
[374] 'Immunological tests for pregnancy', *BMJ*, 22 December 1962, 1668-1669.
[375] 'A better test for pregnancy', *New Scientist*, *323*, 24 January 1963, 190. Launched in 1956, *New scientist* published articles written by scientists, aligning itself with British weekly magazines like the *Economist* and *New statesman* (Nathoo, 2005, 210).

The English branch of Ortho in Saunderton, Buckinghamshire, provided free latex tests to the Portsmouth and Isle of Wight Area Pathological Service, for testing at the Royal Portsmouth Hospital. In the early 1950s a local GP had attributed high demand to the 'particular problem' of the naval port (Duncan, 1952, 379), and the service laboratory, which had its own *Xenopus* breeding programme (Larkin, 1955), performed some 2,000 Hogben tests every year for about 100 area doctors.[376] But animal breeding and testing used up 'considerable' space and time in a laboratory with 'heavy routine commitments' and so in August 1963, Dr Neil Garden and his colleagues were keen to replace *Xenopus* with the latex test (Garden et al., 1963, 480).

Although Hobson visited Uppsala for six months in 1962 on an Eleanor Roosevelt international cancer fellowship to work with Wide on the new immunoassay, he took every opportunity to defend *Xenopus* (**figure 6.5**).[377] In June 1963 he reminded readers of the *BMJ* that only 'a few hundred comparisons' had been made, mostly on urine specimens 'from normal pregnant and non-pregnant women.' In his laboratory, 'less than a third of the 24,000 to 25,000 tests done each year [were] for women with normal pregnancies.' His staff had performed over 3,000 parallel tests and he was unwilling to replace *Xenopus* with a new method that produced falsely positive results. Hobson argued that the Hogben test was never falsely positive, at least not in Edinburgh, and so his choice was 'between an immunological test that will tell nearly 600 women each year that they are pregnant when they are not, and the biological test that will fail to detect the pregnancy of some 170 women' (Hobson, 1963b, 1606).

[376] This works out to about twenty to twenty-five tests per doctor per year, or one or two tests every month per doctor.
[377] On Hobson: http://www.rcpe.ac.uk/obituary/dr-bruce-morris-hobson-frcp-edin. On the fellowship: Maisin, 1968.

Figure 6.5. Hobson and Wide became close friends and published some twenty collaborative studies in thirty years. Photograph of Hobson in Sweden, courtesy of Leif Wide.

For disenchanted Hogben testers, however, false positives were not a deal breaker. Garden and his colleagues, for instance, argued in the *BMJ* that Hobson and those who agreed with him had simply made 'a virtue out of an inherent property of the test' and should reexamine their assumptions about false results (Garden et al., 1963, 482). False positives, Hobson insisted in a rejoinder, were 'to be deplored, not only because they mislead doctors, but because of the effect of telling a patient who may be unmarried or anxious to have a child that she is pregnant when she is not.' Hobson cautioned that the new test kits should be 'used with discretion' lest they 'fall into disrepute' (Hobson, 1963c, 749). Siding with Garden, Warrack argued that a false positive was not 'any less misleading or unhelpful' than a false negative and that both were 'equally deplorable' (Warrack, 1963, 869). But Hobson countered that his 'clinical colleagues, who use[d] the services of this laboratory, [were] unanimous in

agreeing that false-positive results would cause more trouble than false negatives' (Hobson, 1963d), the idea being that non-pregnancy was the default state.

Ortho also provided tests to Dr Albert Sharman, a leading gynaecologist and infertility specialist at the Royal Samaritan Hospital for Women, Glasgow (**figure 6.6**). Since the late 1930s Sharman had experimented with injectable pregnancy tests, hoping these might free him from his reliance on the laboratory. For this pragmatic reason coupled with his ambitions as an innovator (he had invented a kymograph for tubal insufflation) he enthusiastically began collaborating with Ortho.[378] Sharman compared his results with Ortho's reagents to those of Aschheim-Zondek tests routinely performed at the Royal Maternity Hospital, Glasgow, and concluded after 600 attempts that the latex test beat mice. With help from Thomas Pearston, chief technician of the Samaritan hospital pathology department, he next began experimenting with smaller quantities of antiserum. They performed further tests with the original 'tube' test and their own 'slide' test (Shrman & Pearston, 1964, Sharman, 1965).

[378] 'Obituary notices', *BMJ*, 7 March 1970, 634-636, 634. In the late 1930s Sharman promoted the Antuitrin S intradermal test (Sharman, 1937, 1938) and in the late 1950s a cervical mucus test that involved injecting the patient with the female sex hormone oestradiol (Macdonald & Sharman, 1959). On Sharman's experience with and views on artificial insemination: Davis, 2013, 116-117.

Figure 6.6. A formal portrait of Sharman from a compendium on 'Jews and medicine in Scotland' (Collins, 1988, 93).

Sharman's 'exciting' results were first published not in the *BMJ* or *Lancet*, but in the tabloid-format *Medical News*.[379] Following the success of *Pulse*, an entertainment tabloid weekly for GPs launched in 1962 and the first of the 'paramedicals', the *Financial Times* and the *Practitioner* teamed up to produce *Medical News*, which covered British and international medicine, parliamentary reports, and included a section on 'What Your Patients are Reading' intended to keep GPs 'one jump ahead of readers of the women's journals.'[380] Six weeks prior to the publication of Sharman's results in the *Lancet*, *Medical News* reported that he was 'flabbergasted' by the 'new two-minute pregnancy test', which involved 'mixing together on a slide an anti-serum, a latex precipitin and urine.' Having obtained an accuracy of 100% in

[379] 'Exciting results' from new pregnancy test', *Medical News*, 97, 25 October 1963.
[380] Dopson, 1971, 145, Thistlethwaite, 1997, 11, Nathoo, 2005, 50-51. See also 'The London letter', *Canadian Medical Association Journal*, 87, 15 December 1962, 1292-1293.

100 clinically verified tests results, he had 'never come across anything so exciting'.[381] Without waiting for the *Lancet* to publish his article, Sharman sent the Department of Health for Scotland the relevant 'cutting' from *Medical News* and requested 'an observer to watch the test', which, he predicted, would 'replace all biological tests' and 'save' the Department 'very many thousands of pounds per annum'.[382]

As usual, the view from Edinburgh was more cautious. In an in-depth review article in *Medical News*, Barr contended that the new immunoassays were 'of a high standard', but not yet as reliable as a bioassay. Although he acknowledged that the 'great advantages' of commercial tests over bioassays were 'speed and simplicity', Barr maintained that at least in Edinburgh, where *Xenopus* was 'extremely reliable,' the accuracy of immunological tests would need to be increased before it could 'supersede' the Hogben test. His most serious criticism of the new tests was, however, that they all produced false positive results. 'The social implications of this inaccuracy, particularly in the case of unmarried women or where a pregnancy is unwanted, are felt to be of considerable importance.' This might not amount to much where the testing was on a small scale, but the Edinburgh laboratory performed more than 24,000 tests a year, so 2% or 3% false positives meant that 'between 400 and 600 women would be diagnosed as pregnant when they were not.' The Hogben test, on the other hand, would 'fail to detect 170 pregnancies annually.' Barr concluded that immunoassays were 'new and must be used with discretion; when they have been further developed so that the false positive results are not a problem, they will be extremely valuable' (Barr, 1963b, 8).

When Sharman reported on the 'Ortho slide test' in the *Lancet*, it was still 'available only for research and trial', but he was sufficiently impressed with his preliminary results to declare that a 'revolution' in pregnancy testing was 'at hand.' Undeterred by Barr's warnings about false positives, Sharman predicted that immunoassays would 'make obsolete all biological tests.' False positives were 'no longer a problem' because Ortho had reduced the sensitivity of its reagents and the accuracy of the latex

[381] 'Exciting results' from new pregnancy test', *Medical News*, 97, 25 October 1963.
[382] Sharman to the Principal Medical Officer (or Depute), Department of Health for Scotland, 11 November 1963, HH102/858.

test was ‘greater than that of any pregnancy test yet described’. It was so simple, Sharman claimed, that a house surgeon could be trained to do the test ‘virtually as a side-room method’ (Sharman, 1963). Wilfred R. Butt, a Birmingham endocrinologist, concurred in the *Lancet* that ‘a major breakthrough’ was ‘at hand’ and that Ortho had successfully adjusted ‘the sensitivity of the reaction’ to exclude false positives (Butt, 1963). And Jack Ennis, a Durham pathologist, also writing in the *Lancet*, saw ‘no reason why this elegant test should not for most purposes replace the Hogben test’, but cautioned that ‘its place should remain in the clinical laboratory’ (Ennis, 1963, 1379).

In an article that anticipated home pregnancy tests by about a decade, the *Scottish Daily Mail* boasted that ‘British doctors’ had found ‘an instant and foolproof method of telling a woman whether she is expecting a child.’ Claiming Sharman as ‘one of the country’s leading gynaecological surgeons,’ the *Mail* revealed that he had tested 247 Glasgow women. This new test was ‘so simple that families could have their own do-it-yourself kit; so cheap that it will save the National Health Service millions of pounds.’ Doctors expected Ortho to market its new test in a matter of months. Then, it would only take ‘two minutes to mix the three ingredients on a glass slide and watch for the reaction which determines pregnancy.’ This ‘instant’ test would ‘cost only a few coppers each time.’ British doctors, the *Mail* continued, performed ‘well over a million pregnancy tests every year’, which required ‘a great deal of time in surgeries and laboratories.’ The new test could be done ‘by a family doctor or a house surgeon in a hospital’ and was ‘nothing like so complicated or long as the old biological tests using either mice or toads’ (McLeave, 1963, 3).

In March 1964 Ortho first marketed the slide test under the brand name ‘Gravindex’ (**figure 6.7**), which Sharman endorsed as ‘by far the simplest, quickest and most accurate method for the diagnosis of early pregnancy’ (Sharman, 1964, 70). At the City Hospital in Aberdeen, where the Hogben test was routinely used, laboratory director James Brodie and his colleagues compared the three ‘tube’ tests to *Xenopus* in over 500 urine specimens before ‘dispersing’ their colony of about 500 toads.[383] When the slide test became available towards the end of the trial they decided to test

[383] Brodie & Mellis, 1966, 822. On Brodie: Smith et al., 2005, 75-76.

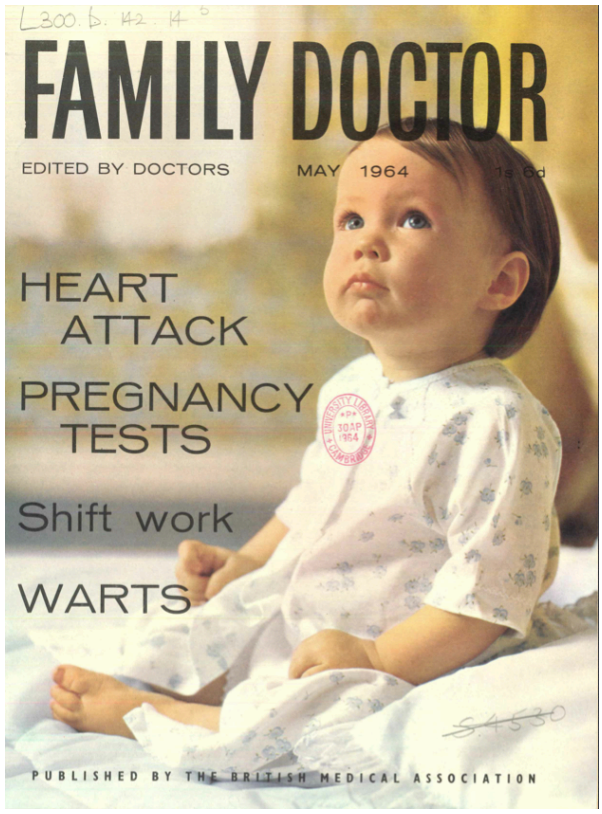
a further 100 specimens and reported in the *Practitioner* that *Xenopus* was 'replaceable' by commercial test kits 'provided the results [were] interpreted along with the clinical findings.'[384]

Figure 6.7. A slick advertisement in *The Journal of Obstetrics and Gynaecology of the British Commonwealth* for Ortho's 'Gravindex', marketed as the 'ultimate in pregnancy testing' (Volume 72, Number 3, June 1965, iii-iv).

[384] Ibid., 825.

In the May 1964 issue of *Family Doctor*, Sharman again predicted that immunoassays would 'make all the biological tests obsolete' (Sharman, 1964, 291) (**figure 6.8**). He did not have to wait long for his prediction to come true. In July 1964 local and national daily newspapers ran with boisterous headlines including 'Wanted—homes for 2,000 rejected toads', 'Second-hand toads', 'Professor jumps at toads in a hole', 'Give a toad a home!', 'Redundant toads', 'Room for 2,000 toads?', and '"Operation toad" gests started!'[385] The conservative *Daily Telegraph* sympathised with *Xenopus*, a victim of the 'old automation story again' made obsolete by the 'march of science.'[386] The Associated Press reported that the FPA would be disposing of 2,000 'shy, retiring' female *Xenopus* (**figure 6.9**). The toads were eventually donated to Sheffield and Southampton Universities as well as Eton and other schools,[387] but not before the story was picked up in the US,[388] resulting in scribbled letters from American schoolboys offering to disburden the FPA. Remarkably, the association responded to each of the boys, informing them that 'good homes' had already been found.[389] In August 1964 even Hobson replaced *Xenopus* with Pregnosticon. Organon had also decreased the sensitivity of its test, nearly eliminating false positives, and a further trial in Edinburgh showed 'an accuracy of 99.0%' (Hobson, 1968, 722). The services of the toad colony established by Francis Crew in the late 1930s and so carefully maintained for some twenty-five years were no longer required.

[385] 'Wanted—homes for 2,000 toads', *Northampton Chronicle*, 9 July 1964; 'Professor jumps at toads in a hole...', *Southampton Evening Echo*, 22 July 1964; 'Give a toad a home!', *Wolverhampton Express*, 9 July 1964; '2,000 toads in a hole', *Daily Mail*, 10 July 1964; '2,000 toads in "hole"', *Lincolnshire Echo*, 9 July 1964; '2,000 toads on his mind', *Daily Mirror*, 16 July 1964; '2,000 toads redundant', *Yorkshire Post*, 10 July 1964; 'Redundant toads', *Birmingham Post*, 10 July 1964; 'Room for 2,000 toads?', *South Wales Echo*, 9 July 1964; 'Second-hand toads', *Eastern Daily Press*, 17 July 1964; 'Toads and holes', *Daily Herald*, 16 July 1964; 'Wanted: new homes for 2,000 toads', *Huddersfield Daily Examiner*, 9 July 1964; '"Operation toad" gets started!', *Glasgow Daily Record*, 21 July 1964.
[386] 'Science makes 2,000 toads redundant', *Daily Telegraph*, 10 July 1964.
[387] '2,000 toads for Eton and universities', *Daily Telegraph*, 7 July 1964; 'Aberdeen may help with too many toads', *Aberdeen Evening Express*, 10 Jul 1964.
[388] 'Who wants 2,134 shy toads? Just write British planners', *The Milwaukee Journal*, 18 August 1964; 'No longer useful: 2,134 toads too many in Britain', *Sarasota Herald Tribune*, 10 July 1964; 'For sale: 2,134 shy toads', *Daytona Beach Morning Journal*, 10 Jul 1964.
[389] Wellcome, 'Pregnancy Diagnosis Laboratory, 1949-1965', SA/FPA/A3/13, Wellcome Library.



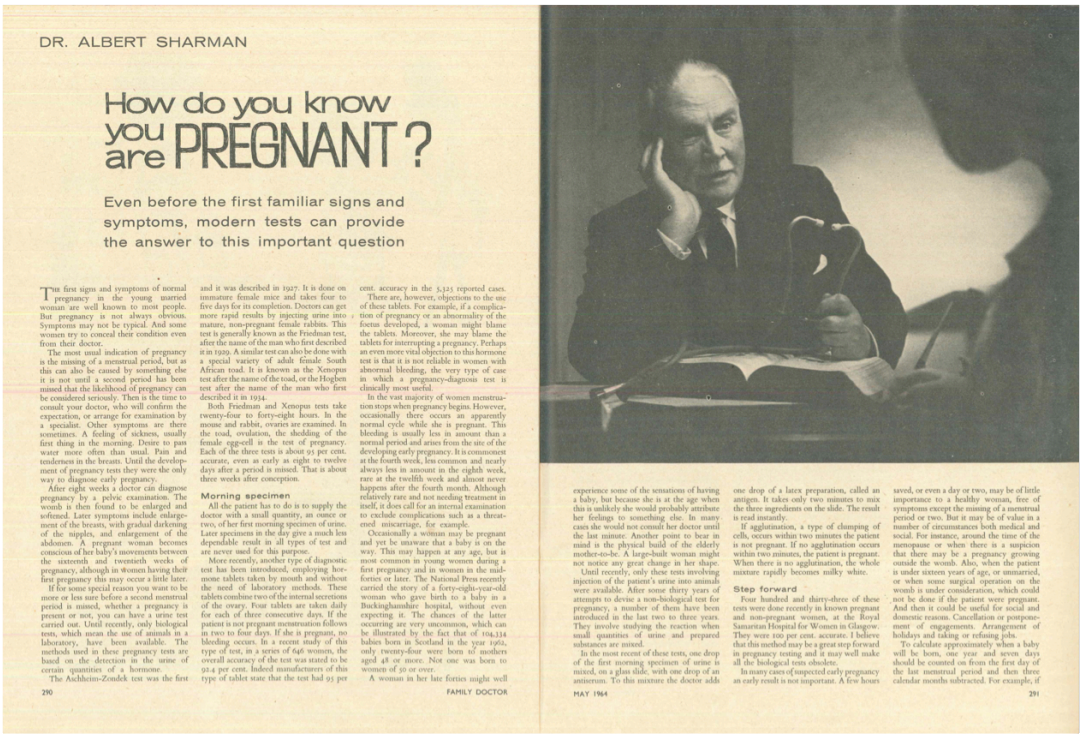


Figure 6.8. The cover (above) and a two-page spread (below) of the issue of *Family Doctor* with Sharman's article, 'How do you know you are pregnant?', showing a staged photograph of a grandfatherly doctor resting on a large tome and holding a stethoscope viewed from the patient's perspective. The position of the camera just over the patient's shoulder reverses the usual portrayal of diagnostic encounter as discussed in Chapter 3 (Sharman, 1964, 290-291).

HOMES FOR 2,000 TOADS WANTED

THE Family Planning Association said today that it wishes to dispose of its 2,000 South African zenopus laevis female toads, following a decision to simplify pregnancy diagnosis tests. For many years the Association has been flying these creatures to Britain for use in the tests, but the new tests—claimed to be "ever more reliable—will be carried out with a chemical manufactured in Britain.

The toads are housed in spacious and specially heated tanks at the Association's London headquarters, where they spend a comfortable life feeding on a diet predominantly of liver.

The man faced with the job of finding them new homes is Brigadier Rupert Elstone, General Secretary of the F.P.A. and he says it is one of the toughest assignments he has ever faced—including his 40 years in the Army!

Second-hand toads

PRESUMABLY one can still please an Arab by expressing the hope that his wives will be fruitful and his sons as numerous as the sands of the desert. Leaning back in his Cadillac, however, the modern sheikh may secretly feel something less than joy at the prospect. This we infer from the fact that the Family Planning Association, which does about 100 pregnancy tests a week in its laboratory in the Tottenham Court Road, has done work for clients in Bahrein.

It is not social attitudes alone which are changing. The laboratory's methods are also changing. At one time the diagnosis of pregnancy involved killing mice or rats. Then it became possible to use toads without disturbing their lives unduly—all they suffered was surprise that they were laying more eggs than usual. Now the tests are entirely chemical, and the collaboration of the toad is no longer necessary.

Our artist stepped in just as the twilight of the toad was descending. The last 2000 toads had been declared redundant, and the association was

Professor jumps at toads in a hole...

"Echo" Staff Reporter

ONE THOUSAND redundant workers from London are heading for Southampton to work for the university.

They will arrive almost unnoticed, because they change colour to blend with their background—and anyway they are only a few inches long.

It was a buyer's market when Southampton University clinched the deal, for their 1,000 zenopus laevis females—toads if you prefer—will cost them about the quarter of the normal price.

HE JUMPED

These little creatures were formerly employed by the Family Planning Association for pregnancy tests, but when a more efficient method was discovered

'OPERATION TOAD' GETS STARTED!

BRIGADIER Rupert Elstone was given one of his toughest assignments yesterday—getting rid of 2000 South African TOADS.

The Family Planning Association has been flying the toads to Britain for years to use in pregnancy diagnosis tests.

Now new tests—claimed to be "even more reliable"—are to be carried out with a chemical.

At present the toads spend a comfortable life in heated tanks at the Association's London headquarters.

The problem of what to do with them has been passed to Brigadier Elstone, the F.P.A.'s general secretary.

Give a toad a home!

NEWS IN BRIEF

THE Family Planning Association said today that it wishes to dispose of its 2,000 South African Zenopus Laevi female toads, following a decision to simplify pregnancy diagnosis tests. The toads are housed in specially heated tanks. They feed on liver. Man faced with the job of finding them new homes is Brigadier Rupert Elstone, general secretary of the F.P.A. He says it is one of the toughest assignments he has ever faced—including his 40 years in the army!

* * *

2,000 TOADS IN A "HOLE"

THE Family Planning Association said today that it wants to dispose of its 2,000 South African Zenopus Laevis female toads, following a decision to simplify pregnancy diagnosis tests.

For many years the association has been flying these creatures to Britain for use in the tests, but the new tests — claimed to be "ever more reliable"—will be carried out with a chemical manufactured here.

The toads are housed in spacious and specially heated tanks at the association's London headquarters, where they spend a comfortable life feeding on a diet predominantly of liver.

The man faced with the job of finding them new homes is Brigadier Rupert Elstone, general secretary of the F.P.A., and he says it is one of the toughest assignments he has ever faced — including his 40 years in the Army.

Figure 6.9. Boisterous headlines in the tabloids proclaimed the end of the Hogben test (SA/FPA/A3/11).

6.3. 'Infamous conduct in a professional respect'

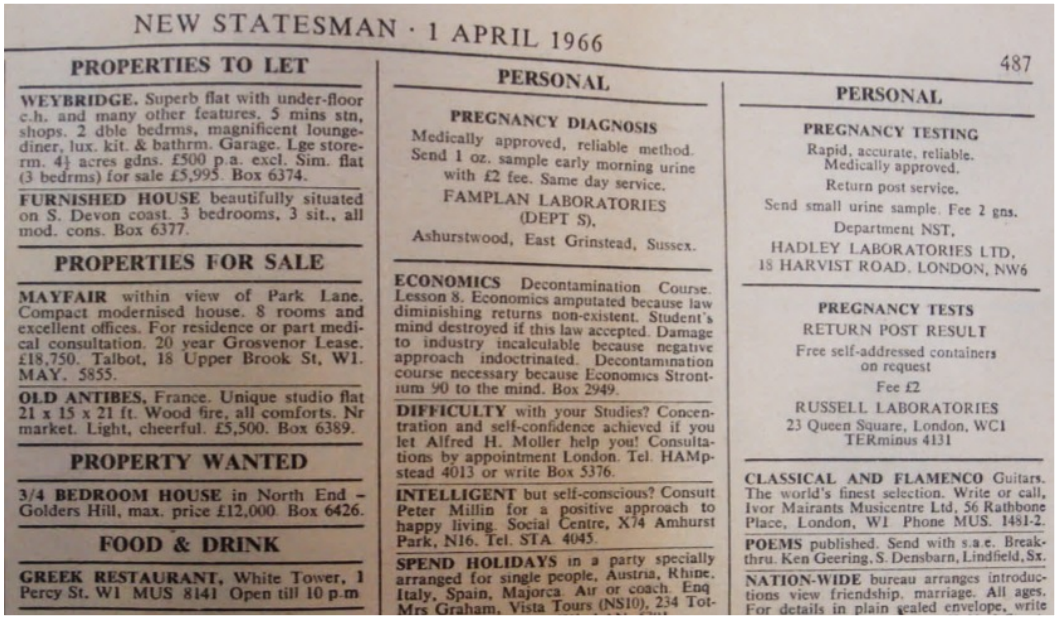
New diagnostic technologies not only put paid to *Xenopus*, but also heralded new social relations and power structures. In 1965 Warrack reflected that with the 'advent of newer and more rapid laboratory methods' doctors and patients were growing dissatisfied with the old 'restrictions' and it was 'becoming increasingly difficult to refuse to satisfy 'the natural desire for a married couple to know as early as possible' (Warrack, 1965, 731). But the NHS was hard pressed and disinclined to meet a growing demand for what it regarded as a non-medical service and not every local hospital was suitably equipped. GPs could send their patients to a local FPA or Marie Stopes clinic, both of which charged £1, but the NHS did not reimburse doctors for non-medical pregnancy tests (Haywood, 1966a, 416). In June 1965, about a year after the FPA and Edinburgh laboratory had switched to immunoassays, one doctor, unable 'to get pregnancy testing done at [his] local hospital' in the low-income northwestern London suburb of Kilburn,[390] decided to take matters into his own hands.

Dr Stanley Solomons, an Oxford-trained GP, called his company Hadley Laboratories, Ltd. Surpassing Beric Wright's previous attempt to circumvent medical gatekeeping, Solomons advertised directly to the public. His professional status as a medical practitioner and the fact that the laboratory occupied the same premises as his Kilburn surgery would eventually land him in trouble with the General Medical Council (GMC).[391] But he had a successful run of two years, during which time he inserted some 2,000 advertisements in medical journals, newspapers and magazines. Charging two guineas per test, his company showed a credit balance of £1,000 in June 1967. His wife, Janice Solomons, who was not medically qualified, owned 49 of the 100 shares and did some of the clerical work. They offered a same-day service, tested all specimens for albumin (which could mislead the immunoassays), offered a free re-test in the event of a negative result, did not dispense any medical advice or treatment and referred 'clients' to their own family doctors in case of health concerns. A 'detailed' instruction and information sheet warned of the possibility of false positives.[392]

[390] 'Pregnancy testing services', *BMJ Supplement*, 17 June 1967, 174.
[391] On Kilburn in the 1960s: Wilson, 1996.
[392] Haywood, 1966a, 416. See also Solomons, 1966, 538.

It did not take long for Solomons' advertising campaign to attract the attention of the BMA and the recently formed Advertising Standards Authority (ASA, 1997). In line with the BMA's longstanding position that pregnancy testing belonged in the hands of doctors, the ASA ruled in October 1965 that the non-medical press should refrain from publishing advertisements for commercial laboratories, but had 'no objection to such advertisements appearing in the medical press, for medical readers, who might wish to make use of the service in connection with their attendance upon patients.'[393] The ASA ruling did not put an end to Solomon's advertising campaign. The *New Statesman*, Britain's leading left-wing political weekly and no stranger to controversy,[394] defiantly continued to publish classified advertisements for Hadley Laboratories. In November 1965, it began taking ads for a second company, Famplan Laboratories, a postal service operating out of East Grinstead, Sussex, and in February 1966, for a third, Russell Laboratories of WC1. These newcomers operated along very similar lines as Hadley Laboratories, but competitively charged a reduced fee of £2 (**figure 6.10**).

[393] *The Third Report of the Advertising Standards Authority, 1 April 1965 – 31 March 1966*, 3 May 1966, 23.
[394] On the earlier history of the magazine, the circulation of which peaked at over 90,000 in the mid 1960s: Hyams, 1963, Smith 1996.



NEW STATESMAN · 1 APRIL 1966 487

PROPERTIES TO LET

WEYBRIDGE. Superb flat with under-floor c.h. and many other features. 5 mins stn, shops. 2 dble bedrms, magnificent lounge-diner, lux. kit. & bathrm. Garage. Lge store-rm. 4½ acres gdns. £500 p.a. excl. Sim. flat (3 bedrms) for sale £5,995. Box 6374.

FURNISHED HOUSE beautifully situated on S. Devon coast. 3 bedrooms, 3 sit., all mod. cons. Box 6377.

PROPERTIES FOR SALE

MAYFAIR within view of Park Lane. Compact modernised house. 8 rooms and excellent offices. For residence or part medical consultation. 20 year Grosvenor Lease. £18,750. Talbot, 18 Upper Brook St, W1. MAY. 5855.

OLD ANTIBES. France. Unique studio flat 21 x 15 x 21 ft. Wood fire, all comforts. Nr market. Light, cheerful. £5,500. Box 6389.

PROPERTY WANTED

3/4 BEDROOM HOUSE in North End – Golders Hill, max. price £12,000. Box 6426.

FOOD & DRINK

GREEK RESTAURANT, White Tower, 1 Percy St. W1 MUS 8141 Open till 10 p.m

PERSONAL

PREGNANCY DIAGNOSIS
Medically approved, reliable method. Send 1 oz. sample early morning urine with £2 fee. Same day service.
FAMPLAN LABORATORIES (DEPT S),
Ashurstwood, East Grinstead, Sussex.

ECONOMICS Decontamination Course. Lesson 8. Economics amputated because law diminishing returns non-existent. Student's mind destroyed if this law accepted. Damage to industry incalculable because negative approach indoctrinated. Decontamination course necessary because Economics Strontium 90 to the mind. Box 2949.

DIFFICULTY with your Studies? Concentration and self-confidence achieved if you let Alfred H. Moller help you! Consultations by appointment London. Tel. HAMpstead 4013 or write Box 5376.

INTELLIGENT but self-conscious? Consult Peter Millin for a positive approach to happy living. Social Centre, X74 Amhurst Park, N16. Tel. STA 4045.

SPEND HOLIDAYS in a party specially arranged for single people, Austria, Rhine, Italy, Spain, Majorca. Air or coach. Enq Mrs Graham, Vista Tours (NS10), 234 Tot-

PERSONAL

PREGNANCY TESTING
Rapid, accurate, reliable.
Medically approved.
Return post service.
Send small urine sample. Fee 2 gns.
Department NST,
HADLEY LABORATORIES LTD,
18 HARVIST ROAD, LONDON, NW6

PREGNANCY TESTS
RETURN POST RESULT
Free self-addressed containers on request
Fee £2
RUSSELL LABORATORIES
23 Queen Square, London, WC1
TERminus 4131

CLASSICAL AND FLAMENCO Guitars. The world's finest selection. Write or call, Ivor Mairants Musicentre Ltd, 56 Rathbone Place, London, W1 Phone MUS. 1481-2.

POEMS published. Send with s.a.e. Breakthru. Ken Geering, S. Densbarn, Lindfield, Sx.

NATION-WIDE bureau arranges introductions view friendship, marriage. All ages. For details in plain sealed envelope, write

Figure 6.10. Classified ads in the *New statesman* for the three laboratories are among the largest and most expensive on the page, appearing alongside smaller ones for flamenco guitar lessons and German language courses in Trier (1 April 1966, 487).

Solomons was medically qualified, but other laboratory directors were not. Brian Block, a pharmacologist, and Derek Lawford, a biochemist, who established Russell Laboratories at Queen Square in Holborn, were already in business together (probably performing toxicological analysis) when Block's wife had 'wanted a pregnancy test' and they 'realized there was a big demand'. Russell Laboratories began as 'a profitable part time sideline' and by 1968 had expanded to bigger premises at Brent Crescent (NW10).[395] A. H. Lloyd established Bell Jenkins Laboratory in Portsmouth in December 1966 under the supervision of 'a qualified laboratory technician' who had 'trained in the Army medical corps.' Lloyd had approached 'a panel of three doctors' to supervise the pregnancy testing, but they had been warned off by the BMA (Black, 1967). A registered nurse qualified as a laboratory technician established a laboratory in Lincoln in September 1966.[396] And a physiologist also qualified as a technician performed pregnancy tests in a spare bedroom (previously a darkroom) of his Kilburn flat, the second such service in that downmarket postcode.[397]

[395] 'The facts about pregnancy testing', *Times*, 30 August 1967, 9.
[396] 'Doctors differ on new test', *Lincoln Echo*, 2 May 1967.
[397] 'The facts about pregnancy testing', *Times*, 30 August 1967, 9.

Despite continued opposition from the BMA, the embargo on advertising laboratories did not last for long. In August 1966 the Consumer Council issued a statement that the ASA would be allowing advertisements 'in the general press at the discretion of publishers, subject to a number of safeguards and a prescribed form of advertisement.'[398] The ASA had determined that commercial laboratories were acting within their legal rights and that women were free to use them.[399] Their new ruling also took into account the assurance that pregnancy testing would soon be 'amply available' under the NHS at hospital laboratories, rather than discouraged 'except in cases of medical or social need'.[400] Commercial laboratories were tolerated in part because of the expectation that they would vanish once the health service got a handle on pregnancy testing. Instead of trying to stop newspapers or magazines from publishing advertisements, the ASA proposed guidelines: tests should be carried out by qualified technicians and clients advised to see a doctor if the result was positive.[401] The ASA also recommended a minimalist form of advertisement 'restricted to the name, address and telephone number of the laboratory, a request for persons responding to provide a sample and state their age, and the amount of fee to be charged.' Some journals applied their own standards. *Medical News* required references from six doctors and only accepted advertisements from Bell Jenkins; the *Lancet* accepted a few others. By the end of 1967 more than twenty laboratories around Britain were advertising in the *Lancet*, *Medical News*, *Nursing Mirror*, *Guardian*, *London Weekly Advertiser*, *Private Eye*, *Daily Telegraph* and *New Statesman* (**Table 6.1**).

[398]The state-funded Consumer Council was founded in 1963 to promote an individualistic model of 'consumer interest': Hilton, 2003, 228-241.
[399] *The Fourth Report of the Advertising Standards Authority, 1 April 1966 – 31 March 1967*, 26.
[400] 'Advertising and pregnancy tests', *Guardian*, 17 August 1966, 6.
[401] 'The facts about pregnancy testing', *Times*, 30 August 1967, 9.

Table 6.1. Commercial laboratories advertised in British medical journals, newspapers and magazines, based on clippings included with A.H. Lloyd's letter to R. H. Davis, 30 December 1967 (NA MH 156/278)

Laboratory	Address	Fee
Hadley Laboratories	18 Harvist Road, Kilburn, NW6	£2
Famplan Laboratories	Furnace Wood, East Grinstead, Sussex	£2
Russell/Belmont Laboratories	23 Queen Square, Holborn, WC1/188 Brent Crescent, NW10	£2
Bell Jenkins Laboratories	4 Charlotte Street, Portsmouth	£2
Welbeck Laboratories	11 Park Square West, NW1	£2 2s
Antigen Medical Laboratories	36 Queen Anne Street, W1	£1 1s 6d
Forte Laboratories	1 St. Swithin's Square, Lincoln	?
Abbey Laboratories	19 Waterloo Street, Glasgow	?
Diagnostic Laboratories	Cowhill Lane, Ashton-under-Lyne, Lancashire	£2
Cook Laboratories	?	37s 6d
Lanark Laboratories	56 Fortune Green Road, London, NW6	£2
Analytical Laboratories	26 Corporation St, Manchester, M4	£2
Gravida Laboratories	Dunraven House, Riverside, Bridgend, Glamorgan	£2
Boden Lab Service	158 Stanningley Town Street, Pudsey, Yorkshire	£2
Medical Services Lab.	69/71 Monmouth Street, WC2	£2
Lab. Dept. 2.	The Guard House, Chidcock, Bridport, Dorset	2gns
Tevic Laboratory	34 Grasmere Ave., London, W5	£2
Wickham Laboratories	Wickham, Hampshire	£2
Lanco Laboratories	20 26 Briddon Street, Manchester, M3	£2
Bristol Laboratories	82 Colston Street, Bristol 1	?
Linhope Laboratories	?	£2

Of all the laboratory directors, Block and Lawford were particularly innovative when it came to advertising by alternative means. The pair changed the name of their company to Belmont Laboratories and began advertising in London underground and British Rail stations in 1966. The Chief Public Relations Officer obtained approval from the Code of Advertising Practices Committee and the London Transport Board signed a £2,000 contract for one year with Belmont Laboratories. But passengers complained and the Commercial Advertising Manager decided that the posters would be removed when the contract expired. The British Transport Authority, however, had not received any complaints and continued to display 330 posters for Belmont in 67 railways around Britain, including ten in Liverpool and in Manchester.[402] Belmont and Famplan were also advertised in *Help yourself to London: a guide to services, facilities and things to do*, which noted that in 'these liberal days' pregnancy testing services were 'in great demand' (Balfour, 1967, 16). In August 1967 a Ministry of Health circular informed local hospital authorities that Pregnosticon and Prepuerin had been made 'available to hospital pathology departments on central supply' and

[402] See Clifton, 1967, Deschampsneufs, 1967, 'Liberties of the subject', Hansard Commons Debates, 1 December 1967, vol. 755 cc808-909.

that pathologists would be expected to 'accept requests for pregnancy tests on referral from general practitioners.'[403] However, as a *BMJ* editorial observed, demand was 'now so great' that some labs were 'compelled to exercise selection' and it was up to the clinician to 'judge the need' and 'indicate the reasons for his decision to the laboratory staff.'[404]

The proliferation of private laboratories advertising pregnancy diagnostic services directly to the public raised questions for the NHS at a time of shifting status for contraception and abortion. Birth control was contentious so upon creation the health service made no commitments to providing contraceptives and continued to rely on arrangements dating from 1930, which permitted local authorities to spend public funds on birth control only in medically indicated cases for married women. Because most birth control clinics were run by voluntary agencies, occasionally subsidised by local authorities, access to contraception was 'patchy' and family planning was 'consigned to the fringes of the health service.' In the 1960s, when high-profile campaigns for family planning services and abortion law reform reflected changing social attitudes and the 'impact' of the oral contraceptive pill, birth control was 'forced back on the political agenda' (Webster, 2002, 132-133).

In line with changing public opinion, younger members of Harold Wilson's Labour government, which came to power in 1963 with a narrow majority and was re-elected with a much larger majority in 1966, supported family planning as part of a broader progressive agenda that included abortion and homosexual law reform (Brooke, 2011, 149). In 1966, Kenneth Robinson, the Labour Minister of Health and long-time supporter of birth control and abortion law reform, issued a circular to local authorities requesting that locally run health clinics use their existing powers to provide free contraceptives to married women whose health was endangered by pregnancy. The National Health Service Amendment (Family Planning) Act in 1967 expanded medical grounds to include social criteria and removed restrictions on age and marital status (Latham, 2002, 69, Cook, 2004, 302-303, Brooke, 2011, 175).

[403] 'Immunological tests for pregnancy', 7 August 1967 (No. 130), 'Pregnancy tests', *BMJ*, 19 August 1967, 504.
[404] 'Tests for pregnancy', *BMJ*, 19 August 1967, 448.

The contraceptive pill was made available in Britain from 1961 and by 1964 was being used by around 480,000 women.[405] The first clinics in London began offering contraceptive advice to unmarried women in 1964 and the 1967 Abortion Act decriminalised and improved access to medical abortion (Weeks, 2012, 339). Oral contraception was made available on the NHS by prescription for therapeutic purposes only in 1961 and it was up to individual doctors to determine whether medical grounds existed to justify prescribing the pill on a case-by-case basis. In 1964 the Ministry of Health issued a statement clarifying that doctors were allowed to issue NHS patients with private prescriptions for oral contraceptives in the absence of medical grounds. In 1966 negotiations between the BMA and Ministry of Health resulted in an agreement that GPs could charge for non-medical family planning services and fees were established for prescriptions of the pill and for prescribing and fitting IUDs and other devices (Leathard, 1980, 109, Latham, 2002, 34). Oral contraception became 'the only drug for which doctors were permitted to charge their National Health Service patients a fee' (Cook, 2004, 279-281).

As with oral contraception, family planning and abortion, NHS provision of pregnancy testing on 'medical' and 'social' grounds was debated in Parliament. In April 1964 when Dr Alan Thompson, the Labour MP for Dunfermline Burghs, asked whether Michael Noble (Baron Glenkinglas), the Tory Secretary of State for Scotland, would 'take steps to ensure' the 'widest possible use' of the immunological test developed by Sharman in Glasgow, Noble responded that it 'would not be proper' for him to influence a 'matter of clinical judgement'.[406] In March 1967 Nicholas Scott, the liberal Tory MP for Paddington, asked Kenneth Robinson 'why it had been decided that pregnancy tests should in future be available without restriction under the National Health Service.'[407] He wanted to know whether it had 'always been possible for these tests to be carried out where there have been good clinics' and

[405] Berridge, 1999, 52; Cook, 2004, 268; Weeks, 2012, 334. See also, Marks, 2010. Though I do not much explore pregnancy tests in relation to contraceptive pills, which did not become widely available until after the cut-off date of this thesis, it is worth noting that in 1960, when the Birmingham FPA managed to enlist 48 volunteers to participate in its first oral contraceptive trial, 'they were asked to collect specimens of urine and dispatch them to the clinic for (Aschheim-Zondek) pregnancy tests' (Eckstein et al., 1961, 1173. By the mid 1960s, falling pregnant while on the pill, perhaps having missed one or more (Jones, 2011, 287-288), and amenorrhoea after coming off the pill (Blackwell & Walker, 1969), constituted new sources of anxiety-driven demand for early diagnosis.
[406] 'Immunological pregnancy test', Hansard Commons Debates, 16 April 1964, vol. 693 c107W.
[407] 'Pregnancy tests: oral answers to questions – Ministry of Health,' Hansard Commons Debates, 20 March 1967, vol. 743, c1049.

whether this decision would result in 'a great increase in the demand for tests with no clinical justification at all?' Robinson replied that it had not always been possible and that NHS pathological laboratories were 'hard pressed.' The new method was far easier and did not 'consume so much of the technician's time', so he expected the pathological service would be 'able to take this additional load.'[408]

The following month Lena Jeger, the Labour MP for Holborn and St Pancras who had advocated abortion law reform since the 1950s,[409] asked Robinson 'if he would legislate to control the advertising of pregnancy testing laboratories.' Robinson replied that, although he had 'been advised that it was better for a woman who thought she was pregnant to consult her doctor', he had 'no power to control these advertisements,' and was 'not satisfied that legislation would be justified.'[410] And in December, Peter Jackson, the Labour MP for the High Peak in Derbyshire, argued that Belmont Laboratories, whose contract had recently been cancelled by the London Transport Board, was 'not a quack body', but 'a perfectly respectable organisation' whose 'perfectly innocuous' advertisements conformed to the British Code of Advertising Practice.[411] Jackson suspected that complaints against the advertisements had been made by a modern Mrs Grundy, that personification of priggishness and propriety, and accused the publicly owned board of inconsistent 'censorship' by withdrawing advertisements for the FPA and pregnancy testing, but not for cigarettes, alcohol, or Sir Oswald Mosley's Union Movement.[412]

The BMA continued to disapprove of commercial laboratories, but the Ministry of Health was powerless to stop them. Unlike therapeutic drugs, no legislation governed diagnostic services and the ASA, a voluntary organisation with no legal power, was the only regulatory body overseeing commercial pregnancy testing.[413] Whereas FPA politics had stymied Beric Wright's advertising to pharmacists, independent

[408] 'Pregnancy tests (advertisements), Hansard Commons Debates, 7 April 1967, vol. 744 cc106-7W. 'Pregnancy tests', *Lancet*, 1 April 1967.
[409] Jeger wrote articles on abortion for the *Guardian* and *Woman's Sunday mirror*: Brooke, 2011, 165.
[410] 'The facts about pregnancy testing', *Times*, 30 August 1967, 9.
[411] The Code vetted certain classes of advertisement for pre-clearance including cigarettes, pregnancy testing and counselling, abortion, vasectomy, and sterilisation: Nevett, 1982, 202.
[412] 'Liberties of the subject', Hansard Commons Debates, 1 December 1967, vol. 755 cc808-909.
[413] In 1964, in 'the aftermath of thalidomide', the British government established the Committee on Safety of Drugs (CSD), 'which reviewed manufacturers' testing before clinical trials and marketing' Previously the Sale of Food and Drugs Act, 1875, 'enabled regulation of adulteration, and hence drug quality, but not safety or efficacy' (Abraham & Davis, 2006, 130).

commercial laboratories had no reason to appease the BMA. Hadley Laboratories, the pioneering company, was a different matter. In contrast to the technicians, physiologists, pharmacologists, biochemists and registered nurses who followed in his footsteps, Stanley Solomons's professional status as a general practitioner uniquely exposed him to the GMC and the prospect of being struck off the Medical Register.

The Medical Act of 1858 had created the GMC to regulate qualified doctors as distinguished from unqualified competitors (Stacey, 1992, Smith, 1994, Morrice, 1994). The GMC could remove or threaten to remove from the register a doctor judged guilty of 'infamous conduct in a professional respect' (Brown, 1991, 51). In the late nineteenth century, cases of infamous conduct involved unqualified assistants, adultery, indecent publications, breach of confidentiality, fraud and shopkeeping (Smith, 1993, 59, Jenkinson, 2012, 28). As practitioners came to define themselves against 'commercialist, self-interested, individualistic, profiteering "quacks"', they increasingly looked down on self-advertising as a 'particularly objectionable' indication of 'commercialism, associated with tradesmen and not gentlemen' (Nathoo, 2009, 35-36). From 1925, 'indirect advertising', which covered dealings with the non-medical press, was formally discouraged by the BMA's Ethical Committee, which in turn dated from 1902 (Morrice, 1994).

In May 1967 the Disciplinary Committee of the GMC, chaired by its president Henry (Lord) Cohen of Birkenhead, accused Solomons of advertising in his own name and charged him with 'infamous conduct'. Solomons claimed that the appearance of his name in a single advertisement in *Rikerservice*, a free monthly classified advertising service for doctors, in June 1965 had been 'an unfortunate mistake by a girl working for him part-time' and confirmed that no other advertisements used his name or address. The usual discrete 'professional plate' indicated his general practice and his company, Hadley Laboratories, was not a 'screen' for advertising his surgery. His receptionist informed any 'patient' who telephoned or 'came to his surgery as a result of reading his advertisements,' that she would 'not be allowed to see him

professionally' and to 'apply to another doctor in the district,' or 'consult [the] list of doctors' at the police station or post office.[414]

A solicitor from the Medical Defence Union argued that 'a woman had a right to obtain information about her condition' and that Solomons was acting 'in the public interest.'[415] If the GMC prevented medical doctors like Solomons from advertising, they would be handing pregnancy testing over to 'unqualified people.' But the committee remained concerned that Solomons had regularly advertised a company located in the same building as his own surgery, the profits of which were only available to himself and to his wife, and insisted that Solomons liquidate Hadley Laboratories and 'dissociate himself entirely from direct-access pregnancy testing.' Solomons agreed and the committee postponed its judgement.[416] One year later, the committee confirmed that Solomons had indeed dissolved the company and found him 'not guilty of infamous conduct, thus concluding the case.'[417]

6.4. 'A woman's right to know'

In March 1966 the *New Statesman* set the terms of a public debate over pregnancy testing that would range widely in newspapers and magazines for months and years to come. This new form of visibility and controversy built on changes in medicine and the media that had been accumulating since the late 1940s, when massive publicity campaigns had been mobilised to inform an increasingly affluent and educated public about what to expect from the new health service. Arguments for and against the NHS and negotiations between policymakers and doctors were hashed out publicly in the media. Doctors and journalists struggled over 'public interest' and differentiated publics became more vocal, challenging the paternalism of both medicine and the media. Until the late 1940s doctors and reporters had mostly cooperated to shore up the professional authority of medicine, but journalists had their own agendas and, in the wider context of 1960s critiques, tensions mounted when there was a perceived conflict of interests about what information should be made accessible to a public

[414] 'Pregnancy testing services', *BMJ Supplement*, 17 June 1967, 174.
[415] On the early history of the Medical Defence Union: Forbes, 1948.
[416] 'Pregnancy testing services', *BMJ Supplement*, 17 June 1967, 174. See also, 'Denial of profit aim by doctor', *The Guardian*, 27 May 1967, 2, 'Doctor accused over pregnancy test firm', *Daily Mail*, 27 May 1967, 7, 'Pregnancy-test doctor warned', *Daily Mirror*, 27 May 1967, 7.
[417] 'Pregnancy-testing service', *BMJ Supplement*, 15 June 1968, 206-207.

constructed as both media consumers and patients (Nathoo, 2009, 33-42). Although medicine 'had become an established part of the news agenda' by 1966, many doctors 'still held the view that a "little learning" was a "dangerous thing" and that medical discussion belonged in medical journals and conferences' (Nathoo, 2005, 55).

By the mid 1960s, after a 'huge shift' in vocabulary, words such as 'pregnancy', 'abortion' and 'termination' were more frequently printed in the press, novels and private letters (Jones, 2007, 234). The first of many articles, letters and editorials to come, an in-depth reportage by journalist Hilary Haywood in the public-health section of the *New Statesman* covered pregnancy testing from a variety of angles. Haywood reported on her sources, fourteen altogether including directors of the three advertising laboratories as well as representatives of the BMA and NHS, before formulating her own pointedly opinionated view of pregnancy testing. Haywood doubted that commercial labs were 'pinching patients' from the NHS and argued that doctors did 'not seem to want to do this service'. She speculated that hidden reasons behind the embargo included concerns about blackmail or illegal abortion, risks that persisted under the current ASA ruling, and asked whether '*control*' would not be better than an apparently ineffective '*prohibition*'. For Haywood, the 'most important' angle was that of 'the client herself.' The 'simple' fact that she was 'referred to as a *client* by the […] labs, but as a *patient* by the BMA' was 'vital and pertinent'. With reference to *Born free*, a recently premiered film about a British couple in Kenya who raise an orphaned lioness named Elsa,[418] she criticised the NHS and defended the non-pregnant woman's status as a non-patient:

> Now none of us is born a patient, we're individuals; and we don't become patients until we're ill or pregnant. A woman whose result proves negative is *not* a patient. Surely she should be free to regard a non-pregnancy as entirely her own business and not be penalised in this most personal of matters? Born free? Only, it appears, if you're a female lion; not if you happen to be a female human being. Not under the NHS anyway – only thanks to the anonymity of the direct [pregnancy testing] laboratory services.

[418] The movie was based on Joy Adamson's (born Friederike Victoria Gessner) bestselling book of the same title, first published in 1960. See Beinart, 2007, Beinart & McKeown, 2009.

Haywood's argument hinged on the assumption that a pregnant woman would do the responsible thing by taking herself to the doctor in any case. Meanwhile, she argued, it was not 'frivolity' that caused laboratories to 'flourish' even when they were denied advertising; there were 'more amusing ways of spending a couple of pounds'. Because 'no one but the woman herself bears the child', Haywood concluded, it was 'surely for her to choose how soon she should know that she is pregnant?'[419]

Agony aunt Claire Rayner came out strongly in favour of commercial laboratories in a letter to the *New Statesman*. She explained that the first three months of 'intra-uterine life' were the 'most vital' because this was when cells differentiated 'to form organs' and were 'most susceptible to damage', for example, from 'the effects of maternal rubella and thalidomide'.[420] Extensive media coverage of birth defects caused by the morning sickness drug thalidomide in 1961 and by rubella (German measles) during the 1962-64 epidemic had shaken public confidence in medicine and renewed public support for abortion law reform (Nathoo, 2009, 49, Reagan, 2010, Parker, 2012, Al-Gailani, 2013). These events provided new rationales and justifications for the early determination of pregnancy, which had not existed before the early 1960s.

Although the hormone therapies Crew and Johnstone hoped would prevent miscarriage in the 1930s had been largely discredited by the 1960s, the older treatment of bed rest remained popular.[421] Rayner divulged that she was writing her letter 'in bed' because she was 'being treated for a threatened abortion.' 'Had I *not* had a test and known for certain I was pregnant,' she explained, 'I might have assumed I was experiencing delayed menstruation, gone about my normal life, and very probably lost my – to me – precious foetus. I wonder how great a waste of foetal life occurs because of doctors who believe pregnancy testing is "seldom necessary"?' Rayner concluded that pregnancy testing 'should be available to *every* woman who has reason to suspect pregnancy. And since it is *her* uterus that is involved, what right

[419] Haywood, 1966a, 416.
[420] On thalidomide and British drug safety regulation: Quirke, 2013.
[421] For endorsements of bed rest and critiques of endocrine therapy in the treatment of 'habitual' or 'threatened' abortion: Dodds, 1944, Stallworthy, 1951, Howkins, 1954, Tenney, 1954, Beattie, 1956. When Ann Oakley's ruptured ectopic pregnancy was misdiagnosed as a threatened abortion in the 1970s, she was 'told that unless the results were clearly negative, [she] would be kept in bed until the bleeding stopped - for the whole of the rest of the nine months if necessary' (Oakley, 1984b, 129-135).

has any paternalistic doctor to demand that the ability to find out about such involvement should only be through him?'[422]

Derek Stevenson, Secretary of the BMA from 1958 to 1976, argued in a letter to the *New Statesman* that 'medical advice' was always needed to correctly interpret a test result and to avoid 'disastrous results' (Stevenson, 1966, 501-502). Haywood maintained that free retesting safeguarded against false negatives and that, in the case of a positive result, a woman would probably go a doctor 'anyway' (Haywood, 1966b, 502). Alan Massam, a medical writer for *Medical News* and the *London evening standard* and soon-to-be founding member of the Medical Journalists' Association (MJA),[423] echoed Rayner's argument about miscarriage: commercial labs enabled 'women to know about their pregnancy early and so take precautions against miscarriage.' Under 'existing NHS rules,' pregnancy was 'left to confirm itself' and as long as doctors were unable to 'offer pregnancy tests under the NHS the very real need for these "private enterprise" tests [was] absolutely obvious' (Massam, 1966, 502).

Pregnancy testers defended the services they offered in letters of their own. Janice Solomons agreed in the *New Statesman* that 'in a perfect world' pregnancy tests would be 'available free and on demand', but in reality the NHS was hampered by 'a restricted budget, no space and no staff' and many clients of Hadley Laboratories had 'been refused pregnancy tests by their doctors (often because it just wasn't available).' Solomons repeated the argument first made by Dorothy Thurtle and Joan Malleson in the late 1930s that pregnancy testing 'saved many women from the danger and misery of an "abortion" when they were not pregnant.' But the 'real issue' in the 1960s was 'freedom': since women were 'not born into a guild of doctors and a mass of patients, but people, and our bodies are our own', Solomons argued for 'regulation' […], not suppression', and offered her 'willing cooperation' to the ASA and the BMA 'in the interests of the public.'[424] As her husband Stanley

[422] Rayner, 1966, 466.
[423] The inaugural meeting of the MJA was in February 1967, though it had been in the works since June 1966: Thistlethwaite, 1997.
[424] Solomons, 1966, 538. See also *Medical News*, 28 April 1966.

unambiguously put it in a letter in *Medical News*: 'We test samples for clients, not patients. There is no question of our clients being patients in any sense at all.'[425]

That the recently founded Sunday edition of *The Daily Telegraph* ran its own investigation by Peter Gladstone Smith, a crime correspondent, testified both to the contested status of pregnancy testing and to the conservative leanings of the paper. Gladstone Smith doubted the wisdom of women using commercial laboratories 'without the knowledge of their doctors' and sided with the BMA's view that direct-to-consumer pregnancy testing was 'unjustifiable, unwise and, unless medically interpreted, unreliable.' In the same article, Block, who supported 'the public being able to do as they please', told him: 'We are not saying we are better, cheaper or quicker than doctors; all we are saying is—we are here.' And the *Telegraph* medical correspondent insisted that a pregnancy test result could not be interpreted properly unless 'linked with a clinical examination', but also admitted that 'shame' might prevent a woman from going to her family doctor. As a compromise, he suggested that a woman could go to 'another doctor for a private consultation' (Gladstone Smith, 1966).

The *Guardian* reported that Niall MacPherson (Lord Drumalbyn), chairman of the ASA, insisted that advertising 'outside the medical press' could 'lead to abuse and abortions.' And Jeremy Potter, the managing director of the *New Statesman*, told the *Guardian* that, although 'unhappy about rowing with the ASA,' the magazine was going to continue publishing the advertisements 'as a matter of principle'. Potter argued that it 'is an elementary human female right to know whether or not one is pregnant' and so the advertisements fulfilled 'a very important end.' But Potter also betrayed a degree of elitism in common with the BMA and its supporters when he conceded that advertisements for pregnancy test services 'might not be suitable in the mass circulation press.'[426] Nor was the *Guardian* immune to paternalism. Dr James Leslie McCallum, a Holborn general practitioner, medical correspondent of the *Guardian*, founding member of the MJA, and a 'passionate advocate' of the NHS,[427] defended the 'medical profession' against accusations that it was 'being a dog in the

[425] 'Pregnancy testing services', *Medical News*, 1 July 1966.
[426] 'ASA stresses danger of pregnancy testing advertisements', *Guardian*, 3 May 1966, 3.
[427] 'J. L. McCallum', *BMJ*, 4 September 4 1971, 586.

manger and of hogging the profits' and argued that the commercial pregnancy testing was 'a money-making project exploiting human need in an unfair manner' that resulted in tragedies.[428]

McCallum's article, attributed to an anonymous doctor, provoked sharply worded responses from Hadley and Russell Laboratories. Janice Solomons argued that the BMA was 'not an official body,' but 'simply the largest medical trade union, and facing revolt from its own members. Its views were 'not those of most doctors' and it had become 'the maiden aunt of medicine.' 'All medical services [were] money-making' and even McCallum had been 'paid for writing his article.' If pregnancy testing was an exploitative 'money-making project', then so was the Cabinet, the BMA, or 'the corporation dustman.' Block and Lawford asked McCallum to substantiate his 'near-libellous remark' that the 'small fee' they charged was unfairly exploitative as well as his statement, 'while confirming that the results were tragic rather than merely amazing, sad, frustrating, etc.'[429]

Expressing a sentiment similar to Crew's on democratisation in the late 1930s, a doctor told the *Lincoln Echo*: 'I have heard that when a Royal Princess is concerned, an early diagnosis is made. It seems we are bringing it down so that every woman can have an early test, but what does it really matter?' [430] In the *Sunday Citizen*, the investigative journalist Irene Black reported on the 'fantastic demand' that was overwhelming the NHS and the advertisements that were 'catching the eye of over 1,000,000 women each year in the personal columns of a great many periodicals.'[431] And in the culturally conservative and populist tabloid *Daily Sketch*, reporter Edward Connelly argued that commercial laboratories were 'cashing in' on the failure of British medicine to make pregnancy testing 'freely available to every woman.' According to Connelly, Harley Street was 'waging war' on a service that thousands of women approved of and relied on. Single girls, he noted could use them to plan an earlier and safer abortion. When it came to pregnancy testing in the lead-up to the 1967 Abortion Act, the medical profession was increasingly portrayed as out of step with public opinion (**figure 6.11**).

[428] 'Pregnancy tests', *BMJ Supplement*, 16 July 1966, 22 and 45.
[429] 'Advertising and pregnancy tests: Letters', *Guardian*, 30 August 1966, 6.
[430] 'Doctors differ on new test', *Lincoln Echo*, 2 May 1967.
[431] Black, 1967. In 1962 *Reynold's News* was re-launched in tabloid format as the *Sunday Citizen*.

DAILY SKETCH, Thursday, May 5, 1966

SKETCH ANALYSIS

The facts in the row over 'instant' pregnancy tests

A WOMAN'S RIGHT TO KNOW

COMMERCIAL laboratories are cashing in on the failure of British medicine to make the new "instant" pregnancy test freely available to every woman.

Because women, married and single, cannot easily get this three minute test through their family doctors, they are going direct to private firms, who charge two guineas or £2 a time.

The profit potential was described by one famous gynaecologist as "enormous."

And the result is a raging row in Harley-street which may lead the General Medical Council to take action.

For, unknown to the clients, some of these businesses are run by doctors—aside from their ordinary work.

Dr. Albert Sharman, the leading Scottish gynaecologist who perfected the new pregnancy test, says that every woman is entitled to know, as swiftly as science can tell her, whether or not she is expecting a child.

His test, called Gravindex, has been given free of charge to 2,500 women in the Royal Samaritan Hospital, during the last three years.

The test is cheap and, in Dr. Sharman's words: "It is so simple as to be unbelievable."

All that is required are two tiny bottles of chemical

by Edward Connolly

or four days after the first missed period.

It was undoubtedly one of these tests which enabled singer Barbra Streisand to announce to a surprised

INSTANT PREGNANCY TEST—IN THREE MINUTES AN ANSWER

selves, nor arrange for it to be done."

PTP did not encourage abortions, said Dr. X.

"We have certain knowledge that our service—diagnosing early non-pregnancy—has saved many women from the danger and misery of having an abortion when they were not in fact pregnant."

All three firms are convinced that no unscrupulous people are taking advantage of PTP. There is no quick financial kill in it for rogues.

WHAT do women think of direct PTP? All I have spoken to are in favour.

One unmarried girl said: "I would certainly use them. I would never go to my doctor."

Another, married: "I imagine many single girls using these labs are planning an abortion if pregnant. So the earlier they find out the better."

The main argument against the PTP firms is the absence of medical responsibility. That is the

Figure 6.11. By 1966 pregnancy testing could be boldly framed as a 'woman's right to know' in a politically conservative and populist tabloid (Connolly, 1966).

The *Times*, a latecomer to the debate, had launched a woman's page in May 1966 as part of a broader initiative to modernise the paper, which had fallen behind the *Daily Telegraph* and *Guardian* and was losing readers to the *Financial times*. By printing news on its front page for the first time, dropping the royal coat of arms from its masthead and adding a diary, a political cartoon and the woman's page, the *Times* boosted its circulation to over 300,000 by the end of the year (Grigg, 1995, 24-25). In August 1967 the *Times* woman's page reported that there were 'insufficient facilities for every woman to have free tests' under the NHS and that GPs were only able to request a test for a patient who was 'in poor health,' 'approaching the menopause,' or 'separated from her husband.' The article questioned the reluctance of the Ministry of Health to regulate advertisements. The investigation had confirmed 'demand' for pregnancy testing services, but also that 'however well-run individual laboratories may be, there [was] scope for less scrupulous operators whose only concern is for commercial profit—backed by the minimum of qualifications and facilities.' Despite the 'apparent safeguard' of the ASA, it was 'perfectly possible to by-pass their

conditions.' It was 'surely not right for an advertising body to be the only watchdog.' 'The theoretical safeguard,' it continued, 'that many publications and other media will not accept advertisements for pregnancy testing laboratories, in fact makes the situation worse by driving it underground.' If the Ministry was 'unable to put its own scheme into operation quickly,' the article concluded, 'it should at least devise a method to ensure that commercial companies providing such a service are properly supervised—by legislation if necessary' (**figure 6.12**).[432]

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THE TIMES WEDNESDAY AUGUST 30 1967 WOMEN'S PAGE SPORTS NEWS 9

The facts about pregnancy testing

A "while you wait" pregnancy testing laboratory opens in north London next week.

The Linhope Laboratory, as it is called, plans to have the result of the test available to clients within half an hour, and has set aside a cheerful (if slightly cramped) waiting area where background music, magazines, and coffee will be part of the service. The fee will be £2, and to ensure complete anonymity clients will not be asked to supply their names but, instead, will be given a number.

At present there are insufficient facilities for every woman to have free tests under the National Health Service, although the Ministry of Health hopes to provide more soon. General practitioners may ask for a test only when a woman is in poor health, or occasionally if she is approaching the menopause, or is a married woman separated from her husband.

Commercial testing laboratories, to which a woman may send her own urine specimen, and from which she will receive the result direct by post or telephone, have been permitted to advertise by the Advertising Standards Authority since August, 1966.

At least one pregnancy testing laboratory has posters in railway stations throughout the country. A few are permitted to advertise in the medical journal the *Lancet*. The newspaper *Medical News*, which requires references from six doctors, accepts advertisements from one laboratory, Bell Jenkins, of Portsmouth.

The Times Women's Page staff traced 12 commercial pregnancy testing services.

When a laboratory wants to advertise, the Advertising Standards Authority relies on the newspaper or magazine to check with the Advertising Investigation Department whether or not the laboratory has registered. If it has not, then the authority can only request the newspaper not to publish the advertisement.

Before a pregnancy testing laboratory can register with the authority, it must show that it is run by a qualified technician. It must offer a second, free test in the case of an early negative result. Should the result be positive, the laboratory's notification must advise the client to consult a medical practitioner immediately, warn that the result is not necessarily conclusive, and be accompanied

the important aspects, but if further information is required, please do not hesitate to let us know".

One of the directors said their chief technician was paid a retainer, but was in fact seldom referred to, because most queries were taken directly to the manufacturers of the chemicals used in the test.

The laboratory, which has been operating since January, employs a State Registered Nurse to do the tests.

Their leaflet, called *What does a Pregnancy Test Service mean to you?*, includes these questions and answers:—

Q. What is a Pregnancy Test . . .?

A. Pregnancy Tests accurately determine a state of pregnancy in the early stages when menstruation is just a few days overdue. Chemical reagents are employed to detect a hormone in the urine of pregnant women. If the hormone is present, a positive result is obtained. When absent, the result is negative.

Q.—Can doctors, midwives, State Registered Nurses, and other auxiliaries of the medical profession, including chemists, drug stores, and herbalists, use the service for their patients and clients?

A.—Yes, and there are special arrangements and special discount terms available. Applications from interested persons are invited.

The cost to a medical practitioner is £1 a test. The laboratory is sending circulars to 23,000 doctors. In conversation a director of the laboratory admitted that pharmacists could not accept tests except through a doctor.

Their pamphlets tell the woman requesting the service that the test was discovered three years ago and "is not generally available under the Health Service. A woman can have the test if her doctor feels it is necessary which, in practice, means that very few women are able to take it in the early uncertain days."

The reader is told that it "will certainly be two months, and probably longer, before her doctor can detect from a clinical examination whether or not she has conceived".

This article also refers to the hormone pills available only if prescribed by a doctor. There are several marketed. The dosage varies, but the tablets are taken for one or two days then dis-

Slide tests being done yesterday in a London laboratory.

are more than 99 per cent accurate. So far they have been notified of only two failures.

They said that the youngest "positive" they had tested was 14 and single. In a sample week they had performed 61 tests for women who gave their name as "Miss", and 114 for those giving the title "Mrs.". There were also five samples sent in by men, and 24 sent in by women who did not state whether they were "Miss" or "Mrs.".

Of the "misses" who gave their ages, nearly two-thirds were aged 18 to 21. The laboratory retests without charge if a test is made before the thirteenth day after the missed menstruation and

men should be tested as promptly as possible, preferably within 12 hours.

The laboratory makes the tests and posts the results on the same day that the specimens are received, but some of them come from as far as Glasgow and Belfast, and are possibly not tested within 12 hours. The £2 fee is increased by 10s. for a telephone or cable reply.

Belmont Laboratories, London, W.C.1, supply only a calendar on which to mark the date of the last period, with a warning that the test would not be valid unless the sample were taken at least 41 days after that date.

The laboratory is run by a

don't tell them over the phone about consulting a doctor. That's not our business. There's no choice for them, is there? I don't know of any woman who has gone through nine months of pregnancy without seeing a doctor. If they are going to have an abortion, nothing we can say will stop them. We provide the service they have asked for and paid for."

Dr. Block said many medical doctors were against private laboratories providing a pregnancy testing service. "Partly because they have got very conservative ideas, and partly because they want to keep it to themselves", he said.

A considerable number of those who used the laboratory service were young, unmarried girls, from 17 to their early 20s, Dr. Block said. Asked if any of them seemed to be in a panic or upset, Dr. Block said: "No, they don't seem to be. If a girl is calm enough to come to a laboratory for testing, she's not likely to get in a panic." Asked whether anyone at the laboratory, such as a nurse or a social worker, advised them what to do if the test showed them to be pregnant, he said that was not necessary, and not the business of a laboratory.

"The tests are all done either by myself or Dr. Lawford, or, if we are pushed for time, by one of our technicians. As it happens, the technician used to be a hospital technician, doing pregnancy tests, though we didn't know that at first."

Belmont Laboratories are tenants of the Royal Institute of Public Health and Hygiene, near the National Hospital. Many laboratories occupy surrounding buildings. The secretary of R.I.P.H., Mr. Robert Horsham, said yesterday: "We have tried to get rid of Belmont Laboratories, and when their lease ends at the end of the year, they are out. When they took the lease they did not tell us what kind of business they were in—they told us they were toxicologists."

Lanark Laboratories Ltd. first advertised their pregnancy testing service in the *New Statesman* on July 28 and August 4. They gave what turns out to be an accommodation address in North London. A young man at the address said it was the headquarters of a business selling detergents to hotels and restaurants. He said the two Lanark Laboratories man were

that it was more central than his own flat at Kilburn, that he was often out during the day (he has a job which he may give up if he decides to make a full-time business of pregnancy testing), and was "a nice-sounding address".

Lanark Laboratories charge £2 a test, and use pregnancy testing kits. According to Mr. Lane, they use slide tests to detect pregnancies at 41 days or over, and the more sensitive tube test to detect a very early pregnancy.

The Lanark tests are carried out in the spare bedroom of a flat in Kilburn, formerly a photographic darkroom. The response to the first advertisement was "quite encouraging", and resulted in a £5 profit. But the second was very disappointing. So far, they have carried out nine tests, about half of which were positive.

The Family Planning Association and the Marie Stopes Memorial Clinic offer the service for £1, and the F.P.A. will communicate the result of the test only to a woman's own doctor. The Marie Stopes Clinic, however, will give the result to the woman, usually through one of the doctors working at the clinic, directly the test has been made.

This clinic makes a real and sympathetic attempt to deal with her whole situation and to help her to decide on the next step to take. If necessary, an immediate appointment is made for her to see a doctor, or in a case of extreme distress, a psychiatrist.

In the Commons in April this year, Mrs. Lena Jeger asked the Health Minister, Mr. Kenneth Robinson, if he would legislate to control the advertising of pregnancy testing laboratories. Mr. Robinson said he had been advised that it was better for a woman who thought she was pregnant to consult her doctor. This, he said, could be particularly important where the symptoms were due to conditions other than pregnancy, when professional medical advice and treatment may be necessary.

The Minister added: "I have, however, no power to control these advertisements, and I am not satisfied that legislation would be justified."

Is the Ministry justified in taking this attitude? Our investigations show quite clearly that (1) there is certainly a demand for pregnancy testing services of this kind and (2) however well-run individual laboratories may be, there is scope for less scrupulous

Figure 6.12. This lengthy piece of investigative journalism in the *Times* exemplifies the mainstreaming of pregnancy testing in the lead-up to the 1967 Abortion Act (30 August 1967, 9).

[432] 'The facts about pregnancy testing', *Times*, 30 August 1967, 9.

Detailed reports and debates over public opinion were not the only forms of news coverage and publicity contributing to the increasing visibility of pregnancy testing in the late 1960s. The technologically mediated realisation moment also features in newspapers for the first time. For example, the *Daily Mail* reported that Bridget Trethewey, the Liberal candidate in the Honiton by-election, 'discovered she was pregnant' when a doctor treating her for 'a gastric germ' she caught in Exmouth decided, with her permission, to 'give [her] a pregnancy test as well.' The positive result had come 'as a complete surprise.'[433] Novels and films also began to feature pregnancy test scenes. Whereas pregnancy realisation narratives in the 1930s were structured around the intimacies of a missed period, morning sickness and failed attempts to restore menstruation, novelists in the 1960s incorporated medical encounters and pregnancy tests into stories of single motherhood, social satire and science fiction.

Jane, the unmarried mother and middle-class heroine in Lynne Reid Banks's bestselling novel, *The L-shaped room*, spends 'a surprising amount of money' on 'a special test' that her doctor claims is 'unnecessary' (Banks, 1960, 33). In *A question of abortion*, by Helen Lourie (the pseudonym of the medical doctor and children's writer Catherine Starr), a gynaecologist named Frances offers to 'have a test made' for a young unmarried patient, possibly an *agent provocateur* sent by the police, whose normally 'clockwork' period is three weeks late (Lourie, 1962, 13). In Anthony Burgess's dystopian novel, *The wanting seed*, Shonny is about to deliver his sister-in-law's twins when he remembers the names 'Zondek and Aschheim', 'the ancient devisers of a pregnancy test' (Burgess, 1962, 100). In David Lodge's comic novel, *The British Museum is falling down*, Barbara tells her husband, a Catholic graduate student named Adam Appleby, that her doctor 'wouldn't prescribe any more tests—not on the National Health, anyway. Besides, by the time the result came through, I'd know anyway' (Lodge, 1965, 77). Val, the trapped narrator of Andrea Newman's novel *The cage* (1966), vaguely remembers something she had read 'in women's magazines in the far-off days when the subject had been merely interesting' and tells her boyfriend Malcolm, 'I think you can have some kind of test with animals when you're a fortnight late' (Newman, 166, 20). And in Yorkshire writer Barry

[433] 'Surprise! I'm expecting a baby', *Daily Mail*, 18 March 1967, 4.

Hines's debut novel *The blinder* (1966), rising football start Lennie Hawk finds out that his girlfriend Jane, the middle-class 'boss's daughter', knows she is pregnant because she 'went to the doctor's' and he 'gave [her] a test' (Hines, 1966, 201).

For working-class characters, however, a missed menstrual period, morning sickness and quickening continued to play an important role in how pregnancy and its realisation were dramatised in 1960s cinema.[434] In the 1961 adaptation of Shelagh Delaney's play, *A taste of honey* (1961), a pregnant teenager named Jo (Rita Tushingham) is exhilarated when she feels her baby kick as a thunderstorm is brewing. The philandering eponymous antihero (Michael Caine) of the adaptation of Bill Naughton's *Alfie* (1966) is alerted by a calendar to his girlfriend's condition. Pregnancy is disclosed when a factory girl runs to the lavatory to be sick in *Up the junction* (1968). Working-class pregnancy testing does not feature in any of these 1960s films. But in the opening sequence of *A touch of love* (1969), Waris Hussein's adaptation of Margaret Drabble's *The millstone* (1965), announced the condition of its decidedly middle-class lead, Rosamund Stacey (Sandy Dennis), who is shown restlessly circling her positive test result in the British Museum reading room (evidently a popular location for contemplating pregnancy), where she is unable to concentrate on her doctoral thesis. Though the full name of the lab falls outside the frame, you can just make out the address and postcode of Belmont Laboratories. Now a Hollywood cliché, this was probably the first on-screen pregnancy test, a testament to just how much its visibility (and particularly that of Block and Lawford's business) had increased by the late 1960s (**figure 6.13**).

[434] On abortion in 1960s fiction and film: Bigman, 2014.

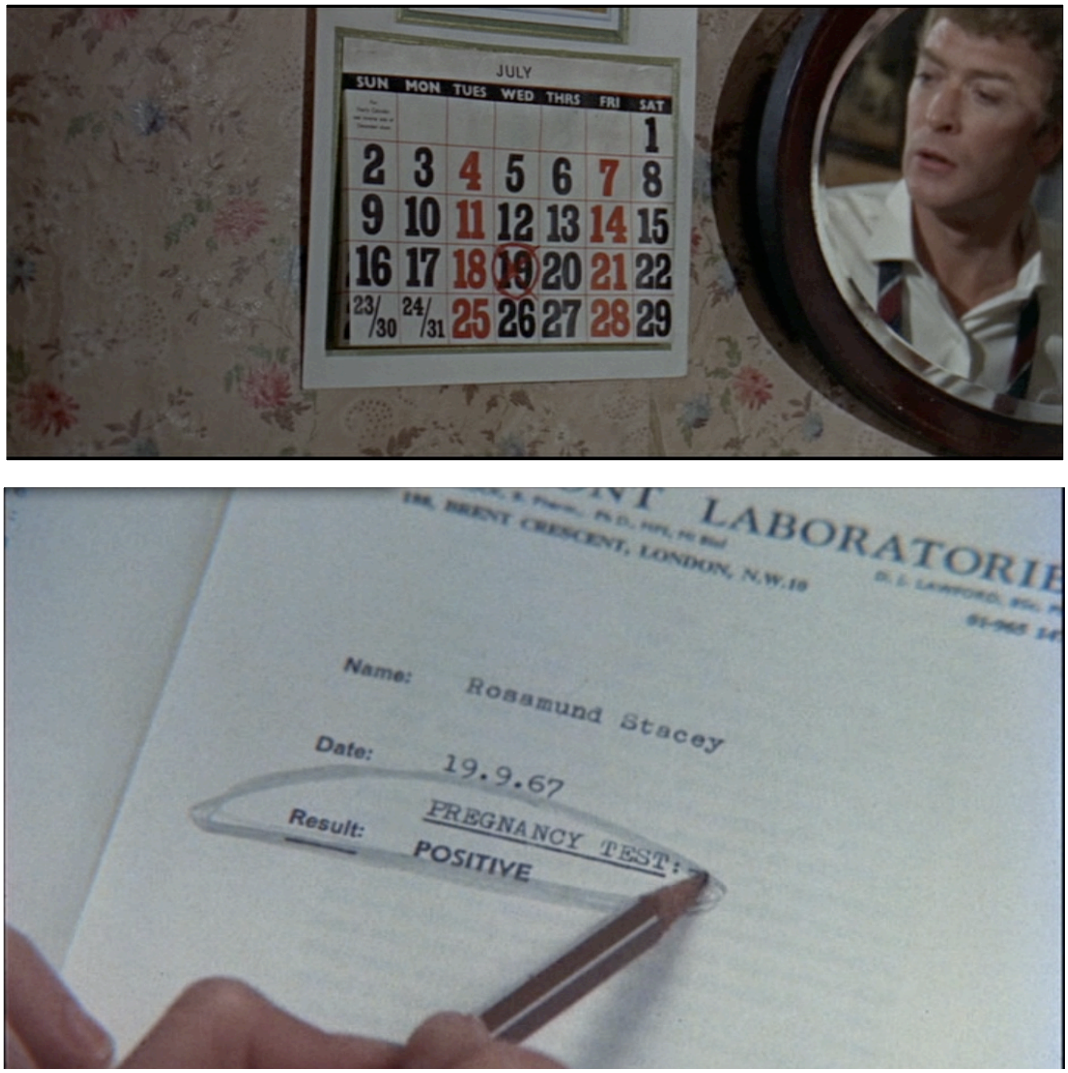


Figure 6.13. Continuity and change is apparent from these two diagnostic moments of 1960s British cinema. In Lewis Gilbert's *Alfie* (1966), actor Michael Caine (top) is alerted by a calendar to his girlfriend's condition. In *A touch of love* (1969), actress Sandy Dennis (bottom) circles her positive test result.

Conclusion

The 1968 edition of William Johnstone's *Textbook of midwifery* finally replaced the image of the dissected Aschheim-Zondek mouse with one of an agglutination inhibition reaction. The section on pregnancy diagnosis was completely rewritten at a time when animals were 'being replaced by a variety of commercially available immunological pregnancy tests' (Johnstone & Kellar, 1968, 103). By the end of 1969, Bruce Hobson reported 'absolutely no demand from anywhere in Scotland for a confirmatory Hogben test' and had 'disbanded' his residual *Xenopus* colony.[435] In February 1970, a *Guardian* headline belatedly proclaimed the 'Hogben test's last croak.' The short article predicted that 'Life for the female immigrant [*Xenopus laevis*], famed for its cooperation in the old Hogben test [would], be easier hereafter.' The recently formed Department of Health and Social Security (DHSS) had decided to close the Sheffield centre,[436] which had performed only two Hogben tests in 1968 and none in 1969. Instead of the 'unfashionable' toad, the NHS favoured the 'much quicker, cheaper, and simpler agglutination tests,' which most hospital laboratories now performed (Clarke, 1970, 18). After nearly four decades, the era of the bioassay and the large pregnancy diagnosis centre had drawn to a close and a new one, of direct-to-consumer advertising and commercial services had begun.

In the late 1930s Crew had proposed that the state could democratise pregnancy testing. But in the 1960s it was commercialisation, not the NHS, that democratised the pregnancy test. This chapter has ended one story of pregnancy testing and started another. It has recovered the fall of *Xenopus* and large-scale biological pregnancy diagnosis centres, on the one hand, and the rise of immunological pregnancy test kits and commercial laboratories, on the other. Building on previous chapters, it has introduced a new set of entrepreneurs from the Swedish medical student Leif Wide and the Glasgow gynaecologist Albert Sharman to the Kilburn GP and his wife Stanley and Janice Solomons. Beyond diagnostic entrepreneurs and consumers, regulatory bodies like the ASA and GMC as well as new venues such as the *Times*

[435] Hobson to Macdonald, 20 November 1969, HH102/858.
[436] The Ministry of Health merged with the Ministry of Pensions and National Insurance to form the DHSS from 1968 to 1988, when it was again split into the Department of Health and the Department of Social Security.

woman's page and *Medical News* structured how pregnancy testing was publicly debated, regulated and advertised in the 1960s.

Historians have noted the shift from *Xenopus* to immunoassays and the rapid technological change was truly striking, but, as David Edgerton has argued, 'to become widely used, a thing does not have to be massively better than what preceded it; it need only be *marginally* better than alternatives' (Edgerton, 2006, 8). And, in any case, technological change is never the whole story. The chapter has also been about the great escape of pregnancy testing from the clutches of medicine, the cutting out of doctors as the proverbial 'middle men', the failure of the NHS to meet expectations and the significant role of the media in sustaining a damaging critique of the 'paternalistic' medical establishment and helping to create a newly liberal 'public opinion' about pregnancy testing as a woman's right. A new economy of pregnancy testing was built on the mass production of immunological test kits, direct-to-consumer advertising and same-day laboratory services.

In the late 1940s Beric Wright had tried to advertise his Hogben testing service to pharmacists, but the medical politics of the FPA interfered with his plans. In the 1960s the GMC threatened Stanley Solomons, a GP, with being struck off the register for running a commercial pregnancy testing service in the same building as his surgery. But the GMC was powerless to stop Block and Lawford and other non-medically qualified laboratory directors from advertising directly to the public. As in the 1930s, the significance and appropriate interpretation of false positive results were debated in the 1960s. But this time, arguments about convenience, demand, women's rights and the 'public interest' trumped older concerns regarding specificity and sensitivity, which could be guarded against by informing the 'client' about the fallibility of the test. Immunoassays and the commercial laboratories that used them were not perfect, but they were good enough. The failure of the NHS to meet the often anxiety-driven demand for pregnancy testing highlights the marginality of reproduction and contraception within the health service. Like the contraceptive pill, pregnancy testing occupied a marginal position and could be paid for out of pocket.

Historians have noted that the home pregnancy coincided with the women's health movement of the 1970s. But the central message of *Our bodies ourselves*, first

published in 1973, had already been articulated in relation to the commercial postal and drop-in services, which dominated in the 1960s, and could also provide anonymity and deliver knowledge of pregnancy directly into a woman's hand, albeit in the form of a lab report. By recovering this crucial transitional period between medical testing and home testing, this chapter has helped to explain how the potential market for a home pregnancy test could be imagined and articulated. The first home test, 'Predictor', was, in fact, Organon's Pregnosticon, repackaged, but not redesigned for home use by women. The laboratory, which cut out the doctor, was in turn cut out by the pharmacy and supermarket.

Thesis conclusion: Continuity and change

Three minutes later, Tracey Emin, the artist who went to the bathroom at the start of this thesis, looked at the pregnancy test: 'it's negative. Of course it's negative. Of course I'm not pregnant. I am relieved, relieved to know that at thirty-seven years of age, I am just a woman with a fucking good imagination' (Emin, 2005, 166). Though intimate first-hand accounts such as Emin's are scarce for earlier decades, I have attempted to recover a history of pregnancy testing from as many perspectives as possible. I have focused on Britain to show how a succession of diagnostic technologies, mostly invented in Germany or the US, were tested, adopted, commercialised and democratised. By emphasising demand and routine use, I have provided an account of how large-scale services were established and maintained. I have also attempted to place the diagnostic laboratory, a surprisingly little studied institution, more centrally in our historical understanding of modern medicine and modern motherhood. To arrive at a richer understanding of laboratory life, on the one hand, and our lost reproductive cultures, on the other, I have combined the methodologies from history of science, technology and medicine with those of social and cultural history. I hope the result has been to bring the diagnostic laboratory into focus as a significant institution, not only in modern medicine, but also in mass society and consumer culture.

To explain the increasing demand for pregnancy testing in twentieth-century Britain, it was necessary to look beyond not only the laboratory, but also beyond the state. Crucially, at every turn it was important to identify who was able and willing to pay for a test.[437] In the early 1930s an editorial in the *Lancet* recommended the Aschheim-Zondek test to general practitioners in part because it could be discretely performed without the patient's knowledge, while the socialist feminist Stella Browne argued that information about and access to the Aschheim-Zondek test should be made generally available to women. In the mid 1960s pregnancy testing attained a degree of public visibility previously only dreamt of: articles and letters published in non-medical newspapers and magazines argued that access to

[437] On 'following the money' to a revisionist history of twentieth-century science, technology and business: Gaudillière, 2001, Edgerton, 2012.

commercial services was a woman's right; laboratories took out classifieds and paid for posters in the London underground and British railway stations; and the existence of pregnancy testing was publicised in guidebooks, novels, and, before the end of the decade, in the pictures. Between the establishment of the Edinburgh pregnancy diagnosis station in 1929 and the Abortion Act of 1967, the doctor-patient-laboratory relationship was reconfigured more than once.

In 1969 Organon marketed 'Planotest', a rapid (5-10 minutes) slide test to family doctors and Block and Lawford founded Pharmacy and Professional Services Ltd. (PPS), a sister company to Belmont Laboratories. They mailed plastic urine bottles, information leaflets and window display stickers to 700 pharmacies (excluding Boots), enabling chemists to provide a pregnancy testing service directly to customers. This further eroded the authority and control of the BMA whose opposition continued to be discussed in an expanding range of media from the BBC television programme '24 Hours' to Radio Merseyside and the *Economist*. By June 1970 more than 3,000 pharmacies around Britain had used PPS, which performed 1,000 tests every month. Demand continued to increase and Organon began selling kits directly to pharmacists.[438] The 1970 edition of the Consumers' Association's *Which?* supplement on contraceptives reviewed pregnancy testing services (including private labs and pharmacies) for the first time, a testament to their commercial success.[439]

By 1971, when the company Chefaro, a subsidiary of Organon, launched 'Predictor', Britain's first over-the-counter (OTC) home pregnancy test kit, a diversified and researchable market for pregnancy testing had already been established. Market research commissioned by Chefaro found that two thirds of women aged 15-44 who responded to a questionnaire had already heard of laboratory tests for pregnancy. 62% of the representative sample, which was stratified by region and town, agreed with the statement, 'It is an excellent method for checking up before going to the

[438] 'Pregnancy testing kits distributed through pharmacists', *Pharmaceutical Journal*, 13 September 1969, 309, 'Pregnancy testing—opposition by B.M.A.', *Pharmaceutical Journal*, 20 September 1969, 319, 'Pregnancy testing: Doctors must show "greater willingness", *Pharmaceutical Journal*, 27 September 1969, 359, 'Pregnancy testing through pharmacies—doctors opposed but public demand increases', *Pharmaceutical Journal*, 1 November 1969, 525, 'Pharmacists' big role in pregnancy testing service', *Pharmaceutical Journal*, 13 June 1970, 680.
[439] *Which? Contraceptives Supplement*, Consumers' Association, January 1970, 73-75.

doctor.'[440] Predictor retailed for £1.75, just under the going rate for a laboratory test, and was supported by a massive £60,000 advertising campaign aimed directly at consumers.[441] But the first home test kit resembled a small chemistry set and was not user-friendly; Predictor was Pregnosticon, repackaged, but not redesigned for home use.

In February 1982, *Which?* reviewed home tests alongside chain saws, refrigerators and margarine, a testament to their increasing ordinariness. There were now two competing models, but clinics, chemists and commercial labs continued to operate. *Which?* stressed that home tests were 'fiddly to use' and that only clinics and advisory centres, though not necessarily doctors, could advise on 'what to do next.' In the 1970s, women's liberation groups organised 'jumble sales to raise money and conferences to share thoughts', wrote '"where we are at" papers', produced 'copies of *Shrew*, the aptly named women's liberation paper', and 'acquired the easy skill of pregnancy-testing,' which they 'offered gratuitously' to local women (Oakley, 1984b, 77-78). As the novelist and volunteer pregnancy tester Michèle Roberts later recalled in her memoirs, some 'delighted' women 'rushed away' upon receiving a positive result, but others were 'devastated'. Roberts felt burdened with the sorrows of unhappy women, until one day she 'collapsed into tears' and wept into the urine sample she was testing, ruining it (Roberts, 2002, 136-137). Cambridge pregnancy testers felt that counselling was 'one of the most important, but also the most difficult of the things that [they were] trying to do.'[442] Pregnancy testing was political.

Pharmaceutical companies continued to manufacture and market pregnancy test tablets and injections until the late 1970s. The particularly controversial story of Schering's Primodos took a dramatic turn in 1967, when a *Nature* article by Dr Isabel Gal of Queen Mary's Hospital for Children in Surrey raised the possibility that the drug was responsible for congenital malformations. Primodos received extensive coverage in *The Sunday Times* and on television and following a warning issued by the Committee on the Safety of Medicines, which had been set up in response to the

[440] Letter to Mrs Helen Graham, 9 November 1971, 'Predictor Home Pregnancy Test', PP/GRA/B.4, Wellcome Library.
[441] 'Home pregnancy test kit', *Pharmaceutical Journal*, 13 November 1971, 475.
[442] 'How we set up a pregnancy testing group' (May 1975), 'Pregnancy testing correspondence and papers', GCIP CWLA 0/3, Girton Women's Liberation Group Archive, Cambridge.

thalidomide tragedy, Schering withdrew Primodos in January 1978. That year parents who had been prescribed Primodos founded the Association for Children Damaged by Hormone Pregnancy Tests and legal actions, claiming compensation, were started against Schering. In September 1981, Schering successfully blocked the 'The Primodos affair', a television documentary from being broadcast on Thames TV. But the case against Schering was left open (pending new evidence) and a Google search for 'Primodos' in 2014 still turns up websites and news coverage of individuals and associations actively pursuing Schering, recently taken over by Bayer AG.[443]

Building on the earlier history trailed in this thesis, the continuing story of Primodos would do much to illuminate medical reporting in the years immediately following the 1960s, a decade covered by Ayesha Nathoo's pioneering study of the first human heart transplants as medical and media events. It would also broaden her analysis beyond the hospitals where cardiac surgery was performed to include the pharmaceutical companies unfettered by public accountability and with the legal and financial wherewithal to prevent an investigative report from being broadcast, an event which became a flashpoint for debates over freedom of the press in the early 1980s and so had ramifications well beyond pregnancy testing.[444] Despite extensive records available at the National Archives in Kew, historians have not written about the 'Primodos affair' and the very notion of pregnancy test drugs today seems even stranger and less plausible than the earlier use of animals.

As with previous decades, which witnessed a palimpsest of diagnostic traditions and technologies, the home pregnancy test did not sweep away the older regimes overnight. Embarrassing-to-buy and difficult-to-use home tests coexisted with laboratory, clinical and volunteer-based pregnancy testing in the 1970s and 1980s, not to mention the older methods of self-diagnosis, which remain important today.[445] Only when Unilever launched Clearblue and Clearblue-Easy in the late 1980s did the home pregnancy test achieve its recognisably modern form: a plastic 'pen' with a display window to indicate a result, usually as one (negative) or two (positive) blue or

[443] See, for example, Sarah Rainey, 'Is this the forgotten thalidomide?' *Daily Telegraph*, 12 May 2014, http://www.telegraph.co.uk/health/10819186/Is-this-the-forgotten-thalidomide.html. See also, 'The case of the deadly pregnancy test', in Silverman et al., 1992, 107-124.
[444] 'Ban to stay on TV drug film', *Times*, 28 January 1981, 9.
[445] For an ethnographic account of self-diagnosis in the 1970s: Jordan, 1977.

pink lines in parallel or forming a cross.[446] And even then, Unilever provided a full phone-in service to advise users. Perhaps only as recently as the 1990s did pregnancy tests become a ubiquitous rite of passage for a younger generation of consumers.

Before-and-after snapshots that place quickening at one end of a spectrum and the pregnancy test or ultrasound at the other, fail to capture the range of new and old diagnostic methods to which women gained access in the twentieth century. As I have shown, statements that contrast a technologically mediated experience with that of the traditional past are misleadingly stark. The older experience of protracted ambiguity and gradual realisation, often mixed with fear or hope, was (and still is) coextensive with the newer experience of a technologically mediated diagnostic moment, which is perhaps not always as definitive as we might expect. Anxiety, such an important actor's category in my analysis, took on new meanings as it shaped expectations for new technologies and demands on laboratory services and the state. To give one final example, in 1969, general practitioners in the London suburb of Sanderstead incorporated anxiety, to some extent pathologised as a symptom of 'psychological stress during the period of amenorrhoea and uncertainty' into a sharpened critique of the NHS:

> If pregnancy was always a carefully planned event, happily awaited, it could be confirmed at leisure without undue hardship. The assumption within the National Health Service has tended towards this idyllic misconception. Until very recently laboratory confirmation of pregnancy was denied general practitioners and even now may be grudgingly given. Instead the public satisfied its needs by patronizing pregnancy testing services advertised in the popular press (Blackwell & Walker, 1969, 694).

Clearly, the analytical category of medicalisation is too one-dimensional to fully explain the struggles over access to pregnancy testing. Doctors were powerful gatekeepers and stakeholders, but so too were clinical pathologists, pharmaceutical companies, chemists, policymakers and journalists. Women voted with their feet.

[446] On Clearblue: Green, 1991, 69-73, Jones & Kraft, 2004, de Chadarevian, 2011, 625n72.

Only by examining the role of doctors in a more relational mode has it been possible to evaluate the extent to which medical authority and control was bolstered or undermined by competing or cooperating agents. Even within the medical profession, it has been important to distinguish between gynaecologists and general practitioners, who displayed a range of motives and agendas and rationales for embracing or rejecting the diagnostic laboratory. Even allowing for its reversal, as Andrea Tone has done, a concept of medicalisation that isolates patients and doctors is too narrowly conceived to have much explanatory power in a reasonably complex account of how diagnostic services were established and maintained on a large scale.

Most diagnostic tests and therapeutic drugs were prescribed for medical reasons. Like the oral contraceptive pill, pregnancy testing was an exception that challenged the legitimate boundaries of the NHS. From the late 1940s until the late 1960s the health service covered 'pathological' and 'social' cases, but rejected 'curiosity' cases. In this regard it is productive to see the pregnancy test as a particular case of a more general reluctance on the part of the British state to offer potentially controversial services related to sex, reproduction and contraception within the health service. In the mid 1960s the oral contraceptive pill became the only drug that GPs were able to prescribe privately to NHS patients for a fee. Similarly, doctors had the option of ordering non-medical pregnancy tests for patients who were willing to pay out of pocket. This continued arrangements that predated the NHS, whereby private patients and practitioners were able to pay for pregnancy tests and diagnostic tests in general. The persistence of private arrangements within the NHS in the case of the contraceptive pill, other contraceptive devices and pregnancy tests suggests a more nuanced approach to understanding NHS hybridity, which is known to have combined older business arrangements with newer bureaucracies. The marginal status of pregnancy testing suggests that to better explain postwar British medicine it is essential to examine tensions between the Ministry of Health and the NHS, on the one hand, and GPs and the BMA, on the other, which were exacerbated by private commercial laboratories in the 1960s.

The underlying tension of pregnancy testing from the late 1930s to the late 1960s was between democratisation and medical control within and beyond the state health care system. Many doctors and the BMA wanted pregnancy testing to remain under

medical supervision. The Ministry of Health and the NHS, however, did not want to take responsibility for a diagnostic service that in many cases was not medically justified. Despite Beric Wright's attempt to bypass medical gatekeeping, the status quo persisted until the mid 1960s when the success of commercial laboratories revealed the inadequacy of the NHS in meeting the non-medical demand for pregnancy testing. Despite repeated promises that the NHS would soon be able to meet this demand, it did not and instead commercial alternatives flourished in the private sector.

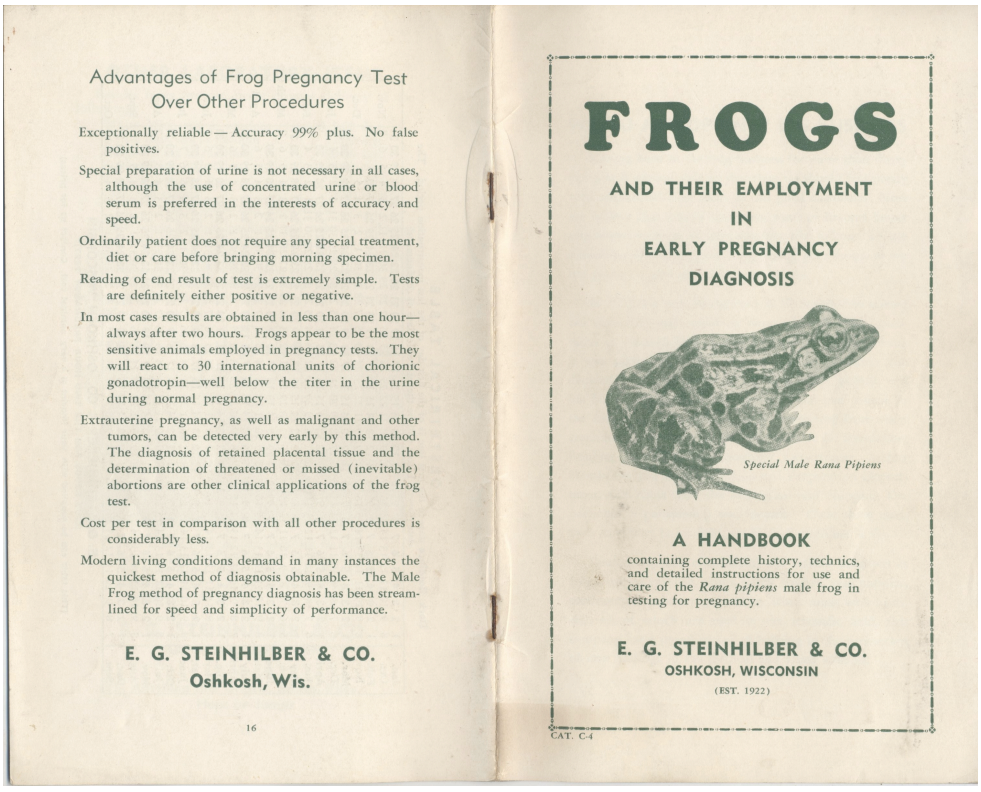
Beyond Britain, much could be learnt from histories of pregnancy testing in other countries. Although Sarah Leavitt has studied the home test in American culture, she barely scratched the surface of the earlier history of biological and immunological tests, which could be productively compared and contrasted to Britain.[447] For example, the race of tested women ('coloured' or 'white'), which only began to be mentioned in British reports in the years around 1960,[448] is indicated in one of the first published studies of a hormonal pregnancy test in the US (Siddall, 1928a). And in August 1965, researchers at the Carolina Population Center used Pregnosticon 'as an epidemiological tool' to survey 'white' and 'Negro' low-income women's fertility in Greensboro, North Carolina.[449] That race also mattered to American laboratory technicians is nicely illustrated by the satirical short story, 'What you don't know won't hurt you', first published in *Harper's magazine* in 1942. The author, African-American novelist Richard Wright, worked as a 'porter' at the Michael Rees Hospital in Chicago, where he prepared caged rabbits for the Aschheim-Zondek test. When a scuffle breaks out between two porters, the pregnancy test rabbits are accidentally released and then, unbeknownst to the white doctors, replaced at random.[450]

The story of eating pregnancy test rabbits (other laboratory animals) is waiting to be told. By the time the Americans joined World War II, laboratory workers at the State

[447] Ziv Eisenberg's otherwise groundbreaking dissertation on the 'making of modern pregnancy in America' does not say anything new about pregnancy testing: Einseberg, 2013, 13-14.
[448] For example, Dr Douglas Hogg, a Newcastle general practitioner, treated a 'Coloured patient' who 'Refused physical examination': Hogg, 1959, 614.
[449] In 'one hot week in August' they began a 'door-to-door' collection of urine specimens for testing 'in the back of a hot, odoriferous panel truck' (Udry et al., 1971, 334). On the centre: Olszynko-Gryn & Weisz, 2010, 299-303.
[450] Wright, 1942. Wright's account portrays the porters as the vital but underappreciated participants in clinical practice: Lederer, 2000, 271-272.

University of Iowa had been eating theirs 'for years with no harmful effects' (Plass, 1943, 194). And the head pathologist at the Elliot Hospital in Manchester, New Hampshire, routinely contributed his to 'the family cooking pot'; these were 'considered a special delicacy, as the meat was very tender.'[451] *Xenopus*, considered a delicacy by Italian POWs, was also imported to the US, first by Abner Weisman, a New York gynaecologist and infertility specialist who learned the Hogben test in Edinburgh,[452] and then by the entrepreneurial Merchant Marine Officer, Lieutenant Jay E. Cook. In the mid 1940s, a *Life* magazine photo-essay declared that the *Xenopus* test was 'Faster than the rabbit or mouse tests',[453] and the *Science news letter* explained that the 'World's oddest toads' were 'being used for pregnancy tests'.[454] A 1952 headline in *Household* magazine asked, 'How far can you trust a frog? How reliable is a rabbit?'[455] And in 1956 an article in the general interest digest magazine *Coronet*, published monthly by *Esquire*, reported on a 60-minute skin reaction test marketed to doctors by Dermal Laboratories (Lobsenz, 1956). The 'Q-test', as it was called, was not available in Britain, and provides a tantalising entry to explore national differences to marketing and clinical practices (**figure 7.1.**).[456]

[451] Sarah Franklin, email, 12 April 2013. See also Weisman & Coates, 1943.
[452] See Weisman, 1941a,b, Weisman & Coates, 1944.
[453] 'Frog test: Egg-laying by African frog yields quick diagnosis of human pregnancy', *Life*, 24 April 1944, 87-88.
[454] 'World's oddest toad', *Science News Letter*, 10 November 1945, 295.
[455] Cooley, 1952.
[456] Sara Dubow briefly mentions the Q-test in her recent 'history of the fetus in modern America': Dubow, 2011.



Advantages of Frog Pregnancy Test
Over Other Procedures

Exceptionally reliable — Accuracy 99% plus. No false positives.

Special preparation of urine is not necessary in all cases, although the use of concentrated urine or blood serum is preferred in the interests of accuracy and speed.

Ordinarily patient does not require any special treatment, diet or care before bringing morning specimen.

Reading of end result of test is extremely simple. Tests are definitely either positive or negative.

In most cases results are obtained in less than one hour—always after two hours. Frogs appear to be the most sensitive animals employed in pregnancy tests. They will react to 30 international units of chorionic gonadotropin—well below the titer in the urine during normal pregnancy.

Extrauterine pregnancy, as well as malignant and other tumors, can be detected very early by this method. The diagnosis of retained placental tissue and the determination of threatened or missed (inevitable) abortions are other clinical applications of the frog test.

Cost per test in comparison with all other procedures is considerably less.

Modern living conditions demand in many instances the quickest method of diagnosis obtainable. The Male Frog method of pregnancy diagnosis has been streamlined for speed and simplicity of performance.

E. G. STEINHILBER & CO.
Oshkosh, Wis.

16

FROGS

AND THEIR EMPLOYMENT IN EARLY PREGNANCY DIAGNOSIS

Special Male Rana Pipiens

A HANDBOOK
containing complete history, technics, and detailed instructions for use and care of the *Rana pipiens* male frog in testing for pregnancy.

E. G. STEINHILBER & CO.
OSHKOSH, WISCONSIN
(EST. 1922)

CAT. C-4

Figure 7.1. These two artefacts suggest interesting similarities and differences between American and British contexts. Above: Mrs Simerson, a medical technician, and Dr Jane Hodgson photographed at a 1952 gynaecologists' convention for the *Chicago Sun-Reporter*. Below: A handbook by E. G. Steinhilber & Co., of Oshkosh, Wisconsin, *c*.1954, promoting their 'hopping business'.

Beyond the US, it would be interesting to know more about the adoption of the Aschheim-Zondek test in the final years of the Weimar Republic and, inevitably more disturbingly, in Nazi Germany. Well-preserved Aschheim-Zondek test results, both positive and negative, can be found among the 40,000 files of the archive of the SS-Hygiene Institute at Auschwitz, where the notorious doctor Joseph Mengele experimented on prisoners.[457] But who were the women, why were they tested, and what happened to them after? It would also be interesting to know more about pregnancy testing in Palestine, where Bernhard Zondek immigrated to in 1934, and then in Israel, a country that embraced the new reproductive technologies and now has more fertility clinics per capita than any other in the world (Kahn, 2000).

Beyond pregnancy testing, this thesis has explored a lost world of laboratory services. We do not yet have an inclusive enough picture of laboratory life to cover 'not just the cutting-edge research laboratory, but also the ordinary school laboratory, [as well as] those commissioned for standardized testing and calibration, mobile fieldwork, diagnostic medical analysis, and industrial quality control' (Gooday, 2008, 788). For instance, the literature on cancer is largely silent about serological tests, the most famous of which, 'Bendien's test', caused a sensation in the 1930s (Panton, 1937). Historians of postwar biomedicine tend to focus more on biological research than routine services.[458] And although in the late 1970s the US diagnostic laboratory industry was worth billions of dollars, approximately as much as the pharmaceutical industry (Creager, 2008, 216), we know comparatively little about it. To better explain the rise of scientific medicine, we need to start recovering the history of diagnostic laboratories—how they were set up and maintained, how they worked in practice and how the services they offered changed, for example, before and after the creation of the NHS.

In light of recent events it seems likely that we can expect similar issues and debates to arise from different kinds of diagnostic technologies. Despite their ongoing relevance and the richness of available sources, the histories of paternity blood testing

[457] Paul Weindling, personal communication, 1 April 2014. On the institute's archives: Kozub, 2009. On Nazi menstrual calendars: Schlünder, 2005.
[458] See, for example, the contributions to Quirke & Gaudillière, 2008.

and fetal sex determination remain under-researched.[459] HIV testing provides an interesting comparison since the virus, like an unplanned pregnancy, can also be the consequence of unprotected sex and has a history of social stigmatisation. In 2012 the US Food and Drug Administration (FDA) approved OraQuick, the first over-the-counter home test for HIV and a version of the swab test that healthcare professionals had been using since 2002. The FDA advised that OraQuick was not 100% reliable and that additional testing by medical professionals was needed to confirm results. OraSure, the manufacturer, claimed a 99% accuracy for negative results, but only 92% for positives.[460] As with pregnancy testing in the 1960s, users are encouraged to see a doctor if they test positive and to re-test if they test negative. The newly approved test for HIV has followed a similar trajectory (from a medical to a commercial context) and raises a familiar set of questions about anxiety, privacy, reliability and consumer responsibility.

The distinction made by the FPA between 'entertainment' or 'keepsake' non-diagnostic ultrasound, on the one hand, and diagnostic imaging, on the other, are reminiscent of past categories of 'curiosity' and 'pathological' cases for pregnancy testing. Since the mid 1990s, local entrepreneurs have bought or leased equipment that has previously been confined to a professional clinical setting. Some doctors and medical organisations in the US have condemned entertainment ultrasound for lack of medical benefit and the risk of false diagnoses, whereas its defenders have argued that the application of consumer safety regulations, not a ban, would adequately ensure the responsible provision of a low-risk, in-demand service to the general public (Burlbaw, 2004, Green & Platt, 2005, Doublilet, 2005, Alexander, 2007). The parallels with pregnancy testing are striking. In both cases we can see the entrepreneurial appropriation and marketing of a medical technology for ends that are not strictly medical in a straightforward sense, and in both cases opposition is framed in terms of state regulation, the risk of false results and doctors' responsibility to control a diagnostic technology that had found a non-medical market.

[459] But see Cederqvist & Fuchs, 1970, Rudavsky, 1996, 1999, Okroi & Voswinckel, 2003, Ha, 2011a.
[460] 'US approves first over-the-counter HIV home-use test', 4 July 2012, BBC News, http://www.bbc.co.uk/news/world-us-canada-18700121.

For some, the 'ideal pregnancy test', still a thing of the future, would be '100% accurate,' 'very cheap,' and 'able to diagnose pregnancy immediately following contraception' (Haarburger & Pillay, 2011, 548). But the standard criteria of accuracy, cost, speed and convenience are not the only ones that have been mobilised when discussing the future of pregnancy testing. Adopting a liberal feminist position, anthropologist Linda Layne has recently proposed that home tests could offer users more information than 'yes' or 'no' by revealing the hCG level that could be tracked over time by repeat testing. Consumers would then be able to use these tests not only to confirm or exclude the possibility of pregnancy, but also to ascertain 'whether a pregnancy is likely to end in miscarriage, is likely a multiple gestation (twins, triplets), or is likely to be an ectopic.' Placed 'in women's hands', this information could 'save lives' (Layne, 2009, 73-74). An 'at-home semi-quantitative pregnancy test' (SQPT) has already been trialled in the US and Vietnam as an 'easy to use' alternative to the medically required clinical follow-up to abortion by mifepristone administration (Blum et al., 2012, Lynd et al., 2013). In a recent interview, Dr Paul Blumenthal, a researcher at Stanford University, suggested that SQPTs, which might one day be plugged into an iPhone, could provide anxious women 'who have had a lot of assistance with reproduction' with the 'reassurance that things are going in the right direction'.[461]

Though forward-looking, SQPTs also hark back to Crew and Wiesner's vision from the 1930s, when, they argued, interval Aschheim-Zondek testing could be used to monitor the progress of miscarriage or infertility treatment. In this limited sense, the pregnancy test has come full circle, from the graded results provided by Edinburgh mice to the five concentrations of hCG indicated by SQPTs. Meanwhile, the choices available to consumers on pharmacy and supermarket shelves have already significantly expanded. In the late 1980s and early 1990s, when more British women were putting off starting a family and with an estimated one in six couples struggling to conceive, Clearblue and subsequent ovulation tests innovatively targeted the modern independent career woman whose fertility was in doubt. Clearblue now offers its digital ovulation test in packs of twenty. Product advice and reviews now come in

[461] See April Cashin-Garbutt, 'Semi-quantitative pregnancy tests: An interview with Dr. Paul Blumenthal, Stanford University School of Medicine', 12 July 2013, http://www.news-medical.net/news/20130712/Semi-quantitative-pregnancy-tests-an-interview-with-Dr-Paul-Blumenthal-Stanford-University-School-of-Medicine.aspx.

the form of official company website videos as well as unofficial user-made YouTube videos and blogs.

The birth of some five million 'miracle' babies worldwide through in vitro fertilisation (IVF) in the past 35 years has transformed how we think about human biology and kinship (Franklin, 2013). IVF has become routine, but failure is still the most likely outcome and dealing with failure 'is undoubtedly the most emotionally wrenching feature of IVF' (Franklin, 1997, 121). This point is made painfully clear by Finnish artist Elina Brotherus's *Annunciation*, a series of self-portraits recently exhibited at the Photographers' Gallery in London. Taken after failed IVF treatments, the photographs depict 'a long process when time after time negative pregnancy tests turn into a deep sorrow and loss.'[462] In the summer of 1975, three years before the birth of the first Louise Joy Brown, the first 'test-tube' baby, Cambridge physiologist Robert Edwards received a telegram from Oldham gynaecologist Patrick Steptoe: 'PREGNANCY TEST POSITIVE RING ME URGENTLY STOP PATRICK.'[463] Though initially 'delighted', two months later a laparoscopy confirmed Steptoe's growing fears that the pregnancy was ectopic; 'the embryo was in the stump of the Fallopian tube and it had to be removed there and then.'[464]

The rise of assisted reproductive technology (ART) has, if anything, intensified the ambivalence of an early positive pregnancy test result and the potential for loss. One man told Linda Layne 'of how he and his wife had been unable to have a child until doctors discovered his wife needed supplemental progesterone in order for a fertilized egg to implant in the walls of her uterus. He explained that they now felt they had suffered a series of miscarriages' (Layne, 2003, 82). A contributor to Sarah Leavitt's online repository of pregnancy test stories expressed her 'mixed feelings about the early tests because they allow you to get positive results, only to learn it is really a chemical pregnancy or "early miscarriage"' (quoted in Layne, 2009, 66). This new term, 'chemical pregnancy' – as opposed to 'clinical pregnancy' – appears to help patients and doctors make sense of early losses that would have gone unnoticed but

[462] 'Elina Brotherus and *Home truths*', The Finnish Institute in London, http://www.finnish-institute.org.uk/en/articles/646-elina-brotherus-and-home-truths.
[463] Edwards, 1980, 125-126. On Edwards and Steptoe: Johnson et al., 2010, Johnson, 2011.
[464] Edwards, 1980, 129.

for a test.[465] Mary Chadwick, a patient undergoing IVF, told the anthropologist Sarah Franklin: 'you know, I *was* pregnant, even it being just a chemical pregnancy and that, you were told it was positive' (Franklin, 1997, 181).

The testimonies of New England women in Robin Gregg's *Pregnancy in a high-tech age* demonstrate that pregnancy realisation is 'not a monolithic experience' (Gregg, 1995, 54). Likewise, the narratives collected in Ann Oakley's *Becoming a mother* suggest a 'tension between a desire to defer to medical authority and a feeling that the body's own signals should be trusted.' For example, Nancy Carter, a clerk, who 'didn't actually think she *was* pregnant', 'went to the doctor's because' of a 'terrible itching.' He said 'I think you are', but 'couldn't tell definitely' until Nancy 'had a test.' José Brice, a manicurist, was 'so regular, it's ridiculous. I know that it's going to be about six o'clock in the evening. It's so funny, because at seven o'clock my husband said: oh, you're pregnant, then?' And Mandy Green, a hairdresser, decided not to go to the doctor when she 'half felt' pregnant because she 'thought if I get to know too soon it's going to be an awfully long nine months. So I didn't want to go any earlier' (Oakley, 1979, 27-28).

As Ann Oakley put it, 'it may seem obvious that [...] the person whose body the baby is in should know about it first. But, on the other hand, people are used to going to doctors to have their symptoms interpreted. Why should pregnancy be a special case?'[466] Yet in many ways, it is a special case. Pregnancy is not a disease in any straightforward sense and, historically, many doctors and other maternity experts rejected the demand by healthy women to take responsibility for the medical confirmation of early pregnancy. The ramifications of a positive test result could place a woman, particularly if unmarried, in an awkward position. I want to conclude by suggesting that women's deference to medical authority or technology, as the case may be, has more to do with the particular anxieties, social relations and public cultures of pregnancy than with deskilling or the devaluation of women's self-knowledge as such. Today, the online NHS video 'Doing a pregnancy test' asks the question: 'Is the pregnancy test accurate?' The equivocal answer is that a positive result is probably correct, but a negative result should not be trusted if 'you feel that

[465] See, for example, Macklon, 2002, Schreiber et al., 2008, Annan et al., 2013.
[466] Oakley, 1979, 30.

you are pregnant or you continue to miss your period'.[467] Feeling pregnant still counts.

[467] See http://www.nhs.uk/conditions/pregnancy-and-baby/pages/pregnancy-test.aspx, thanks to Kathryn Schoefert for the link.

Archives

Addenbrooke's Hospital, Cambridge University Hospitals, NHS Foundation Trust
AHAR 'Departmental records'.
AHPR, 'Patient records'.
AHRO 1/2/9, 'Gravindex register'.

Edinburgh University Archives
IN1/ACU/A1, 'Institute of Animal Genetics'.
IN1/ACU/S1/1, 'Interviews with staff of the Institute of Animal Genetics'.

Girton Women's Liberation Group Archive
GCIP CWLA 0/3, 'Pregnancy testing correspondence and papers'.

Liverpool Record Office and Local History Service
614 WOM 14/3, 'Miscellaneous bundle of laboratory reports, reports from the Pregnancy Diagnosis Station, Department of Obstetrics, University of Liverpool etc. for Mr. Jeffcoate'.

London Metropolitan Archives
HA/NT/117/000702, 'N.E. Metropolitan Regional Hospital Board Circulars'.

Lothian Health Services Archive
GD11, 'Robert William Johnstone'.

Mass-Observation Archive
SxMOA1/4, 'Mass Observation Diaries (1939-1945)'.

Millennium Memory Bank, National Sound Archive
C900/16008 C1, Sheila Walker.

National Archives

DPP 2/564, ‘Bourne, Dr Aleck W: Abortion’.

FD 1/2816, ‘Sexual hormones: research by Dr B P Wiesner, Edinburgh University’.

FD 23/127, ‘Congenital malformations and application of hormonal pregnancy tests: correspondence’.

FD 23/4486, ‘Quality control of pregnancy diagnosis: correspondence and journal articles’.

HO 45/24517, ‘CAPITAL PUNISHMENT: Sentence of Death (Expectant Mothers) Act 1931 (respite death charge to penal servitude for life): papers leading up to passing of the Act: memoranda: barrister's query and queries from other countries’.

HO 45/24715, ‘VIVISECTION: CREWE, Dr F A E: pioneer in animal genetics and pregnancy testing techniques’.

HO 45/25145, ‘VIVISECTION: Pregnancy tests: legal opinion as to the necessity for licence coverage’.

MA 71/26, ‘Interdepartmental Committee on Abortion (Ministry of Health; Home Office); Circulated papers 131 - 150’.

MA 71/27, ‘Interdepartmental Committee on Abortion (Ministry of Health; Home Office); Circulated papers 151 - 170’.

MH 149/1105, ‘Prescribing of oral diagnostic pregnancy tests’.

MH 156/278, ‘Pregnancy: Immunological tests; reassessing regulations’.

MH 156/633, Review of the arrangements for pregnancy testing: proposals for the introduction of statutory licensing of pregnancy testing kits’.

MH 159/77, ‘Pregnancy testing facilities: advertising by private laboratories; introduction of immunological tests; provision of tests on demand under NHS; circulated letters and papers’.

MH 159/78, ‘Pregnancy testing facilities: advertising by private laboratories; introduction of immunological tests; provision of tests on demand under NHS; circulated letters and papers’.

MH 160/643, ‘Choriocarcinoma following hydatidiform mole: proposals for setting up a screening service; reports and minutes of meetings’.

MH 171/67, ‘Congenital abnormalities: report on human serum vitamin A and carotenoids during pregnancy, labour and post partum; Dr Isabel Gal’.

MH 71/26, ‘Ministry of Health: Various Committees’ Correspondence, Minutes and Reports. Interdepartmental Committee on Abortion (Ministry of Health; Home Office). Circulated papers 131-150’.
MH 71/27, ‘Ministry of Health: Various Committees’ Correspondence, Minutes and Reports. Interdepartmental Committee on Abortion (Ministry of Health; Home Office). Circulated papers 151-170’.
MH 71/39, ‘Use of hormone pregnancy tests: development of hydrocephaly or meningoencephalocoele in the foetus’.

National Archives of Scotland
HH 102/858, ‘Laboratory services: Pregnancy diagnosis services’.

Schering Archiv
B2 1677, ‘Dr Kamnitzer Und Dr Joseph’.
S1 63-64, ‘Pharma Präparate, Cyclotropin, Maturin’.
S1 166 ‘Pharma Präparate, Duogynon’.

Wellcome Library
PP/GRA/B.4, ‘Predictor Home Pregnancy Test’.
PP/PRE/J.1/18, ‘Interviews, Beric Wright (HRW’s son)’.
PP/PRE/J.1/22/7, ‘Beric Wright: 26 Nov 1980’.
SA/BMA/D.156, ‘Pregnancy diagnosis test service’.
SA/EUG/C.96, ‘Dr R E Elkan’.
SA/FPA/A14/201, ‘Dr Beric Wright'.
SA/FPA/A23/1, ‘World League for Sexual Reform conference including letters from Dr. E. Elkan’.
SA/FPA/A23/53/UD/12A-B, ‘“Publications of the FPA” with notice of Seminological, Pregnancy diagnosis, Mail order services’.
SA/FPA/A3/11-13, ‘Pregnancy Diagnosis Laboratory’.
SA/FPA/A7/90, ‘Organon Laboratories Ltd’.
SA/FPA/C/B/2/30/1, ‘BPAS report on pregnancy testing’.
WF/M/PL/247, ‘Prepuerin’.

Unpublished sources

Al-Gailani, S. (2010). *Teratology and the clinic: Monsters, obstetrics, and the making of antenatal life in Edinburgh, c.1900*, Ph.D. Thesis, University of Cambridge.

Bhatia, G. (1996). *Social obstetrics, maternal health care policies and reproductive rights: the role of Dugald Baird in Great Britain, 1937-65*, M.Phil. Thesis, University of Oxford.

Bigman, F. (2014). *'Nature's a wily dame': Abortion in British literature and film, 1907-1967,* Ph.D. Thesis, University of Cambridge.

Close-Koening, T. (2011). *Betwixt and between: Production and commodification of knowledge in a medical school pathological anatomy laboratory in Strasbourg (mid-19th century to 1939)*, Ph.D. Thesis, Strasbourg.

Cox-Maksimov, D. (1997). *The making of the clinical trial in Britain, 1910-1945: Expertise, the state and the public*, Ph.D. Thesis, University of Cambridge.

Eisenberg, Z. (2013). *The whole nine months: Women, men, and the making of modern pregnancy in America*, Ph.D. Dissertation, Yale University.

Erlingsson, S. J. (2005). *The rise of experimental zoology in Britain in the 1920s: Hogben, Huxley, Crew, and the Society for Experimental Biology*, Ph.D. Thesis, University of Manchester.

Gallwey, A. (2011). *Lone motherhood in England, 1945-1990: Economy, agency and identity*, Ph.D. thesis, University of Warwick.

Ha, N. Q. (2011a). *Marking bodies: A history of genetic sex in the twentieth century*, Ph.D. Thesis, Princeton University.

Hackney, F. (2010). *'They opened up a whole new world': feminine modernity and the feminine imagination in women's magazines, 1919-1939*, Ph.D. Thesis, Goldsmiths, University of London.

Hiddinga, A. (1995). *Changing normality: Pregnancy and scientific knowledge claims 1920-1950, with special reference to the USA*, Ph.D. Thesis, University of Amsterdam.

Homrighaus, R. E. (2010). *Baby farming: The care of illegitimate children in England, 1860-1943*, Ph.D. Dissertation, 2003. Rev. ed., 2010, at Historytools, http://www.historytools.org/babyfarming/baby-farming.html.

Jones, E. L. (2007). *Abortion in England, 1861-1967*, Ph.D. Thesis, Royal Holloway, University of London.

Kirk, R. G. W. (2005). *Reliable animals, responsible scientists: Constructing standard laboratory animals in Britain c.1919-1976*, Ph.D. Thesis, University College London.

Marie, J. (2004). *The importance of place: A history of genetics in 1930s Britain*, Ph.D. Thesis, University College London.

Merrick, L. A. (2008). *Local authorities and the development of the National Health Service (NHS) in Scotland, 1939 to 1974*, Ph.D. Thesis, University of Glasgow.

Olszynko-Gryn, J. (2009). *Locating the pregnancy hormone, 1928-1945: the Aschheim-Zondek test and the controversy over the hormonal placenta*, MPhil essay, University of Cambridge.

Olszynko-Gryn, J. (2010). *Animals in the diagnostic laboratory: the rise and fall of living pregnancy tests in Britain and beyond, 1929*-64, MPhil dissertation, University of Cambridge.

Radin, J. M. (2012). *Life on ice: Frozen blood and biological variation in a genomic age, 1950-2010*, Ph.D. Thesis, University of Pennsylvania.

Raphael, A.-J. (2010). *Natural childbirth in twentieth century England: A history of alternative approaches to birth from the 1940s to the 1990s*, Ph.D. Thesis, Queen Mary University of London.

Rudavsky, S. (1999). *Blood will tell: The role of science and culture in twentieth-century paternity disputes*, Ph.D. thesis, University of Pennsylvania.

Russell, R. (2012). *Nausea and vomiting: A history of signs, symptoms and sickness in nineteenth-century Britain*, Ph.D. Thesis, University of Manchester.

Valier, H. K. (2002). *The politics of scientific medicine in Manchester,* c.*1900-1960*, Ph.D. Thesis, University of Manchester.

van Kammen, J. R. (2000). *Conceiving contraceptives: The involvement of users in anti-fertility vaccines development*, Ph.D. Thesis, Universiteit van Amsterdam.

Published sources

Anonymous works are cited fully in the footnotes and do not appear in the bibliography; both primary and secondary sources are included in this bibliography.

Abderhalden, E. (1914a). *Abwehrfermente das Auftreten blutfremder Substrate und Fermente im tierischen Organismus unter experimentellen physiologischen und pathologischen Bedingungen*, 4th ed., Berlin: Springer.

Abderhalden, E. (1914b). *Defensive ferments of the animal organism against substances out of harmony with the body, the blood-plasma and the cells*, London: Bale & Danielsson.

Abraham, J., & Davis, C. (2006). Testing times: The emergence of the Practolol disaster and its challenges to British drug regulation in the modern period, *Social History of Medicine*, 19, 127-147.

Adhikari, M. (2005). *Not white enough, not black enough: Racial identity in the South African coloured community*, Athens, OH: Ohio University Press.

Adler, K. (2007). *Contributions to the history of herpetology, Vol. 2*, St. Louis, Mo: Society for the Study of Amphibians and Reptiles.

Adler-Kastner, L. (1998). From *personae non gratae* in Vienna 1938 to respected citizens of Edinburgh: A vignette of my parents, Dr Ernst Adler and Dr Regina Kapeller-Adler, *Wiener Klinische Wochenschrift*, 110, 174-180.

Al-Gailani, S. (2013). Making birth defects 'preventable': Pre-conception vitamin supplements and the politics of risk reduction, *Studies in the History and Philosophy of Biological and Biomedical Sciences*, http://dx.doi.org/10.1016/j.shpsc.2013.10.009.

Alexander, A. A. (2007). Just scanning around with diagnostic medical ultrasound: Should state regulate the nondiagnostic uses of this technology? *Annals of Health Law*, 16, 1-41.

Alexander, S. (1996). The mysteries and secrets of women's bodies: Sexual knowledge in the first half of the twentieth century. In M. Nava & A. O'Shea (eds.), *Modern times: Reflections on a century of English modernity* (pp. 161-75), London: Routledge.

Alexander, S. S., & Bellerby, C. W. (1935). The effect of captivity upon the reproductive cycle of the South African clawed toad (*Xenopus laevis*). *Journal of Experimental Biology*, 12, 306-314.

Allan, H., & Dickens, F. (1930). The Zondek and Aschheim test for pregnancy, *Lancet*, 215, 39-41.

Allbutt, H. A. (1887). *The wife's handbook: How a woman should order herself during pregnancy, in the lying-in room, and after delivery. With hints on the management of the baby, and on other matters of importance, necessary to be known by married women*, 4th ed., London: Rorder.

Allison, R. M. (1955). The merits of some English and foreign male toads and frogs used for the diagnosis of pregnancy and measures to overcome their disadvantages. *Laboratory Practice*, 4, 277.

Allison, R. M. (1957). In A. N. Worden & W. Lane-Petter (eds.), *The UFAW handbook on the care and management of laboratory animals*, 2nd ed., London: UFAW.

Amsterdamska, O., & Hiddinga, A. (2003). The analyzed body. In R. Cooter & J. Pickstone (eds.), *Companion to medicine in the twentieth century* (pp. 417–433). London: Routledge.

Anderson, S. (2005) *Making medicines: A brief history of pharmacy and pharmaceuticals*, London: Pharmaceutical Press.

Anderson, S. C., & Berridge, V. S. (2000). The role of the community pharmacist in health and welfare, 1911-1986. In J. Bornat, R. B. Perks, P. Thompson, & J. Walmsley (eds.), *Oral history, health and welfare* (pp. 48-74), London: Routledge.

Annan, J. J. K., Gudi, A., Bhide, P., Shah, A., & Homburg, R. (2013). Biochemical pregnancy during assisted conception: A little bit pregnant, *Journal of Clinical Medicine Research*, 5, 269-274.

Arbuthnot-Lane, W. (1934). *The modern woman's home doctor*, London: Odhams.

Armon, R. (2012). Between biochemists and embryologists: The biochemical study of embryonic induction in the 1930s, *Journal of the History of Biology*, 45, 65-108.

ASA (1997). *Celebrating 35 years of effective self-regulation, 1962-1997*, London: ASA.

Aschheim, S. (1929). The early diagnosis of pregnancy, chorion-epithelioma and hydatidiform mole by the Aschheim-Zondek test, *American Journal of Obstetrics and Gynecology*, 28, 335-342.

Austoker, J. (1988). *A history of the Imperial Cancer Research Fund, 1902-1986*. Oxford: Oxford University Press.

Austoker, J., & Bryder, L. (eds.) (1989). *Historical perspectives on the role of the MRC*, Oxford: Oxford University Press.

Bahl, O. P. (1969). Human chorionic gonadotropin I. Purification and physicochemical properties, *Journal of Biological Chemistry*, 244 (10 February), 567-574.

Baird, D. (1950). *Combined textbook of obstetrics and gynaecology for students and practitioner* (5th ed.), Edinburgh: Livingstone.

Balfour (1967). *Help yourself to London: A guide to services, facilities and things to do*, London: Garnstone.

Ballantyne, J. W. (1913). Blood tests, especially Abderhalden's, in pregnancy. *Edinburgh Medical Journal*, October 1913, 362-367.

Ballantyne, J. W. (1914). *Expect motherhood: Its supervision and hygiene*. London: Cassell.

Ballin, A. S. (1904). *The expectant mother: A complete guide to the care of her health and the preparations for the infant*, London: Office of 'Baby: the mother's magazine'.

Balmer, B. (2001). *Britain and biological warfare: Expert advice and science policy, 1930-65*, Basingstoke: Palgrave.

Balmer, B. (2002). Biological warfare: The threat in historical perspective. *Medicine, Conflict and Survival*, 18, 120-137.

Bamforth, J. (1936). Experiences of the Friedman test for pregnancy. *St. Thomas's Hospital Reports*, 1, 132-139.

Bangham, D. R. (1999). *A history of biological standardization: The characterization and measurement of complex molecules important in clinical and research medicine. Contributions from the UK 1900-1995. What, why, how, where and by whom. A personal account*, London: Society for Endocrinology.

Banks, L. R. (1960). *The L-shaped room*, London: Chatto & Windus.

Barr, W. A. (1963a). A comparison of the Hogben pregnancy test with an immunological method, *Journal of Obstetrics and Gynaecology of the British Commonwealth*, August, 551-556.

Barr, W. A. (1963b). Immunological methods used in pregnancy diagnosis, *Medical News*, 1 November, 8.

Barrell, J., & B. Braithwaite (1988). *The business of women's magazines*, 2nd ed., London: Kogan Page.

Bartrip, P. W. J. (1996). *Themselves writ large: The British Medical Association 1832-1966*. London: BMA.

Barton, G. M. (1953). Comparison of the male toad and Hogben pregnancy tests, *BMJ*, 2, 868.

Batten, L. W. (1939). *The single-handed mother*, London: George Allen & Unwin.

Bayly, M. B. (1936). *Cancer: The failure of modern research.* London: Health Education and Research Council.

Bayon, H. P. (1939). Ancient pregnancy tests in light of contemporary knowledge. *Proceedings of the Royal Society of Medicine*, 32, 1527-1538.

Beattie, J. (1956). Miscarriage. In *Refresher course for general practitioners: Specially commissioned articles from the British medical journal*, *3rd collection* (pp. 340-347), London: BMA.

Beauman, N. (1983). *A very great profession: The woman's novel, 1914-39*, London: Virago.

Bedson, S.P. (1953). Clinical pathology in general practice: Facilities under the National Health Service, *BMJ*, 3 October, 774-775.

Beinart, W. (2007). The lion queen. *Environmental History*, 12, 383-386.

Beinart, W., & McKeown, K. (2009). Wildlife media and representations of Africa, 1950s to the 1970s, *Environmental History*, 14, 429-452.

Bellerby, C. W. (1933). The endocrine factors concerned in the control of the ovarian cycle. I. *Xenopus laevis* as a test animal. *Biochemical Journal*, 27, 615-620.

Bellerby, C. W. (1934). A rapid test for the diagnosis of pregnancy, *Nature*, 133, 494-495.

Benninghaus, C. (2012). Beyond constructivism? Gender, medicine and the early history of sperm analysis, Germany 1870-1900, *Gender & History*, 24, 647-676.

Bensen, A. R. (1969). *Rose Macaulay*, New York: Twayne Publishers.

Bentley, A. (1998). *Eating for victory: Food rationing and the politics of domesticity.* Urbana: University of Illinois Press.

Berkeley & Bonney (1919). *A guide to gynaecology in general practice*, 2nd ed., London: Frowde.

Berridge, V. (1999). *Health and society in Britain since 1939*, Cambridge: Cambridge University Press.

Bettendorf, G. *Zur Geschichte der Endokrinologie und Reproduktionsmedizin. 256 Biographien und Berichte*, Berlin: Springer.

Bew, M. (1960). 'Orasecron' and pregnancy, *Practitioner*, 184, 372-373.

Bingham, A. (2004). *Gender, modernity, and the popular press in inter-war Britain*, Oxford: Clarendon.

Bingham, A. (2009). *Family newspapers?: Sex, private life, and the British popular press 1918-1978*, Oxford: Oxford University Press.

Bingham, A. (2012). Newspaper problem pages and British sexual culture since 1918, *Media History*, 18, 51-63.

Bishop, P. M. F. (1932). The Zondek-Ascheim reaction and the early diagnosis of pregnancy, *Guy's Hospital Gazette*, 46, 89-90.

Bishop, P. M. F. (1933). The Friedman test for pregnancy: An analysis of the results of a year's experience and a suggested modification, *Guy's Hospital Report*, 83, 308-335.

Bishop, P. M. F. (1934). Pregnancy diagnosis, *BMJ*, 1, 1186.

Bishop, P. M. F. (1951). *Gynaecological endocrinology for the practitioner*, 2nd ed., Edinburgh: Livingstone.

Björk, R. (2001). Inside the Nobel Committee on Medicine: Prize competition procedures 1901-1950 and the Fate of Carl Neuberg. *Minerva*, 39, 393-408.

Black, I. (1967). Pregnancy tests, *Sunday Citizen*, 1 January 1967.

Blacker, C. P. (1939). Maternity and child welfare work and the population problem. *Eugenics Review*, 31, 91-95.

Blackwell, B., & Walker, K. P. (1969). Possible pregnancy in a general practice, *Practitioner*, 202, 691-695.

Blaikley, J. B., & Chamberlain, G. (1971). Chelsea Hospital for Women, 1871-1971, *Journal of Obstetrics and Gynaecology of the British Commonwealth*, 78, 1053-1057.

Blair-Bell, W. (1930). *Some aspects of the cancer problem*, London: Baillière.

Blair-Bell, W. (1934). *Principles of gynaecology: A textbook for students and practitioners*, 4th ed., London: Baillière.

Blanarsch, M. (2009). Die Arzt-Patienten-Beziehung zu Beginn des 18. Jahrhunderts, untersucht anhand Johann Storchs Kasuistik zu Molenschwangerschaften. *Medizin, Gesellschaft und Geschichte*, 28, 121–152.

Bland, L. (2012). '"Hunnish scenes" and a "virgin birth": A 1920s case of sexual and bodily ignorance, *History Workshop Journal*, 73, 118-143.

Bliss, M. (1988). *The discovery of insulin*, London: Faber.

Blum J., Shochet, T., Lynd, K., Lichtenberg, E.S., Fischer, D., & Arnesen, M. (2012). Can at-home semi-quantitative pregnancy tests serve as a replacement for clinical follow-up of medical abortion? A US study, *Contraception*, 86, 757-762.

Blumenfeld, S. (1935). *Jew boy*, London: Jonathan Cape.

Borell, M. (1985). Organotherapy and the emergence of reproductive endocrinology, *Journal of the History of Biology*, 18, 1-30.

Borell, M. (1987). Biologists and the promotion of birth control research, 1918-1938, *Journal of the History of Biology*, 19, 51-87.

Bosman, L. P. (1937). Early diagnosis of pregnancy, *British Journal of Medicine*, 6 November, 939.

Bourne, A. (1935). *Midwifery for nurses*, London: Churchill.

Bowlby, R. (2013). *A child of one's own: Parental stories*, Oxford: Oxford University Press.

Bowler, P. J. (2006). Experts and publishers: Writing popular science in early twentieth-century Britain, writing popular history of science now, *British Journal for the History of Science*, 39, 159-187.

Bowler, P. J. (2009). *Science for all: The popularization of science in early twentieth-century Britain*, Chicago: University of Chicago Press.

Boyden, S. V. (1951). The adsorption of proteins on erythrocytes treated with tannic acid and subsequent hemagglutination by antiprotein sera, *Journal of Experimental Medicine*, 93, 107-120.

Brandt, C. (2010). The metaphor of 'nuclear reprogramming': 1970's cloning research and beyond. In A. Barahona, E. Suarez-Díaz, & H.-J. Rheinberger (eds.), *The hereditary hourglass. Genetics and epigenetics, 1868-2000* (pp. 85-95), Berlin: Max Plank Institute for the History of Science.

Braybrooke, P. (1927). *Some goddesses of the pen,* London: Daniel.

Brendon, P. (1991). *Thomas Cook: 150 years of popular tourism*, London: Secker & Warburg.

Brewer, H. F. (1934). The Aschheim-Zondek reaction, *St. Bartholomew's Hospital Journal*, 41, 65-69.

Brews A. (1935). A Follow-up survey of the cases of hydatidiform mole and chorion-epithelioma treated at the London Hospital since 1912, *Proceedings of the Royal Society of Medicine*, 28, 1213-1228.

Brews, A. (1939). Blair-Bell Memorial Lecture January 27th, 1939. Hydatidiform mole and chorion-epithelioma, *Journal of Obstetrics & Gynaecology of the British Empire*, 46, 815-835.

Brittain, V. (1957). *Testament of experience: An autobiographical story of the years 1925-1950*, London: Gollancz.

Britton, H. G. (1956a). Pregnancy test, *BMJ*, 2, 419.

Britton, H. G. (1956b). Diagnosis of early pregnancy, *BMJ*, 2, 1118.

Brodie, J., & Mellis, H. (1966). A comparative study of pregnancy tests, *Practitioner* 196, 821-825.

Bröer, R. (2004). Motes, protective ferments and hormones: Pregnancy testing from antiquity to the present day. In M. Barthels (ed.), *Senses, sensors and systems: A journey through the history of laboratory diagnosis* (pp. 129-143), Basel, Switzerland: Editiones Roche.

Brooke, S. (2001). 'A new world for women'? Abortion law reform in Britain during the 1930s. *American Historical Review*, 106, 431-59.

Brooke, S. (2011). *Sexual politics: Sexuality, family planning, and the British Left from the 1880s to the present day*, Oxford: Oxford University Press.

Brookes, B. L. (1988). *Abortion in England, 1900-1967*, London: Croom Helm.

Brookes, B. L., & Roth, P. (1994). *Rex v. Bourne* and the medicalization of abortion. In M. Clark & C. Crawford (eds.), *Legal medicine in history* (pp. 314-343), Cambridge: Cambridge University Press.

Brown, A. C. (2003). Centennial history of the Zoology Department, University of Cape Town, 1903-2003: A personal memoir, *Transactions of the Royal Society of South Africa*, 58, 11-34.

Brown, E., & Grover, M. (2012). *Middlebrow literary cultures: The battle of the brows, 1920-1960*, Houndmills: Palgrave Macmillan.

Brown, K. (2003). The maternal physician: Teaching American mothers to put the baby in the bathwater. In C. E. Rosenberg (Ed.), *Right living: An Anglo-American tradition of self-help medicine and hygiene* (pp. 88-111), Baltimore: Johns Hopkins University Press.

Brown, P. S. (1991). Medically qualified naturopaths and the General Medical Council, *Medical History*, 35, 50-77.

Browne, S. (1939). Pregnancy tests and notification, *Lancet*, 25 February, 478.

Browner, C. (1980). The management of early pregnancy: Colombian folk concepts of fertility control, *Social Science & Medicine*, 14, 25-32.

Bruehl, F. S. (1952). The development of pregnancy tests, *American Journal of Nursing*, 52, 591-593.

Brumberg, J. J. (1993). 'Something happens to girls': Menarche and the emergence of the modern American hygiene imperative, *Journal of the History of Sexuality*, 4, 99-127.

Brunton, D. (2004). The Rise of Laboratory Medicine. In D. Brunton (ed.), *Medicine transformed: Health, disease and society in Europe 1800-1930* (pp. 92-117), Manchester: Manchester University Press.

Bryder, L. (1984). Papworth Village Settlement – a unique experiment in the treatment and care of the tuberculous? *Medical History*, 28, 372-390.

Buchanan, R. J. M., & E. W. Hope (1904). *Husband's forensic medicine, toxicology and public health*, 7th ed., Edinburgh: Livingstone.

Bud, R. (1993). The *uses of life: A history of biotechnology*, Cambridge: Cambridge University Press.

Buckle, A. E. R. (1959). Methotrexate in treatment of metastasizing chorioncarcinoma: a care report, *BMJ*, 2, 1210-1213.

Bull, T. (1877). *Hints to mothers: For the management of health during the period of pregnancy and in the lying-in room with an exposure of popular errors in connection with those subjects and hints upon nursing*, 14th ed. London: Longmans, Green.

Bullock, W. E. (1915). A critical study of the basis of Abderhalden's serum reaction, *Lancet*, 30 January, 223-228.

Bullough, V. L. (1994). *Science in the bedroom: A history of sex research*, New York: BasicBooks.

Burgess, A. (1962). *The wanting seed*, London: Heinemann.

Burlbaw, J. (2004). Obstetric sonography—that's entertainment? *Journal of Diagnostic Medical Sonography*, 20, 444-448.

Burney, I. (1997). Review of Mark Jackson, *New-born child murder: Women, illegitimacy and the courts in eighteenth-century England* (Manchester University Press, 1996), *Medical* History, 41, 499-500.

Burney, I, & Pemberton, N. (2011). Bruised witness: Bernard Spilsbury and the performance of early twentieth-century English forensic pathology, *Medical History*, 55, 41-60.

Burnstein, J., & Braunstein, G. D. (1995). Urine pregnancy tests from antiquity to the present, *Early Pregnancy: Biology and Medicine*, 1, 288-296.

Bury, V. (1953). African clawed frog (*Xenopus laevis*). *Water Life and Aquaria World*, June, 145.

Butt, W. R. (1963). Immunological pregnancy tests, *Lancet*, 21 December, 331-332.

Bynum, W. F. (ed.) (2006). *The western medical tradition: 1800 to 2000*, Cambridge: Cambridge University Press.

Calder, A. B. (1906). *Questions and answers on midwifery for midwives*, 2nd ed. London: Ballière.

Cambrosio, A., & Keating, P. (1995). *Exquisite specificity: Monoclonal antibody revolution*, Oxford: Oxford University Press.

Cameron, A. T. (1936). *Recent advances in endocrinology*, 3th ed., London: Churchill.

Cameron, G. D. W. (1945). The organization of laboratory services: Observations from a recent visit to Britain, *Canadian Journal of Public Health*, 36, 58-64.

Cameron, S. B. (1948). *Moses in the laboratory*, 66, 488-490.

Cameron, S. J., McLellan, A. N., Lennie, R. A., & Hewitt, J. (1924). *A Glasgow manual of obstetrics*, London: Arnold.

Campion, S. (1950). *National baby*, London: Ernest Benn.

Cantor, D. (2008). *Cancer in the twentieth century*, Baltimore, MD: Johns Hopkins University Press.

Capel, L. (1958). Morning sickness, *Family Doctor*, June, 382.

Casper, M. J., & Clarke, A. E. (1998). Making the Pap smear into the 'right tool' for the job. *Social Studies of Science*, 28, 255-290.

Cederqvist, L. L., & Fuchs, F. (1970). Antenatal sex determination: A historical review, *Clinical Obstetrics & Gynecology*, 13, 159-177.

Cesarani, D., & Kushner, T. (1993). *Internment of aliens in twentieth century Britain*, London: Frank Cass.

Charpa, U., & Deichmann, U. (eds.), *Jews and sciences in German contexts: Case studies from the 19th and 20th centuries*, Tübingen: Mohr Siebeck.

Chen, W. (1992). The laboratory as business: Sir Almroth Wright's vaccine programme and the construction of penicillin. In A. Cunningham & P. Williams (eds.), *The laboratory revolution in medicine* (pp. 245-297), Cambridge: Cambridge University Press.

Childerhose, J. E., & MacDonald, M. E. (2013). Health consumption as work: The home pregnancy test as a domesticated health tool, *Social Science & Medicine*, 86, 1-8.

Chisolm, A. E. (1930). Diagnosis in gynaecology. *Practitioner*, 124, 561-569.

Church, R. & Tansey, E. M. (2007). *Burroughs Wellcome & Co. Knowledge, trust, profit and the transformation of the British pharmaceutical industry, 1880-1940*, Lancaster: Crucible.

Cianfrani, T. (1960). *A short history of obstetrics and gynecology*. Springfield, IL: Charles C. Thomas.

Claire Rayner (1966). Pregnancy testing, *New Statesman*, 1 April, 466.

Clarke, A. E. (1987). Research materials and reproductive science in the United States, 1910-1940. In G. L. Geison (ed.), *Physiology in the American context, 1850-1940* (pp. 323-350), Baltimore, MD: American Physiological Society.

Clarke, A. E. (1998). *Disciplining reproduction: Modernity, American life sciences, and 'the problems of sex'*, Berkeley: University of California Press.

Clarke, A. E. (2000) Maverick reproductive scientists and the production of contraceptives, 1915-2000+. In A. Saetnan, N. Oudshoorn, & M. Kirejczyk (eds.), *Bodies of technology: Women's involvement with reproductive medicine* (pp. 37-89), Columbus: Ohio State University Press.

Clarke, A. E. (2007). Reflections on the reproductive sciences in agriculture in the UK and US, ca. 1900-2000+. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 38, 316-339.

Clarke, A. E., & Casper, M. J. (1996). From simple technology to complex arena: Classification of Pap smears, 1917-90, *Medical Anthropology Quarterly*, 10, 601-623.

Clarke, P. (1970). Hogben test's last croak, *Guardian*, 7 February, 18.

Claye, A. M. (1936). Haemorrhage in early pregnancy, *Clinical Journal*, 65, 309-314.

Clifton, T. (1967). The tube drops an advert, *Sunday Times*, 20 August.

Cockburn, J. S. (1972). *A history of English assizes, 1558-1714*, Cambridge: Cambridge University Press.

Colls, R. (2013). *George Orwell: English rebel*, Oxford: Oxford University Press.

Coen, D. R. (2006). Living precisely in fin-de-siècle Vienna, *Journal of the History of Biology*, 39, 493–523.

Collins, H. M. (1985). *Changing order: Replication and induction in scientific practice*, London: Sage.

Collins, K. E. (1988). *Go and learn: The international story of Jews and medicine in Scotland*, Aberdeen: Aberdeen University Press.

Collins, K. (2009). European refugee physicians in Scotland, 1933-1945, *Social History of Medicine*, 22, 513-553.

Colpus, E. (2011). *The week's good cause*: Mass culture and cultures of philanthropy at the inter-war BBC, *Twentieth Century British History*, 22, 305-329.

Comrie, J. D. (1931). *Woman's Own home doctor*, London: George Newnes.

Conboy, (2006). *Tabloid Britain: Constructing a community through language*, London: Routledge.

Connolly, E. (1966). A woman's right to know, *Daily Sketch*, 5 May.

Cook, H. (2004). *The long sexual revolution: English women, sex, and contraception 1800-1975*, Oxford: Oxford University Press.

Cook, H. J. (1986). *The decline of the old medical regime in Stuart London*, Ithaca, NY: Cornell University Press.

Cooley, D. G. (1952). How good are pregnancy tests? *Household*, January, 11, 34, 36, 60.

Cooper, J. E. (1989). The guiding hand...foundations of lower vertebrate pathology. The first Edward Elkan Memorial Lecture, *Herpetopathologia*, 1, 1-4.

Cooter, R. (2004). The rise and decline of the medical members: Doctors and parliament in Edwardian and interwar Britain, *Bulletin of the History of Medicine*, 78, 59-107.

Cooter, R., & Stein, C. (2013). *Writing history in the age of biomedicine*, New Haven, CT: Yale University Press.

Coopey, R., O'Connell, S., & Porter, D. (1999). Mail order in the United Kingdom *c*.1880-1960: How mail order competed with other forms of retailing, *International Review of Retail, Distribution and Consumer Research*, 9, 261-273.

Coopey, R., O'Connell, S., & Porter, D. (2005). *Mail order retailing in Britain: A business and social history*, Oxford: Oxford University Press.

Cowie, A. T. (1948). *Pregnancy diagnosis tests: A review*, Edinburgh: Commonwealth Bureau of Animal Breeding and Genetics.

Cox, G. M. (1933). *The woman's book of health: A complete guide to physical well-being*, London: C. Arthur Pearson.

CRA. (1929). *The practitioner's guide to clinical research: A review of recent advances, followed by alphabetically arranged general sections*, London: Clinical Research Association.

Craft, I. (1975). Specialized futures: Essays in honour of Sir George Godber, G.C.B., London: Oxford University Press.

Cramer, W. (1930). The metabolism of the trophoblast. In British Empire Cancer Campaign (ed.), *Studies on the diagnosis and nature of cancer* (pp. 125-134). Bristol: Wright.

Creager, A. N. H. (2008). Molecular surveillance: A history of radioimmunoassays. In K. Kroker, J. Keelan, & P. M. H. Mazumdar (eds.), *Crafting immunity: Working histories of clinical immunology* (pp. 201-230), Burlington, VT: Ashgate.

Crenner, C. (2006). Private laboratories and medical expertise in Boston circa 1900. In C. Timmermann & J. Anderson (eds.), *Devices and designs: Medical technologies in historical perspectives* (pp. 61-73), Basingstoke: Palgrave Macmillan.

Crew, F. A. E. (1929a). Biological diagnosis of pregnancy, *Lancet*, *213*, 688.

Crew, F. A. E. (1929b). Diagnosis of early pregnancy, *BMJ*, *1*, 633.

Crew, F. A. E. (1930). Pregnancy diagnosis station: Report on first year's working, *BMJ*, 1, 662-664.

Crew, F. A. E. (1934). Pregnancy diagnosis station, *BMJ*, 2, 531.

Crew, F. A. E. (1936). Laboratory tests for early diagnosis of pregnancy, *BMJ*, 28 *November*, 1092-1094.

Crew, F. A. E. (1936a). Notes from a pregnancy diagnosis laboratory (1935), *BMJ*, 1, 993-996.

Crew, F. A. E. (1936b). The endocrines in theory and practice: Laboratory tests for the early diagnosis of pregnancy, *BMJ*, 2, 1092-1094.

Crew, F. A. E. (1937a). Early diagnosis of pregnancy. *BMJ*, 20 November, 1044.

Crew, F. A. E. (1937b). Notes from a pregnancy diagnosis laboratory (1936). *American Journal of Obstetrics and Gynecology*, 33, 989-999.

Crew, F. A. E. (1939). Biological pregnancy diagnosis tests: A comparison of the rabbit, the mouse, and the 'clawed toad' (*Xenopus laevis*) as the experimental animal, *BMJ*, 1, 766-770.

Crew, F. A. E. (1971). The genealogy of the poultry research centre, Edinburgh. *British Poultry Science*, 12, 289-295.

Cruickshank, R. (1962). Forward. In W. A. R. Thomson (ed.), *Calling the laboratory* (vii-viii), Edinburgh: Livingstone.

Cunningham, G. J. (1992). *History of British pathology*. Bristol: White Tree Books.

Cunningham, A., & Williams, P. (1992). Introduction. In A. Cunningham & P. Williams (eds.), *The laboratory revolution in medicine* (pp. 1-13), Cambridge: Cambridge University Press.

D'Antonio, A. (2008). Shopping for the Ballin Baby: Infant food and maternal authority in *Baby* magazine, *Nineteenth-Century Gender Studies*, 4.1, http://www.ncgsjournal.com/issue41/antonio.htm.

Dakin, W. R. (1897). *A handbook of midwifery*, London: Longmans, Green.

Daniel, F. (1925). *The expectant mother*, London: C. W. Daniel.

Davidson, A. (1948). Public health in Britain: The changing science, *American Journal of Public Health and the Nation's Health*, 38, 319-324.

Davidson, H. A. (1949). Male subfertility: Interim report of 3,182 cases, *BMJ*, 10 December, 1328-1332.

Davidson, H. A. (1953). Family planning: The past and the future, *Eugenics Review*, 44, 202-204.

Davies, M. L. (1978). *Maternity: Letters from working-women collected by the Women's Co-operative Guild*, London: Virago (first published 1915).

Davin, A. (1978). Imperialism and motherhood, *History Workshop*, 5, 9-65.

Davin, D. (2014). 'Using commercial pregnancy test in the 1960s', personal communication, 19 January 2014.

Davis, A. (1963). A single-injection pregnancy test, *Practitioner*, 191, 70-71.

Davis, A. (2012). *Modern motherhood: Women and family in England, 1945-2000*., Manchester: Manchester University Press.

Davis, G. (2008). *'The cruel madness of love': Sex syphilis and psychiatry in Scotland, 1880-1930*, Amsterdam: Rodopi.

Davis, G. (2013). Test tubes and turpitude: Medical responses to the infertile patient in mid-twentieth-century Scotland. In J. Greenlees & L. Bryder (eds.), *Western maternity and medicine, 1880-1990* (pp. 113-127), London: Pickering & Chatto.

Davis, G., and Davidson, R. (2006). 'A fifth freedom' or 'hideous atheistic expediency'? The medical community and abortion law reform in Scotland, *c*.1960-1975, *Medical History*, 50, 29-48.

de Chaderevian, S. (2002). *Designs for life: Molecular biology after World War II.* Cambridge: Cambridge University Press.

de Chaderevian, S. (2006). Mice and the reactor: The 'genetics experiment' in 1950s Britain, *Journal of the History of Biology*, 39, 707-735.

de Chaderevian, S. (2011). The making of an entrepreneurial science: Biotechnology in Britain, 1975-1995, *Isis*, 102, 601-633.

Deacon, M. (c.1971). 'The Institute of Animal Genetics at Edinburgh: The first twenty years', unpublished typescript copy, Edinburgh University Library Special Collections (Reference Code: GB 237 Coll-1057/2/5).

Deeson, T. (1995). *Parke-Davis in Britain: The first hundred years,* Eastleigh: Parke-Davis & Co.

Deichmann, U. (2007). 'I detest his way of working': Leonor Michaelis (1875-1949), Emil Abderhalden (1877-1950) and Jewish and non-Jewish biochemists in Germany. In U. Charpa & U. Deichmann (eds.), *Jews and sciences in German contexts: Case studies from the 19th and 20th centuries* (pp. 101-126), Tübingen: Mohr Siebeck.

Deichmann, U., & B. Müller-Hill (1998). The fraud of Abderhalden's enzymes, *Nature*, 393, 109-11.

Deschampsneufs, P. (1967). Tube and rail differ on pregnancy posters, *Sunday Times*, 22 October.

Dick-Read, G. (1942). *Revelation of childbirth: The principles and practice of natural childbirth*, London: Heinemann.

Digby, A. (1994). *Making a medical living: Doctors and patients in the English market for medicine, 1720-1911*, Cambridge: Cambridge University Press.

Digby, A., & Bosanquet, N. (1988). Doctors and patients in an era of national health insurance and private practice, 1913–1938, *Economic History Review*, 41, 74-94.

Dingwall, H. M. (2003). *A history of Scottish medicine: Themes and influences*, Edinburgh: Edinburgh University Press.

Dodd, P. H. (1914). *Chavasse's advice to a wife: On the management of her own health and on the treatment of some of the complaints incidental to pregnancy, labour, and suckling*, 16th ed. London: Churchill.

Dodds, G. H. (1930). Value of the bromine test for diagnosis of pregnancy, *BMJ*, 1, 948-949.

Dodds, G. H. (1931). Rapid laboratory test for pregnancy, *BMJ*, 2, 700-701.

Dodds, G. H. (1936). The Visscher-Bowman test for pregnancy. *BMJ*, 2, 224-225.

Donaldson, M., Cade, S., Harmer, W. D., Ward, R. O., & Edwards, A. T. (1936). *The early diagnosis of malignant disease for the use of general practitioners*, London: Oxford University Press.

Dopson, L. (1971). *The changing scene in general practice*, London: Johnson.

Dorland, W. A. N., & Hubeny, M. J. (1926). *The X-ray in embryology and obstetrics*, London: Henry Kimpton.

Dose, R. (2003). The World League for Sexual Reform: Some possible approaches, *Journal of the History of Sexuality*, 12, 1-15.

Doublilet, P. M. (2005). Entertainment ultrasound, *Journal of Ultrasound in Medicine*, 24, 251-253.

Douglas, C., & McKinlay, P. L. (1935). *Report on maternal morbidity and mortality in Scotland*, Edinburgh: Department of Health for Scotland.

Dry, S. (2006). The population as patient: Alice Stewart and the controversy over low-level radiation in the 1950s. In T. Schlich & U. Tröhler (eds.), *The risks of medical innovation: Risk perception and assessment in historical context* (pp. 108-122), New York: Routledge.

Dubow, S. (1995). *Scientific racism in modern South Africa*, Cambridge: Cambridge University Press.

Dubow, S. (2011). *Ourselves unborn: A history of the fetus in modern*, Oxford: Oxford University Press.

Dubowitz, V. (1962). Virilisation and malformation of a female infant, *Lancet*, 25 August, 405-406.

Dubowitz, V. (2005). *Ramblings of a peripatetic paediatrician: Victor Dubowitz*, Stanhope: Memoir Club.

Duden, B. (1991). *The woman beneath the skin: A doctor's patients in eighteenth-century Germany*, Cambridge, MA: Harvard University Press.

Duden, B. (1992). Quick with child: An experience that has lost its status, *Technology in Society*, *14*, 335–344.

Duden, B. (1993). *Disembodying women: Perspectives on pregnancy and the unborn*, Cambridge, MA: Harvard University Press.

Dukes, C. (1936). Clinical examination of the urine, *Practitioner*, 137, 900-905.

Dukes, C. E. (1939). *Urine: Examination and clinical interpretation*, London: Oxford University Press.

Duncan, M. N. S. (1952). The general practitioner and the laboratory service, *Lancet*, 23 August, 379-380.

Dunn, C. L. (1952) *The Emergency Medical Services, 2 Vols.*, London: HMSO.

Dunn, C. L. (1953) *The Emergency Medical Services, Volume II*, London: HMSO.

Dupree, M. W. (1997). Other than healing: Medical practitioners and the business of life assurance during the nineteenth and early twentieth centuries, *Social History of Medicine*, 10, 79-103.

Dyke, S. C. (1946). Clinical pathology in the hospital surveys, *BMJ*, 2, 95-96.

Eckstein, P., Waterhouse, J. A. H., Bond, G. M., Mills, W. G., Sandilands, D. M., Shotton, D. M. (1961). The Birmingham oral contraceptive trial, *BMJ*, 4 November, 1172-1179.

Eden, T. W. (1897). The diagnosis of early pregnancy, *American Journal of the Medical Sciences*, 114, 629-745.

Eden, T. W. (1906). *A manual of midwifery*, London: Churchill.

Eden, T. W. (1919). *A manual of midwifery*, 5th ed., London: Churchill.

Eder, S. (2010). The volatility of sex: Intersexuality, gender and clinical practice in the 1950s, *Gender & History*, 22, 692-707.

Edgerton, D. (1999). From innovation to use: Ten eclectic theses on the historiography of technology. *History and Technology*, 16, 111-136.

Edgerton, D. (2006). *The shock of the old: Technology and global history since 1900*, London: Profile.

Edgerton, D. (2010). Innovation, technology, or history: What is the historiography of technology about? *Technology and Culture*, 51, 680–697.

Edgerton, D. (2012). Time, money, and history, *Isis*, 103, 316-327.

Edwards, R., & Steptoe, P. (1980). *A matter of life: The story of a medical breakthrough*, New York: William Morrow.

Elkan, E. (1938a). The *Xenopus* pregnancy test, *Practitioner*, March, 312-315.

Elkan, E. (1938b), The *Xenopus* pregnancy test, *BMJ*, 17 December, 1253-1256.

Elkan, E. (1939a). L'epreuve de Grossesse *Xenopus*, *Presse Médicale*, *25 February*, 308.

Elkan, E. (1939b). Biological pregnancy diagnosis tests, *BMJ*, 29 April, 899-900.

Elkan, E. (1939c). *Xenopus laevis*, Daudin, *Aquarist and Pondkeeper*, 19 May, 95-100.

Elkan, E. (1940). Pregnancy tests in war-time, *Lancet*, 30 November, 697.

Elkan, E. (1946a). A new test for pregnancy, *Postgraduate Medical Journal*, 22, 87-93.

Elkan, E. (1946b). The *Xenopus laevis* pregnancy test, *Human Fertility*, December, 103-108.

Elkan, E. (1947a). *Xenopus laevis* Daudin. In A. N. Worden (ed.), *The UFAW handbook on the care and management of laboratory animals* (pp. 251-262), London: Baillière.

Elkan, E. (1947b). A useful pregnancy test, *Marriage Hygiene*, 1, 104-105.

Elkan, E. (1960). Some interesting pathological cases in amphibians, *Proceedings of the Zoological Society of London*, 134, 274-296.

Elkan, E. (1983). *Sketches from my life*, unpublished memoirs.

Elliot, R. (2014). Miscarriage, abortion or criminal feticide: Understandings of early pregnancy loss in Britain, 1900-1950. *Studies in History and Philosophy of Biological and Biomedical Sciences*, http://dx.doi.org/10.1016/j.shpsc.2014.02.002.

Elston, M. A. (1987). Women and anti-vivisection in Victorian England, 1870-1900. In N. A. Rupke (ed.), *Vivisection in historical perspective* (pp. 259-93), London: Croom Helm.

Emin, T. (2005). *Strangeland*, London: Sceptre.

Ennis, J. E. (1963). Immunological pregnancy tests, *Lancet*, 28 December, 1379.

Eraso, Y. (2007). Biotypology, endocrinology, and sterilization: The practice of eugenics in the treatment of Argentinian women during the 1930s, *Bulletin of the History of Medicine*, 81, 793-822.

Erlingsson, S. J. (2009a). The costs of being a restless intellect: Julian Huxley's popular and scientific career in the 1920s, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 40, 101-108

Erlingsson, S. J. (2009b). The Plymouth Laboratory and the institutionalization of experimental zoology in Britain in the 1920s, *Journal of the History of Biology*, 42, 151-183.

Erskine, C. G. (1929). *Why be childless?* London: Christophers.

Evans, B. (1984). *Freedom to choose: The life and work of Dr Helena Wright, pioneer of contraception*, London: Bodley Head.

Falconer, D. (1993). Quantitative genetics in Edinburgh: 1947-1980, *Genetics*, 133, 137-142.

Ferguson, M. (1998). *Animal advocacy and Englishwomen, 1780-1900: Patriots, nation, and empire*, Ann Arbor, MI: University of Michigan Press.

Ferreira, H. P. (1954). The relative merits of the various biological tests for pregnancy, *Postgraduate Medical Journal*, 30, 355-369.

Feudtner, J. C. (2003). *Bittersweet: Diabetes, insulin, and the transformation of illness*, Chapel Hill, NC: University of North Carolina Press.

Fine, J. (1939). Laboratory tests for pregnancy, *Nursing Mirror*, 15 April, 91-92.

Finkelstein, M., & Zondek, B. (1966). Professor Bernhard Zondek: An interview, *Journal of Reproduction and Fertility*, 12, 3-19.

Fisher, K. (1998). Women's experience of abortion before the 1967 Act. In E. Lee (ed.), *Abortion, law and politics today* (pp. 27-42), Basingstoke: Macmillan Press.

Fisher, K. (1999). 'Didn't stop to think, I just didn't want another one': The culture of abortion in interwar South Wales. In F. X. Eder, L. A. Hall, & G. Hekma (eds.), *Sexual cultures in Europe: Themes in sexuality* (pp. 213-232), Manchester: Manchester University Press.

Fisher, K. (2006). *Birth control, sex, and marriage in Britain, 1918-1960*, Oxford: Oxford University Press.

Fissell, M. E. (2003). Making a masterpiece: The Aristotle texts in vernacular medical culture. In C. E. Rosenberg (ed.), *Right living: An Anglo-American tradition of self-help medicine and hygiene* (pp. 59-87), Baltimore, MD: Johns Hopkins University Press.

Fleck, L. (1979). *Genesis and development of a scientific fact* (F. Bradley, & T. J. Trenn, Trans). Chicago: University of Chicago Press (first published 1935).

Fleming, J. B. (1966). Montgomery and the follicles of the areola as a sign of pregnancy (1837), *Irish Journal of Medical Science*, 6, 169-182.

Florence, L. S. (1956). *Progress report on birth control*, London: Heinemann.

Forbes, R. (1948). *Sixty years of medical defence*, London: Medical Defence Union.

Forbes, T. R. (1957). Early pregnancy and fertility tests, *Yale Journal of Biology and Medicine*, 30, 16-29.

Forbes, T. R. (1988). A Jury of matrons, *Medical History*, 31, 23-33.

Ford, R. K. (1935). *A short ante-natal and post-natal handbook*, London: Oxford University Press.

Forster, D. H. (1959). Early diagnosis of pregnancy, *Lancet*, 29 August, 242.

Foster, W. D. (1961). *A short history of clinical pathology*, Edinburgh: Livingstone.

Foster, W. D. (1983). *Pathology as a profession in Great Britain and the early history of the Royal College of Pathologists*, London: Royal College of Pathologists.

Fothergill, W. E. (1900). *Manual of midwifery*, 2nd ed., Edinburgh: William F. Clay.

Fothergill, W. E. (1907). *A course of lectures to midwives and maternity nurses*, Edinburgh: Green.

Frank, R. T. (1929). *Female sex hormone*, London: Ballière.

Frankau, P. (1939). *The devil we know*, London: Heinemann.

Franklin, S. (1997). *Embodied progress: A cultural account of assisted conception*, New York, Routledge.

Franklin, S. (2013). *Biological relatives: IVF, stem cells, and the future of kinship*, Durham, NC: Duke University Press.

Franklin, S., & Roberts, C. (2006). *Born and made: An ethnography of preimplantation genetic diagnosis*, Princeton, NJ: Princeton University Press.

Frazer, J. F. D. (1950). The use of amphibia in pregnancy tests: A review, *British Journal of Herpetology*, 1, 84.

Frazer, J. F. D., & Wohlzogen, F. X. (1949). Male-toad pregnancy test. *Lancet*, 2, 134.

Frazer, J. F. D., & Wohlzogen, F. X. (1950). Use of the male British toad as a pregnancy test animal, *BMJ*, 5 August 1950, 330-331.

Friedman, M. H., & Lapham, M. E. (1931). A simple, rapid procedure for the laboratory diagnosis of early pregnancies, *American Journal of Obstetrics and Gynecology*, 21, 405-410.

Fulthorpe, A. J., Park, J. A. C., Tovey, J. E., & Monckton, J. C. (1963). Pregnancy diagnosis by a one-stage passive haemagglutination inhibition method, *BMJ*, 20 April, 1049-1054.

Galabin, A. L. (1900). *A manual of midwifery*, 5th ed., London: Churchill.

Galabin, A. L., & G. Blacker (1910). *The practice of midwifery*, 7th ed., London: Churchill.

Galli Mainini, C. (1947a). Reacción diagnóstica de embarazo en la que se usa el sapo macho como animal reactivo, *Semana Médica*, 54, 337-340.

Galli Mainini, C. (1947b). Pregnancy test using the male toad. *Journal of Clinical Endocrinology*, 7, 653-658.

Galli Mainini, C. (1948a). *El diagnostico del embarazo con batracios machos*, Buenos-Aires: Editorial Impaglione.

Galli Mainini, C. (1948b). Pregnancy test using the male batrachian, *JAMA*, 138, 121-125.

Galli Mainini, C. (1948c). Pregnancy test with the male batrachian, *Endocrinology*, 43, 349-350.

Gallwey, A. (2013). The rewards of using archived oral histories in research: The case of the Millennium Memory Bank, *Oral History Society Journal*, 41, 37-50.

Garden, N. R., Miller, H., & Durant, J. A. (1963). Serological pregnancy test using latex particles: An assessment of its reliability and convenience, *BMJ*, 24 August, 480-483.

Gardiner, J. (2010). *The thirties: An intimate history*, London: HarperPress.

Gaudillière, J.-P. (2001). The pharmaceutical industry in the biotech century: Toward a history of science, technology and business? *Studies in History and Philosophy of Biological and Biomedical Sciences*, 32, 191-201.

Gaudillière, J.-P. (2002). *Inventer la biomédecine: la France, l'Amérique et la production des savoirs du vivant (1945-1965)*, Paris: Découverte.

Gaudillière, J.-P. (2005). Better prepared than synthesized: Adolf Butenandt, Schering Ag and the transformation of sex steroids into drugs (1930-1946), *Studies in History and Philosophy of Biological and Biomedical Sciences*, 36, 612-644.

Gaudillière, J.-P. (2006). Hormones at risk: Cancer and the medical uses of industrially-produced sex hormones in Germany, 1930-1960. In T. Schlich & U.

Tröhler (eds.), *The risks of medical innovation: Risk perception and assessment in historical context* (pp. 136-154), New York: Routledge.

Gaudillière, J.-P. (2010). The visible industrialist: Standards and the manufacture of sex hormones. In C. Gradmann & J. Simon (eds.), *Evaluating and standardizing therapeutic agents, 1890-1950* (pp. 174–201), Houndmills: Palgrave Macmillan.

Gavronsky, J. O. (1915). Results of clinical investigations based on the methods of Abderhalden. *Lancet*, 16 January, 119-123.

Gavronsky, J. O. (1918). The Abderhalden reaction, *Lancet*, 14 December, 830.

Geoghegan, J., & McGrath, F. (1944). Experience with the Hogben test, *Irish Journal of Medical Science*, 19, 509-516.

Geppert, A. C. T. (1998). Divine sex, happy marriage, regenerated marriage: Marie Stopes's marital manual *Married Love* and the making of a best-seller, 1918-1955. *Journal of the History of Sexuality*, 8, 389-433.

Gerritsma, K. W. (1980). Emeritaat Professor Polderman, *Pharmaceutisch Weekblad*, 2, 82-85.

Gevers, W. (1998). Henri (Harry) Zwarenstein 1900-1905, *Transactions of the Royal Society of South Africa*, 52, 433-434

Giaimo, S. (2005). *Markets and medicine: The politics of health care reform in Britain, Germany, and the United States*, Ann Arbor: University of Michigan Press.

Gill, A. M., & Howkins, J. (1937). The Antuitrin S intradermal pregnancy test, *BMJ*, 2, 1069.

Gladstone Smith, P. (1996). Pregnancy tests, *Sunday Telegraph*, 27 March.

Glaister, J. (1910). *Text-book of medical jurisprudence and toxicology*, 2nd ed., Edinburgh: Livingstone.

Glasson, C. J. (1901). *Motherhood*, London: John Bale, Sons & Danielsson.

Glover, T. A. (1900). *Midwifery notes: For the use of students*, Edinburgh: Livingstone.

Glucksman, M. (1990). *Women assemble: Women workers and the new industries in inter-war Britain*, London: Routledge.

Gooday, G. (2008). Placing or replacing the laboratory in the history of science? *Isis*, 99, 783-795.

Gordon, B. M. (2012). Reinventions of a spa town: The unique case of Vichy, *Journal of Tourism History*, 4, 35-55.

Gorsky, M. (2004). 'Threshold of a new era': The development of an integrated hospital system in Northeast Scotland, 1900-39, *Social History of Medicine*, 17, 247-267.

Gorsky, M. (2008). The British National Health Service, 1948-2008: A review of the historiography, *Social History of Medicine*, 21, 437-460.

Gottlieb, R. (1936). The bitterling test for pregnancy, *Canadian Medical Association Journal*, April, 431-432.

Gradmann, C. & Simon, J. (eds.) (2010). *Evaluating and standardizing therapeutic agents, 1890-1950*, Houndmills: Palgrave Macmillan.

Greaves, R. I. N. (1968). Serum-plasma preservation: Historical review, *Cryobiology*, 5, 76-86.

Green, K. (1991). Shaping technologies and shaping markets: creating demand for biotechnology, *Technology Analysis & Strategic Management*, 3, 57-76.

Green, N., & Platt, L. D. (2005). Nonmedical use of ultrasound: Greater harm than good? *Journal of Ultrasound in Medicine*, 24, 123-125.

Green-Armytage, V. B. (1934). Obstetrical regrets, *Clinical Journal*, 63, 53-59.

Greene, G. (1999). *The woman who knew too much: Alice Stewart and the secrets of radiation*, Ann Arbor, MI: University of Michigan Press.

Greenfield, J., & C. Reid (1998). Women's magazines and the commercial orchestration of feminity in the 1930s: Evidence from *Woman's Own*, *Media History*, 4, 161-174.

Greer, G. (1984). *Sex and destiny: The politics of human fertility*, London: Secker & Warburg.

Gregg, R. (1995). *Pregnancy in a high-tech age: Paradoxes of choice*, New York: New York University Press.

Grey, D. J. R. (2013). 'What woman is safe...?': Coerced medical examinations, suspected infanticide, and the response of the women's movement in Britain, 1871-1881, *Woman's History Review*, 22, 403-421.

Grier, K. C. (2006). *Pets in America: A history*, Chapel Hill, NC: University of North Carolina Pres.

Griffith, E. F. (1939). *The childless family: Its cause and cure*, London: Kegan Paul.

Griffiths, J. (1997). Creating, transmitting, and transforming a corporate culture in a public sector enterprise: The General Post Office, 1920-1990, *Business and Economic History*, 26, 676-685.

Grigg, J. (1995). *The history of the Times, Vol. 6, The Thomson years, 1966-1981*, London: Harper Collins.

Grob, P. R., B. T. Manners, J. A. B. Weston & J. F. Gibbs (1968). A clinical trial of a slide pregnancy test in general practice, *Practitioner*, November, 811-815.

Grossmann, A. (1995). *Reforming sex: The German movement for birth control and abortion reform, 1920-1950*, Oxford: Oxford University Press.

Gunn, J. W. C. (1939a). *Xenopus* test for pregnancy, *BMJ*, 17 June, 1258.

Gunn, J. W. C. (1939b). *Xenopus* test for pregnancy, *BMJ*, 9 September, 580.

Gurdon, J. B., & Hopwood, N. (2000). The introduction of *Xenopus laevis* into developmental biology: Of empire, pregnancy testing and ribosomal genes, *International Journal of Developmental Biology*, 44, 43-50.

Ha, N. Q. (2011b). The riddle of sex: Biological theories of sexual difference in the early twentieth-century, *Journal of the History of Biology*, 44, 505-546.

Haarburger, D., & Pillay. T. S. (2011). Historical perspectives in diagnostic clinical pathology: Development of the pregnancy test, *Journal of Clinical Pathology*, 64, 546-548.

Hackney, F. (2007). 'They opened up a whole new world': Narrative, text and image in British women's magazines in the 1930s, *Working Papers on Design*, 2, 1-24. http://www.herts.ac.uk/__data/assets/pdf_file/0013/12325/WPD_vol2_hackney.pdf

Hackney, F. (2008). 'Women are news': British women's magazines 1919-1939. In A. Ardis & P. Collier (eds.), *Transatlantic print culture, 1880-1940: Emerging media, emerging modernisms*, New York: Palgrave Macmillan.

Haines, M. (1948b). The male-toad test for pregnancy, *Lancet*, 252, 923-926.

Hajo, C. M. (2010). *Birth control on main street: Organizing clinics in the United States, 1916-1939*, Urbana: University of Illinois Press.

Hall, B. K. (1992). Waddington's legacy in development and evolution, *American Zoologist*, 32, 113-122.

Hall, L. A. (2000). 'Not a domestic utensil but a woman and a citizen': Stella Browne on women, health and society, *Clio Medica*, 60, 275-302.

Hall, L. A. (2011). *The life and times of Stella Browne: Feminist and free spirit*, London: I. B. Tauris.

Hall, L. A. (2013). *Sex, gender, and social change in Britain since 1880*, 2nd ed., New York: Palgrave Macmillan.

Hall, R. (ed.) (1978). *Dear Dr Stopes: Sex in the 1920s*, London: Deutsch.

Hey, D. (1949). A report on the culture of the South African clawed frog *Xenopus laevis* (Daudin) at the Jonkershoek inland fish hatchery, *Transactions of the Royal Society of South Africa*, 32, 45-54.

Hey, D. (1977). *Water: Source of life*, Oxford: Oxford University Press.

Hamera, J. (2012). *Parlor ponds: The cultural work of the American home aquarium, 1850-1970*, Ann Arbor: University of Michigan Press.

Hamilton, D. (1986). *The monkey gland affair*, London: Chatto & Windus.

Hamilton, D. (2003). *The healers: A history of medicine in Scotland*, Edinburgh: Mercat Press.

Hammerborg, M. (2011). The laboratory and the clinic revisited: The introduction of laboratory medicine into the Bergen General Hospital, Norway, *Social History of Medicine*, 24, 758-775.

Han, S. (2013). *Pregnancy in practice: Expectations and experience in the contemporary US*, New York: Berghahn.

Hannan, J. H. (1930). The detection of the presence of the hormone of the anterior pituitary body in the urine as an aid to the diagnosis of pregnancy, *Proceedings of the Royal Society of Medicine*, 23, 634-639.

Hannan, J. H. (1933). Chorionic carcinoma, *BMJ*, 2, 1046-1047.

Hanson, C. (2004). *A cultural history of pregnancy: Pregnancy, medicine and culture, 1750-2000*, Basingstoke: Palgrave Macmillan.

Harding, T. S. (1931). *The degradation of science*, New York: Farrar & Rinehart.

Hardy, A. (2001). *Health and medicine in Britain since 1860*, Houndmills: Palgrave.

Hardyment, C. (1983). *Dream babies: Child care from Locke to Spock*, Oxford: Oxford University Press.

Harland, R. M., & Grainger, R. M. (2011). *Xenopus* research: Metamorphosed by genetics and genomics, *Trends in Genetics*, 27, 507-515.

Harrison, S., & McDonald, R. (2008). *The politics of healthcare in Britain*, London: Sage.

Haultain, W. F., & Fahmy, E. C. (1931). *Ante-natal care, including the abnormalities associated with pregnancy and a section on postnatal care*, Edinburgh: Livingstone.

Haywood, H. (1966a). Pregnancy testing, *New Statesman*, 25 March, 416.

Haywood, H. (1966b). Pregnancy testing, *New Statesman*, 8 April, 502.

Henriksen, E. (1941). Pregnancy tests of the past and present, *Western Journal of Surgical Obstetric Gynecology*, 85, 610-618.

Henry, J. B., & Little, W. A. Immunological test for pregnancy, *JAMA*, October 20, 230-233.

Herschkorn-Barnu, P. (2002). Wie der Fötus einen klinischen Status erhielt: Bedingungen und Verfahren der Produktion eines medizinischen Fachwissens, Paris 1832–1848. In B. Duden, J. Schlumbohm, & P. Veit (eds.), *Geschichte des Ungeborenen: Zur Erfahrungs- und Wissenschaftsgeschichte der Schwangerschaft, 17.–20. Jahrhundert* (pp. 167-203), Göttingen: Vandenhoeck & Ruprecht.

Higgins, G. L. & Sadler, W. R. (1960). A two-tablet oral pregnancy test, *Practitioner*, 185, 677-680.

Hilliard, C. (2006). *To exercise our Talents: The democratization of writing in Britain*, Cambridge, MA: Harvard University Press.

Hilton, M. (2003). *Consumerism in twentieth-century Britain: The search for a historical movement*, Cambridge: Cambridge University Press.

Hines, B. (1966). *The Blinder*, London: Joseph.

Hinz, A., Ebert, A., & Goetze, B. (1994). Der Exodus: Robert Meyer, Selmar Aschheim und Bernhard Zondek. In A. Ebert & H. K. Weitzel (eds.), *Die Berliner Gesellschaft für Geburtshilfe und Gynäkologie 1844-1994* (pp. 206-242), Berlin: Walter de Gruyter.

Hirst, J. C., & C. F. Long (1926). The early diagnosis of pregnancy by methods of precision: Further observations on sugar tolerance tests: Final report, *American Journal of the Medical Sciences*, 171, 846-853.

Hitchens, R. A. N., & Lowe, C. R. (1966). Laboratory services in general practice, *Medical Care*, 4, 142-149.

Hobson, B. M. (1952). Routine pregnancy diagnosis and quantitative estimation of chorionic gonadotrophin using female *Xenopus laevis*, *Journal of Obstetrics and Gynaecology of the British Empire*, 59, 352-362.

Hobson, B. M. (1959). Early diagnosis of pregnancy, *Lancet*, 19 September, 409.

Hobson, B. M. (1963a). A better test for pregnancy, *New Scientist*, 325, 309.

Hobson, B. M. (1963b). Immunological pregnancy tests, *BMJ*, 15 June, 1606-1607.

Hobson, B. M. (1963c). Latex tests for pregnancy, *BMJ*, 21 September, 749.

Hobson, B. M. (1963d). Immunological pregnancy tests, *BMJ*, 9 November, 1203.

Hobson, B. M. (1966). Review: Pregnancy diagnosis, *Journal of Reproduction and Fertility*, 12, 33-48.

Hobson, B. M. (1968). Pregnancy diagnosis using the Pregnosticon haemagglutination inhibition test, *Journal of Obstetrics and Gynaecology of the British Commonwealth*, 75, 718-723.

Hodge, A. E. (1927). *Tropical aquarium-fishes: How to breed and rear them. A practical guide for the amateur*, London: Witherby.

Hogben, A., & Hogben, A. (1998). *Lancelot Hogben: Scientific humanist. An unauthorised autobiography*, Rendlesham: Merlin Press.

Hogben, L. T. (1923). A method of hypophysectomy in adult frogs and toads. *Quarterly Journal of Experimental Physiology*, 13, 177-179.

Hogben, L. T. (1930). *Principles of animal biology*, London: Christophers.

Hogben, L. T. (1930). Some remarks on the relation of the pituitary gland to ovulation and skin secretion in *Xenopus laevis*, *Proceedings of the Royal Society of South Africa*, *19 March* (in *Transactions of the Royal Society of South Africa*, 22, pt. 2, xvii-xviii).

Hogben, L. T. (1939). *Xenopus* test for pregnancy, *BMJ*, 2, 38-39.

Hogben, L. T. (1946a). History of the Hogben test. *BMJ*, 12 October, 554.

Hogben, L. T. (1946b). The Hogben test. *BMJ*, 21 December, 962-963.

Hogben, L. T. (1974). Francis Albert Eley Crew, 1886-1973, *Biographical Memoirs of Fellows of the Royal Society*, 20, 135-153.

Hogben, L. T. (1974). Francis Albert Eley Crew, 1886-1973, *Biographical Memoirs of Fellows of the Royal Society*, 20, 135-153.

Hogben, L. T., & F. A. E. Crew (1923). Studies on internal secretion. II. Endocrine activity in foetal and embryonic life, *British Journal of Experimental Biology*, 1, 1-13.

Hogg, D. (1959). Withdrawal bleeding in diagnosis of pregnancy, *Practitioner*, 182, 612-614.

Hoggart, R. (1957). *The uses of literacy: Aspects of working-class life with special reference to publications and entertainments*, London: Penguin.

Holtby, W. (1936). *South Riding*, London: Collins.

Honigsbaum, F. (1989). *Health, happiness, and security: The creation of the National Health Service*, London: Routledge.

Hopwood, N. (1996). Producing a socialist popular science in the Weimar Republic, *History Workshop Journal*, 41, 117-153.

Hopwood, N. (2011). Approaches and species in the history of vertebrate embryology. In F. J. Pelegri (ed.), *Vertebrate embryogenesis: Methods in molecular biology*, 1-20.

Horder, T. J. (2008). A history of evo-devo in Britain: Theoretical ideals confront biological complexity. *Annals of the History and Philosophy of Biology*, 13, 101-174.

Howell, J. D. (1995). *Technology in the hospital: Transforming patient care in the early twentieth century*, Baltimore, MD: Johns Hopkins University Press.

Howkins, J. (1954). The management of spontaneous and threatened abortion, *Practitioner*, 173, 11-17.

Hull, A. (2007). Teamwork, clinical research, and the development of scientific medicine in interwar Britain: The 'Glasgow school' revisited, *Bulletin of the History of Medicine*, 81, 569-593.

Humble, N. (2001). *The feminine middlebrow novel, 1920s to 1950s: Class, domesticity, and Bohemianism*, Oxford: Oxford University Press.

Hume, M. C. W. (1947). Law and practice: The rights of laboratory animals. In A. N. Worden (ed.), *The UFAW handbook on the care and management of laboratory animals* (pp. 1-20), London: Baillière.

Hume, M. C. W. (1962). *Experiments on animals in Great Britain*, 2nd ed., London: UFAW.

Humphries, S. (1988). *A secret world of sex, forbidden fruit: The British experience, 1900-1950*, London: Sidgwick & Jackson.

Hüntelmann, A. C. (2013). A different mode of marketing? The importance of scientific articles in the marketing process of Salvarsan, *History and Technology*, 29, 116-134.

Hunter, G. (1922). Note on Knoop's test for histidine. *Biochemical Journal*, 16, 637-639.

Hurry, E. (1982). A laboratorian's view of pregnancy testing, *American Journal of Medical Technology*, 48, 971.

Hutt, F. B. (1931). The work of the Department of Animal Genetics of the University of Edinburgh, *Journal of Animal Science*, 1931, 102-105.

Huxley, J. S., & Hogben, L. (1922). Experiments on amphibian metamorphosis and pigment responses in relation to internal secretions, *Proceedings of the Royal Society of London, Series B*, 93, 36-53.

Hyams, E. (1963). *The New Statesman: The history of the first fifty years, 1913-1963*, London: Longmans.

Ingman, H. (1998). *Women's fiction between the wars: Mothers, daughters and writing*, Edinburgh: Edinburgh University Press.

Isherwood, C. (1937). *Sally Bowles*, London: Hogarth.

Jackson, M. (2013). *The age of stress: Science and the search for stability*, Oxford: Oxford University Press.

Jacyna, L. S. (2001). 'A host of experienced microscopists': The establishment of histology in nineteenth-century Edinburgh, *Bulletin of the History of Medicine*, 75, 225-253.

Jalland, P. (1988). *Women, marriage and politics 1860-1914*, Oxford: Clarendon.

Jardine, R. (1905). *Clinical obstetrics*, 2nd ed., London: Rebman.

Jaffé, G. V. (1960). Early diagnosis of pregnancy, *Lancet*, 19 March, 654.

Jeffree, G. M. (1953). The comparative sensitivity of the male toad pregnancy test and the Friedman test, *Journal of Clinical Pathology*, 6, 150-154.

Jeffries, L. M. (1935). Treatment of repeated abortion, *BMJ*, 1, 1265.

Jenkinson, J. (2002). *Scotland's health, 1919-1948*, New York: Peter Lang.

Jenkinson, J. (2012). A 'crutch to assist in gaining an honest living': Dispensary shopkeeping by Scottish general practitioners and the responses of the British medical elite, *ca*. 1852-1911, *Bulletin of the History of Medicine*, 86, 1-36.

Jenner, M. S. R., & Wallis, P. (2007). *Medicine and the market in England and its colonies, c.1450-c.1850*, Basingstoke: Palgrave Macmillan.

Jesse, F. T. (1934). *A pin to see the peep show*, London: Heinemann.

Johnson, D. K. (2010). Physique pioneers: The politics of 1960s gay consumer culture, *Journal of Social History*, 43, 867-892.

Johnson, M.H. (2011). Robert Edwards: The path to IVF. *Reproductive BioMedicine Online*, 23, 245-262.

Johnson, M. H., Franklin, S. B., Cottingham, M., & Hopwood, N. (2010). Why the Medical Research Council refused Robert Edwards and Patrick Steptoe support for research on human conception in 1971, *Human Reproduction*, 25, 2157-2174.

Johnstone, R. W. (1913). *A text-book of midwifery for students and practitioners*, London: Black.

Johnstone, R. W. (1923). *A text-book of midwifery for students and practitioners,* 4th ed., London: Black.

Johnstone, R. W. (1929a). Biological diagnosis of pregnancy, *Lancet*, 213, 306.

Johnstone, R. W. (1929b). Diagnosis of early pregnancy, *BMJ*, 1, 264.

Johnstone, R. W. (1930). The new physiology of menstruation and its practical implications in obstetrics and gynecology. The Joseph Price Foundation Lecture, *American Journal of Obstetrics and Gynecology*, 19, 167-180.

Johnstone, R. W. (1932). *A text-book of midwifery for students and practitioners*, 6th ed., London: Black.

Johnstone, R. W. (1933). Gynaecological aspects of endocrinology, *BMJ*, 2, 557-560.

Johnstone, R. W. (1934). *A text-book of midwifery for students and practitioners*, 7th ed., London: Black.

Johnstone, R. W. (1947). Ballantyne's ghost. *Transactions of the Edinburgh Obstetrical Society*, 54, 1-13.

Johnstone, R. W. (1954). The diagnosis of pregnancy. In J. M. Munro Kerr, R. W. Johnstone, & M. H. Phillips, *Historical review of British Obstetrics and Gynaecology, 1800-1950* (pp. 92-93), Edinburgh: Livingstone.

Johnstone, R. W., Wiesner, B. P., & Marshall, P. G. (1932). The therapeutic application of gonadotropic hormones, *Lancet*, 220, 509-511.

Johnstone, R.W. (1954). The diagnosis of pregnancy. In J. M. Munro Kerr, R. W. Johnstone, & M. H. Phillips (eds.), *Historical review of British obstetrics and gynaecology, 1800-1950* (pp. 92-93), Edinburgh: Livingstone.

Johnstone, R.W., & R. J. Kellar (1968). *A text-book of midwifery for students and practitioners*, 21st ed., London: Black.

Jones, E. L. (2011). Attitudes to abortion in the era of reform: Evidence from the Abortion Law Reform Association correspondence, *Women's History Review*, 20, 283-298.

Jones, G., & Kraft, A. (2004). Corporate venturing: The origins of Unilever's pregnancy test, *Business History*, 46, 100-122.

Jordan, B. (1977). The self-diagnosis of early pregnancy: An investigation of lay competence, *Medical Anthropology*, 2, 1-38.

Kaasch, M. (2000). Sensation, Irrtum, Betrug? Emil Abderhalden und die Geschichte der Abwehrfermente, *Acta Historica Leopoldina*, 36, 145-210.

Kahn, S. M. (2000). *Reproducing Jews: A cultural account of assisted conception in Israel*, Durham, NC: Duke University Press.

Kamnitzer, H., & Joseph, S. (1921a). Zur biologischen Diagnostik der Schwangerschaft, *Therapie der Gegenwart*, 62, 312-324.

Kamnitzer, H., & Joseph, S. (1921b). Zur Phloridzindiagnostik der Frühgravität, *Therapie der Gegenwart*, 62, 459-461.

Kanter, A. E., Bauer, C. P., Klawans, A. H. (1934). A new biologic test for hormones in pregnancy urine. Preliminary report, *Journal of the American Medical Association*, 29 December, 2026-2027.

Kapeller-Adler, R. (1933). Über eine neue Methode zur quantitativen Histidinbestimmung und über deren Anwendbarkeit zur Untersuchung von biologischen Flüssigkeiten, insbesondere von Gravidenharnen. *Biochemische Zeitschrift*, 264, 131-141.

Kavanah, J. (1999). The BBC's written archives as a source for media history, *Media History*, 5, 81-86.

Keating, J. (2009). *A child for keeps: The history of adoption in England, 1918-1945*, Basingstoke: Palgrave MacMillan.

Keating, P., & Cambrosio, C. (2003). *Biomedical platforms: Realigning the normal and the pathological in late-twentieth-century medicine*, Cambridge, MA: MIT Press.

Keevil, N. L. (1937). Antuitrin S intradermal pregnancy test, *BMJ*, 2, 1199.

Kemp, R. (1959). The friendly bufo bufo and his chums, *Family Doctor,* May, 280-281.

Kenton, R. J. (1959). Early diagnosis of pregnancy, *Lancet*, 19 September, 409-410.

Keown, J. (1988). *Abortion, doctors and the law: Some aspects of the legal regulation of abortion in England from 1803 to 1982*, Cambridge: Cambridge University Press.

Kerr, D. (1935). *Forensic medicine: A textbook for students and a guide for the practitioner*, London: Black, 1935.

Kevles, D. J. (1995). *In the name of eugenics: Genetics and the uses of human heredity*, New York: Alfred Knopf.

Kinchin, J., & O'Connor, A. (2011). *Counter space: Design and the modern kitchen*, New York: Museum of Modern Art.

King, H. (2007). *Midwifery, obstetrics and the rise of gynaecology: The uses of a sixteenth-century compendium*, Aldershot: Ashgate.

King, W. W. (1913). The serum reaction in pregnancy and cancer by the coagulation method, *Journal of Obstetrics and Gynaecology of the British Empire*, December, 296-303.

Kirk, R. G. W. (2008). 'Wanted—standard guinea pigs': Standardisation and the experimental animal market in Britain ca. 1919-1947, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 39, 280-291.

Kirk, R. G. W. (2009). Between the clinic and the laboratory: Ethology and pharmacology in the work of Michael Robin Alexander Chance, *c*.1946-1964. *Medical History*, 53, 513-536.

Kirk, R. G. W. (2010). A brave new animal for a brave new world: The British Laboratory Animals Bureau and the constitution of international standards of laboratory animal production and use, circa 1947-1968, *Isis*, 101, 62-94.

Klee, A. J. (2003). *The toy fish: A history of the aquarium hobby in America. The first one hundred years*, Pascoag, RI: Finley Aquatic Books.

Klein, R. (2010). *The new politics of the NHS: From creation to reinvention*, 6th ed., Oxford: Radcliffe.

Kleiner, I. S., Weisman, A. I., & Barowsky, H. (1935). An investigation of the new biologic test for hormones in pregnancy urine, *Journal of the American Medical Association*, 13 April, 1318-1319.

Klopper, A., & Frank, H. (1949). The use of English male toads in pregnancy tests, *Lancet*, 2 July, 9-11.

Kohler, R. E. (1982). *From medical chemistry to biochemistry: The making of a biomedical discipline*, Cambridge: Cambridge University Press.

Kohler, R. E. (1993). *Drosophila*: A life in the laboratory, *Journal of the History of Biology*, 26, 281-310.

Kohler, R. E. (1994). *Lords of the fly:* Drosophila *genetics and the experimental life*, Chicago: University of Chicago Press.

Kohler, R. E. (2008). Lab history, *Isis*, 99, 761-768.

Kozub, B. A. (2009). discussion of the conservation of 'SS-Hygiene Instituted documents in the archives of the Auschwitz-Birkenau State Museum, *Book and Paper Group Annual*, 28, 33-35.

Kracke, R. R. (1938). *Textbook of clinical pathology*, London: Baillière.

Kroker, K., Keelan, J., & Mazumdar, P. M. H. (2008), *Crafting immunity: Working histories of clinical immunology* (pp. 177-200), Aldershot: Ashgate.

Kynaston, D. (2010). *Austerity Britain, 1945-51*, London: Bloomsbury.

LaFollette, M. C. (2008). *Science on the air: Popularizers and personalities on radio and early television*, Chicago: University of Chicago Press.

Lambert, T. D. (1956). Diagnosis of early pregnancy, *BMJ*, 10 November, 118.

Landgrebe, F. W. (1939). The maintenance of reproductive activity in *Xenopus laevis* for pregnancy diagnosis, *Journal of Experimental Biology*, 16, 89-95.

Landgrebe, F. W. (1946). The Hogben test, *BMJ*, 21 December, 963.

Landgrebe, F. W. (1948). A preliminary investigation of *Xenopus laevis* as a test animal for biological assay of chorionic gonadotrophin, *Proceedings of the Royal Society of Edinburgh Section B: Biology*, 63, 213-217.

Landgrebe, F. W., & Hobson, B. M. (1949). Aschheim-Zondek and Hogben pregnancy tests modified and compared, *BMJ*, 2 July, 17-18.

Landgrebe, F. W., & Purser, G. L. (1941). Breeding of *Xenopus* in the laboratory, *Nature*, 148, 115.

Landgrebe, F. W., & Samson, L. (1944). The Hogben pregnancy test with a note on the breeding of *Xenopus* in the test, *Journal of Obstetrics and Gynaecology of the British Empire*, April, 133-139.

Lane-Petter, W. (1961). *Provision of laboratory animals for research: A practical guide*, Amsterdam: Elsevier.

Lane-Roberts, C. S. L., Sharman, A., Walker, K., & Wiesner, B. P. (1939). *Sterility and impaired fertility: Pathogenesis, diagnosis and treatment*, London: Hamish Hamilton.

Lane-Roberts, C. S. L., Sharman, A., Walker, K., & Wiesner, B. P. (1948). *Sterility and impaired fertility: Pathogenesis, diagnosis and treatment*, 2nd ed., London: Hamish Hamilton.

Langhamer, C. (2000). *Women's leisure in England, 1920-60*, Manchester: Manchester University Press.

Langhamer, C. (2007). *Mass Observation and histories of women*, Mass Observation.

Lansbury, C. (1985). *The old brown dog: Women, workers, and vivisection in Edwardian England*, Madison, WI: University of Wisconsin Press.

Larkin, I. M. (1955). The nursery requirements of *Xenopus laevis*, *Journal of Obstetrics and Gynaecology of the British Empire*, 62, 67-69.

Latham, M. (2002). *Regulating reproduction: A century of conflict in Britain and France*, Manchester: Manchester University Press.

Law, J. W. (1949). Notes on the male toad test for pregnancy, *Bulletin of the Institute of Medical Laboratory Technology*, 14, 175-178.

Lawrence, A. S. C. (1941). *The scientific photographer*, Cambridge: Cambridge University Press.

Lawrence, C. (1987). Cinema verité: The image of William Harvey's experiments in 1928. In N. A. Rupke (1990). *Vivisection in historical perspective*, London: Routledge.

Lawrence C. (1998). Still incommunicable: Clinical holists and medical knowledge in inter-war Britain. In C. J. Lawrence & G. Weisz (eds.), *Greater than the parts: Holism in biomedicine, 1920-1950* (pp. 94-111), Oxford: Oxford University Press.

Lawrence, C. (1999). A tale of two sciences: Bedside and bench in twentieth-century Britain, *Medical History*, 43, 19-21.

Lawrence, C. (2005). *Rockefeller money, the laboratory, and medicine in Edinburgh, 1919-1930: New science in an old country*, Rochester, NY: University of Rochester Press.

Lawrence, N. (2012). The Prime Minister and the platypus: A paradox goes to war. *Studies in History and Philosophy of Biological and Biomedical Sciences*, 43, 290-297.

Layne, L. L. (2003). *Motherhood lost: A feminist account of pregnancy loss in America*, New York: Routledge.

Layne, L. L. (2009). The home pregnancy test: A feminist technology? *Women's Studies Quarterly*, 37, 61-79.

Layne, L. L. (2010). Why the home pregnancy test isn't the feminist technology it's cracked up to be and how to make it better. In L. L. Layne, S. L. Vostral & K. Boyer, *Feminist technology* (pp. 89-118), Urbana: University of Illinois Press.

Leap, N., & B. Hunter (1993). *The midwife's tale: An oral history from handywoman to professional midwife*. London: Scarlet Press.

Leathard, A. (1980). *The fight for family planning: The development of family planning services in Britain 1921-74*, London: Macmillan.

Leavitt, S. A. (2006). 'A private little revolution': The home pregnancy test in American culture, *Bulletin of the History of Medicine*, 80, 317-345.

Lederer, S. E. (1992). Political animals: The shaping of biomedical research literature in twentieth-century America, *Isis*, 83, 61-79.

Lederer, S. E. (2000). The Tuskegee syphilis study in the context of American medical research. In S. M. Reverby (ed.), *Tuskegee's truths: rethinking the Tuskegee syphilis study* (pp. 266-275), Chapel Hill, NC: University of North Carolina Press.

Lee, E., & Jackson, E. (2002). The pregnant body. In M. Evans & E. Lee (eds.), *Real bodies: A sociological introduction* (pp. 115-132), Basingstoke: Palgrave.

Leger Brockman, R. St. (1913). The diagnostic value of Abderhalden's method in carcinoma. *Lancet*, 15 November, 1385-1387.

Lehmann, R. (1936). *The weather in the streets*, London: Collins.

Leitch, A. (1914). The serum diagnosis of pregnancy and of cancer: A critical study of Abderhalden's method, *BMJ*, 15 August, 330-35.

LeMahieu, D. L. (1988). *A culture for democracy: Mass communication and the cultivated mind in Britain between the wars*, Oxford: Clarendon.

Lennerhed, L. (2009). Taking the middle way: Sex education debates in Sweden in the early twentieth century. In L. D. H. Sauerteig & R. Davidson (eds.), *Shaping sexual knowledge: A cultural history of sex education in twentieth century Europe* (pp. 55-70), New York: Routledge.

Lewis, J. (1980). *The politics of motherhood: Child and maternal welfare in England, 1900-1939*, London: Croom Helm.

Li, A. (2003). *J. B. Collip and the development of medical research in Canada: Extracts and enterprise*, Montreal: McGill-Queen's University Press.

Lindroth, S. (1976). *A history of Uppsala university, 1477-1977*, Stockholm: Almqvist & Wiksell international.

Lister, U. M. (1962). Tests for the early diagnosis of pregnancy. In W. A. R. Thomson (ed.), *Calling the laboratory* (pp. 83-86), Edinburgh: Livingstone (reprinted from *Practitioner*, 186, May 1961, 590-593).

Lobsenz, N. M. (1956). 60-minute pregnancy test, *Coronet*, 39, April, 141-144.

Lodge, D. (1965). *The British Museum is falling down*. London: MacGibbon & Kee.

Logan, C. (2007). Overheated rats, race, and the double gland: Paul Kammerer, endocrinology and the problem of somatic induction, *Journal of the History of Biology*, 40, 683-725.

Long, C. F., & J. C. Hirst (1923). Ingestion glycosuria, an aid to early diagnosis of pregnancy: Preliminary report, *New York Medical Journal and Medical Record*, 118, 543-546.

Longford, E. (1986). *The pebbled shore: The memoirs of Elizabeth Longford*, London: Weidenfeld & Nicolson.

Loudon, I., & Drury, M. (1988). Some aspects of clinical care in general practice. In I. Loudon, J. Horder, & C. Webster (eds.), *General practice under the National Health Service, 1948-1997: The first fifty years* (pp. 92-127), Oxford: Oxford University Press.

Loughlin, K. (2005). Networks of mass communication: Reporting science, health and medicine in the 1950s and 60s. In V. Berridge (ed.) *Making health policy: Networks in research and policy after 1945* (pp. 295-322), Amsterdam: Rodopi.

Lourie, H. (1962). *A question of abortion*, London: Bodley Head.

Lovat, A. (1921). *Marriage and motherhood*, London: Oates & Washbourne.

Löwy, I. (1993). Testing for a sexually transmissible disease, 1907-1970: The history of the Wassermann reaction. In V. Berridge & P. Strong (eds.), *AIDS and contemporary history* (pp. 74-92), Cambridge: Cambridge University Press.

Löwy, I. (1996). *Between bench and bedside: Science, healing, and interleukin-2 in a cancer ward*, Cambridge, MA: Harvard University Press.

Löwy, I. (2004). 'A river that is cutting its own bed': The serology of syphilis between laboratory, society and the law, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 35, 509-524.

Löwy, I. (2009). Producing pharmaceutical standards at the margins: Chemical contraceptives between the laboratory and the field. In C. Bonah, C. Masutti, A. Rasmussen, & J. Simon (eds.), *Harmonizing drugs: Standards in 20th-century pharmaceutical history* (pp. 297-322), Paris: Editions Glyphe.

Löwy, I. (2010). *Preventive strikes: Women, precancer and prophylactic surgery*, Baltimore, MD: Johns Hopkins University Press.

Löwy, I. (2011). 'Sexual chemistry' before the Pill: Science, industry and chemical contraceptives, 1920-1960, *British Journal for the History of Science*, 44, 245-274.

Löwy, I. (2012). Defusing the population bomb in the 1950s: Foam tablets in India, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 43, 583-593.

Löwy, I. (2014). Prenatal diagnosis: The irresistible rise of the 'visible fetus', *Studies in History and Philosophy of Biological and Biomedical Sciences*, Available online 17 January 2014, http://dx.doi.org/10.1016/j.shpsc.2013.12.003.

Luckin, B. (1990). *Questions of power: Electricity and environment in inter-war Britain*, Manchester: Manchester University Press.

Lynd, K., Blum, J., Ngoc, N. T. N., Shochet, T., Blumenthal, P. D., Winikoff, B. (2013). Simplified medical abortion using a semi-quantitative pregnancy test for home-based follow-up, *International Journal of Gynecology and Obstetrics*, 121, 144-148.

Macdonald, G. (1980) *In pursuit of excellence: One hundred years Wellcome, 1880-1980*, London: Wellcome Foundation.

Macdonald, R. R. & Sharman, A. (1959). Early diagnosis of pregnancy, *Lancet*, 274, 566-567.

Mackenzie Wallis, R. L. (1913). The serum diagnosis of pregnancy. *Journal of Obstetrics and Gynaecology of the British Empire*, November, 249-256.

Mackenzie Wallis, R. L. (1914). Critical review: The value of Abderhalden's tests in the diagnosis of pregnancy. *Journal of Obstetrics and Gynaecology of the British Empire*, February, 53-73.

Mackenzie Wallis, R. L. (1916). Critical review: The protective ferments of the body. *QJM*, January, 138-163.

Macklon, N. S., Geraedts, J. P. M., & Fauser, B. C. J. M. (2002). Conception to ongoing pregnancy: The 'black box' of early pregnancy loss, *Human Reproduction Update*, 8, 333-343.

Maclean, U. (2004). History of the Usher Institute. In R. Bhopal & J. Last (eds.), *Public health: Past, present and future. Celebrating academic public health in Edinburgh, 1902-2002* (pp. 49-69). London: The Nuffield Trust.

Macleod, D. (1936). Obstetrics and gynaecology. *Practitioner*, 137, 554–568.

Magian, A. C. (1922). *The practitioner's manual of gynaecology*. London: Heinemann.

Maisin, J. H. (1968). *History of the International Union Against Cancer*, Geneva: UICC.

Malleson, J. (1939). Criminal abortion: A suggestion for lessening its incidence. *Lancet*, 11 February, 366-367.

Melody, M. E., & Peterson, L. M. (1999). *Teaching America about sex: Marriage guides and sex manuals from the late Victorians to Dr. Ruth*, New York: New York University Press.

Mann, J. D. (1902). *Forensic medicine and toxicology*, 3rd ed., London: Griffin.

Marcus, P. (2011). The evolution of the urine pregnancy test, *Female Patient*, 36, 40-43.

Marcuse, M. (1927). *Sexualforschung: Verhandlungen des 1. internationalen Kongresses Berlin, 10.-16. Oktober 1926*, *Vol. 2*, Berlin: A. Marcus & E. Weber's Verlag.

Marks, L. (2010). *Sexual chemistry: A history of the contraceptive pill*. New Haven, CT: Yale University Press.

Marsh, W., & W. Ronner (2008). *The fertility doctor: John Rock and the reproductive revolution*, Baltimore, MD: Johns Hopkins University Press.

Martin, J. (2010). The wild rabbit: Plague, polices and pestilence in England and Wales, 1931-1955, *Agricultural History Review*, 58, 255-276.

Massam, A. (1966). Pregnancy testing, *New Statesman*, 8 April 1966, 502.

Mathieu, A. (1929). Pregnancy tests, *Medical Sentinel*, 37, November, 1929, https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/8978/Mathieu_Albert_Pregnancy_Tests.pdf.

Matthew, G. D. (1956). Simple clinical test for the diagnosis of early pregnancy, *BMJ*, 27 October, 979.

Matthew, G. D. & Hobson, B. M. (1953). Observations on progesterone-oestrogen withdrawal bleeding and the Hogben test in the diagnosis of pregnancy, *Journal of Obstetrics and Gynaecology of the British Empire*, 60, 363-367.

Mazumdar, P. M. H. (1989). *Immunology 1930-1980: Essays on the history of immunology*, Toronto: Wall & Thompson.

Mazumdar, P. M. H. (1992). *Eugenics, human genetics and human failings: The Eugenics Society, its sources and its critics in Britain*, London: Routledge.

Mazumdar, P. M. H. (2002). *Species and specificity: An interpretation of the history of immunology*, Cambridge: Cambridge University Press.

Mazumdar, P. M. H. (2008). Antitoxin and *Anatoxine*: The League of Nations and the Institut Pasteur, 1920-1939. In K. Kroker, J. Keelan & P. M. H. Mazumdar (eds.)

Crafting immunity: Working histories of clinical immunology (pp. 177-200), Aldershot: Ashgate.

Mazzoni, C. (2002). *Maternal impressions: pregnancy and childbirth in literature and theory*, Ithaca, NY: Cornell University Press.

McAleer, J. (1992). *Popular reading and publishing in Britain, 1914-50*, Oxford: Clarendon.

McCallin, W. (1901). *Introduction to medical jurisprudence*, London: Ballière.

McClive, C. (2002). The hidden truths of the belly: The uncertainties of pregnancy in early modern Europe, *Social History of Medicine*, 15, 209-227.

McClive, C. & King, H. (2007). When is a foetus not a foetus?: Diagnosing false conceptions in early modern France. In V. Dasen (ed.), *L'embryon humain à travers l'histoire: Images, savoirs et rites* (pp. 223-238), Paris: Infolio.

McCrae, A. M. (2003). *The National Health Service in Scotland: Origins and ideals, 1900-1950*, East Linton: Tuckwell Press.

McCraw, T. K. (2007). *Prophet of innovation: Joseph Schumpeter and creative destruction*, Cambridge, MA: Harvard University Press.

McIntosh, T. (2000). 'An abortionist city': Maternal mortality, abortion, and birth control in Shefield, 1920-1940, *Medical History*, 44, 75-96.

McIntosh, T. (2012). *A social history of maternity and childbirth: Key themes in maternity care*, New York: Routledge.

McLaren, A. (1984). *Reproductive rituals: The perception of fertility in England from the sixteenth century to the nineteenth century*, London: Methuen.

McLaren, A. (1993). *A prescription for murder: The Victorian serial killings of Dr. Thomas Neill Cream*, Chicago: University of Chicago Press.

McLaren, A. (2012). *Sex, robots, trees, and test-tube babies in interwar Britain*, Chicago: University of Chicago Press.

McLeave, H. (1963). British doctors find quick way to test for pregnancy. *Scottish Daily Mail*, 9 December, 3.

McTavish, D. (2000). The NHS – is Scotland different? A case study of the management of health care in the hospital service in the West of Scotland, 1947-87, *Scottish Medical Journal*, 45, 155-162.

McTavish, D. (2005). Scottish and English health policy from 1948 to the 1973 reforms: Management through a UK prism, *Scottish Affairs*, 51, 59-78.

Measey, G. J., Rödder, D., Green, S. L., Kobayashi, R., Lillo, F., Lobos, G., Rebelo, R., & Thirion, J.-M. (2012). Ongoing invasions of the African clawed frog, *Xenopus laevis*: A global review, *Biological Invasions*, 14, 2255-2270.

Mechling, J. (1975). Advice to historians on advice to mothers, *Journal of Social History*, 9, 44-63.

Medina-Domenech, R., & Castañeda, C. (2007). Redefining cancer during the interwar period: British Medical Officers of Health, state policy, managerialism, and public health, *American Journal of Public Health*, 97, 1563-1571.

Medvei, V. C. (1993). *The history of clinical endocrinology: A comprehensive account of endocrinology from earliest times to the present day*, Carnforth: Parthenon Publishing Group.

Meredith, H. T. D. (1935). *The modern home doctor*, London: Daily Express.

Meryman, H. T. (1976). Historical recollections of freeze-drying, *Developments in Biological Standardization*, 36, 29-32.

Michaels, P. A. (2014). *Lamaze: An international history*, Oxford: Oxford University Press.

Milnor, G. C., & Fennel, E. A. (1924). The diagnosis of pregnancy, *JAMA*, 16 February, 538-540.

Milton, R. F. (1946). The *Xenopus* pregnancy test, *BMJ*, 17 September, 328.

Ministry of Health and Home Office (1939). *Report of the inter-departmental committee on abortion*, London: HMSO.

Mitchison, N. (1935). *We have been warned*, London: Constable.

Mitchison, N. (1979). *You may well ask: A memoir, 1920-1940*, London: Gollancz.

Mold, A. (2010). Patient groups and the construction of the patient-consumer in Britain: An historical overview, *Journal of Social Policy*, 39, 505-521.

Mold, A. (2011). Making the patient-consumer in Margaret Thatcher's Britain. *Historical Journal*, 54, 509-528.

Mold, A. (2013). Repositioning the patient: Patient organizations, consumerism, and autonomy in Britain during the 1960s and 1970s, *Bulletin of the History of Medicine*, 87, 225-349.

Morrice, A. A. G. (1994). 'The medical pundits': Doctors and indirect advertising in the lay press, 1922-1927, *Medical History*, 38, 255-280.

Moscucci, O. (1990). *The science of woman: Gynaecology and gender in England 1800-1929*, Cambridge: Cambridge University Press.

Moscucci, O. (2003). Holistic obstetrics: The origins of 'natural childbirth' in Britain, *Postgraduate Medical Journal*, 79, 168-173.

Moscucci, O. (2009). The British fight against cancer: Publicity and education, 1900-1948, *Social History of Medicine*, 23, 356-373.

Munro Kerr, J. M., J. H. Ferguson, J. Young & J. Hendry (eds.) (1923). *A combined textbook of obstetrics and gynaecology*, Edinburgh: Livingstone.

Nathoo, A. (2009). *Hearts exposed: Transplants and the media in 1960s Britain*, Houndsmills: Palgrave Macmillan.

Neavill, G. B. (1971). Victor Gollancz and the Left Book Club, *Library Quarterly*, 41, 197-215.

Nevett, T. R. (1982). *Advertising in Britain: A history*, London: Heinemann.

Newman, A. (1966). *The cage*, London: Blond.

Nicholas, S. (1995). 'Sly demagogues' and wartime radio: J. B. Priestley and the BBC, *Twentieth Century British History*, 6, 247-266.

Nicholson, M. (1995). *What did you do in the war, mummy?* London: Pimlico.

Nicolson, M. (2011). James Young Simpson and the development of physical diagnosis. In A. Nuttall & R. Mander (eds.), *James Young Simpson: Lad o pairts* (pp. 57-75), Erskine: Scottish History Press.

Nicolson, M., & Fleming, J. (2013). *Imaging and imagining the fetus: The development of obstetric ultrasound*, Baltimore, MD: John Hopkins University Press.

Nield, B. (1972). *Farewell to the Assizes: The sixty-one towns*, London: Garnstone.

Nixon, W. C. W. (1956). Antenatal care, in *Refresher course for general practitioners: Specially commissioned articles from the British medical journal*, *3rd collection* (pp. 311-322), London: BMA.

Noll, R. (2006). The blood of the insane, *History of Psychiatry*, 17, 395-418.

Nordlund, C. (2011). *Hormones of life: Endocrinology, the pharmaceutical industry, and the dream of a remedy for sterility, 1930-1970*, Sagamore Beach: Science History Publications.

Nottingham, C. (2000). *The NHS in Scotland: The legacy of the past and the prospect of the future*, Aldershot: Ashgate.

Nutton, V. (1992). Healers in the medical market-place: Towards a social history of Graeco-Roman medicine. In A. Wear (ed.), *Medicine in society: Historical essays* (pp. 15-58), Cambridge: Cambridge University Press.

O'Dowd, M. J., & Philipp, E. E. (2000). *The history of obstetrics and gynecology*, Carnforth: Parthenon.

Oakley, A. (1984a) *The captured womb: A history of the medical care of pregnant women*, New York: Blackwell.

Oakley, A. (1984b). *Taking it like a woman*, London: Cape.

Obermer, E. (1935a). *Health and a changing civilisation*, London: John Lane.

Obermer, E. (1935b). *Individual health: A technique for the study of individual constitution and its application to health*, London: Chapman & Hall.

Obermer, E. (1947). Vitamin-D requirements in pregnancy, *BMJ*, 2, 927.

Obermer, E. (1948). Wartime rationing and nutrition in pregnancy. First communication, *Journal of Hygiene*, 46, 325-330.

Okroi, M., & Voswinckel, P. (2003). 'Obviously impossible'—the application of the inheritance of blood groups as a forensic method. The beginning of paternity tests in Germany, Europe and the USA, *International Congress Series*, 1239, 711-714.

Oldham, J. (1986). 'On pleading the belly': A history of the jury of matrons, *Criminal History*, 6, 1-64.

Oliver, R. A. M. (1963). Haemagglutination-inhibition tests in the diagnosis of pregnancy, *Lancet*, 19 October, 840.

Olszynko-Gryn, J. (2013). When pregnancy tests were toads: The *Xenopus* test in the early NHS. *Wellcome History*, 51, 1-3.

Olszynko-Gryn, J. (2014). The demand for pregnancy testing: the Aschheim-Zondek reaction, diagnostic versatility, and laboratory services in 1930s Britain, *Studies in History and Philosophy of Biological and Biomedical Sciences*, available online, http://dx.doi.org/10.1016/j.shpsc.2013.12.002.

Organon Laboratories (1957). *An introduction to endocrinology*, 2nd ed., London: Organon.

Organon Laboratories (1959). *Everyday treatment of endocrine disorders*, London: Organon.

Orwell, G. (1936) *Keep the aspidistra flying*, London: Victor Gollancz.

Oudshoorn, N. (1990). On the making of sex hormones; Research materials and the production of knowledge, *Social Studies of Science*, *20*, 5-33.

Oudshoorn, N. (1994). *Beyond the natural body: An archeology of sex hormones*, London: Routledge.

Oudshoorn, N., Rommes, E., & Marcelle, S. (2004). Configuring the user as everybody: Gender and design cultures in information and communication technologies*, Science, Technology & Human Values*, 29, 30-63.

Owen, S. (2005). *The abuse of literacy* and the feeling hearth: The trials of Richard Hoggart, *Cambridge Quarterly*, 34, 147-176.

Panton, P. N. (1937). Cancer tests and treatments, *Lancet*, 229, 793-795.

Panton, P. N. (1951). *Leaves from a doctor's life*, London: Heinemann.

Papen, U. (2008). Pregnancy starts with a literacy event: Pregnancy and antenatal care as textually mediated experiences, *Ethnography*, 9, 377-402

Parke, Davis & Co. (c.1949). *Descriptive catalogue and therapeutic index*, Hounslow: Parke, Davis & Co.

Parker, C. (2012). From immorality to public health: Thalidomide and the debate for legal abortion in Australia, *Social History of Medicine*, 25, 863-880.

Parkes, A. S. (1947). *Xenopus laevis*, *The School Science Review*, 28, 219-223.

Parkes, A. S. (1966). The rise of reproductive endocrinology 1926-1940. *Proceedings of the Society of Endocrinology*, 34, 20-32.

Passty, J.N. 1988. *Eros and androgyny: The legacy of Rose Macaulay*, London: Associated University Pres.

Pater, J. E. (1981). *The making of the National Health Service*, London: King Edward's Hospital Fund for London.

Patterson, J. (1937). The chemical diagnosis of early pregnancy: A method based upon the detection of oestriol in the urine, *BMJ*, 2, 522-524.

Paul, D. (1984). Eugenics and the Left. *Journal of the History of Ideas*, 45, 567-590.

Paul, D. B. (1988). *The politics of heredity: Essays on eugenics, biomedicine, and the nature-nurture debate*, Albany: State University of New York Press.

Peel, J. (1976). *The lives of the fellows of the Royal College of Obstetricians and Gynaecologists, 1929-1969*, London: Heinemann.

Peel, J. (1986). *William Blair-Bell: Father and founder*, London: Royal College of Obstetricians and Gynaecologists.

Pelling, M. (2003). *Medical conflicts in early modern London: Patronage, physicians, and irregular practitioners, 1550-1640*, Oxford: Clarendon.

Pfeffer, N. (1987). Artificial insemination, in-vitro fertilization and the stigma of infertility. In M. Stanworth (ed.), *Reproductive technologies: Gender, motherhood and medicine* (pp. 81-97), Cambridge: Polity.

Pfeffer, N. (1993). *The stork and the syringe: A political history of reproductive medicine*, Cambridge: Polity Press.

Phillips, H. (1993). *The University of Cape Town, 1918-1948: The formative years*, Cape Town: University of Cape Town Press.

Picton-Turbervill, E. (1939). *Life is good: An autobiography*. London: F. Muller.

Pinch, T. (1993). Testing, one, two, three-testing: Towards a sociology of testing, *Science, Technology & Human Values*, 18, 25-41.

Pink, C. V. (1930). *The ideal management of pregnancy: Talks with expectant mothers*, London: Cassell.

Pink, C. V. (1941). *The foundations of motherhood*, London: Cassell.

Plass, E. D. (1943). Edibility of rabbits used for pregnancy tests, *Journal of the American Medical Association*, 15 May, 15.

Playfair, W. S. (1893). *A treatise on the science and practice of midwifery*, 8th ed., London: Smith, Elder.

Polack, S. S. (1949). The *Xenopus* pregnancy test, *Canadian Medical Association Journal*, 60, 159-161.

Poore, G. V. (1902). *A treatise on medical jurisprudence: Based on lectures delivered at University College, London*, 2nd ed. London: John Murray.

Porter, D. (1997). The decline of social medicine in Britain in the 1960s. In D. Porter (ed.), *Social medicine and medical sociology in the twentieth century* (pp. 97-119), Amsterdam: Rodopi.

Porter, R. (1985). The patient's view: Doing medical history from below, *Theory and Society*, 14, 175-198.

Porter, R. (1988). Before the fringe: 'Quackery' and the eighteenth-century medical market. In R. Cooter (ed.), *Studies in the history of alternative medicine* (pp. 1-27), Basingstoke: Macmillan.

Porter, R. (1989). *Health for sale: Quackery in England, 1660-1850*, Manchester: Manchester University Press.

Porter, R., & Hall, L. (1995). *The facts of life: Creation of sexual knowledge in Britain, 1650-1950*, New Haven, CT: Yale University Press.

Pross, C., & Winau, R. (1984). *Nicht mißhandeln: Das Krankenhaus Moabit. 1920-1933: Ein Zentrum jüdischer Ärzte in Berlin: 1933-1945: Verfolgung, Widerstand, Zerstörung*, Berlin: Edition Hentrich.

Proctor, R. (1988). *Racial hygiene: Medicine under the Nazis*, Cambridge, MA: Harvard University Press.

Prüll, C.-R. (2003). *Medizin am Toten oder am Lebenden? Pathologie in Berlin und in London, 1900-1945*, Basel: Schwabe & Co. AG Verlag.

Prüll, C.-R. (ed.) (1998). *Pathology in the 19th and 20th centuries: The relationship between theory and practice*, Sheffield: European Association for the History of Medicine and Health Publications.

Punnett, R. C. (1941). *Proceedings of the VII International Genetical Congress, Edinburgh, Scotland, 23-30 August 1939*, Cambridge: Cambridge University Press.

Quirke, V. (2008). *Collaboration in the pharmaceutical industry: Changing relationships in Britain and France, 1935-1965*, New York: Routledge.

Quirke, V. (2009). The material culture of British pharmaceutical laboratories in the golden age of drug discovery (*c*.1935-75), *International Journal for the History of Engineering & Technology*, 79, 280-299.

Quirke, V. (2013). Thalidomide, drug safety regulation, and the British pharmaceutical industry: The Case of Imperial Chemical Industries. In J.-P. Gaudillière & V. Hess (eds.), *Ways of Regulating Drugs in the 19th and 20th Centuries* (pp. 150-80), Basingstoke: Palgrave Macmillan.

Quirke, V., & Gaudillière, J.-P. (2008). The era of biomedicine: Science, medicine, and public health in Britain and France after the Second World War, *Medical History*, 52, 441-452.

Rader, K. (2004). *Making mice: Standardizing animals for American biomedical research, 1900-1955*, Princeton, NJ: Princeton University Press.

Ralph, R. S. (1934). Hormone tests for pregnancy, *Journal of Clinical Research*, *20*, 54-59.

Ramsden, E. (2011). From rodent utopia to urban hell: Population, pathology, and the crowded rats of NIMH, *Isis*, 102, 659-688.

Rapp, R. (1999). *Testing women, testing the fetus: The social impact of amniocentesis in America*, London: Routledge.

Rasmussen, N. (1997). *Picture control: The electron microscope and the transformation of biology in America, 1940-1960*, Stanford, CA: Stanford University Press.

Rayner, C. (1966). Pregnancy testing, *New Statesman*, 1 April, 466.

Rayner, C. (2003). *How did I get here from there?* London: Virago.

Read, C. H., & Stone, D. B. (1958). An immunologic assay for minute amounts of human pituitary growth hormone, *Journal of Diseases of Children*, 96, 538.

Read, D. (1960). Early diagnosis of pregnancy, *Lancet*, 16 July, 158.

Reagan, L. (2010). *Dangerous pregnancies: Mothers, disabilities, and abortion in modern America*, Berkeley, CA: University of California Press.

Renault, M. (1939). *Purposes of love*, London: Longmans.

Rentetzi, M. (2011). Packaging radium, selling science: Boxes, bottles and other mundane things in the world of science, *Annals of Science*, 68, 375-399.

Renton, H. (1935). A new pregnancy test, demonstrating the presence of histidine in the urine of pregnant women, *South African Medical Journal*, 13 July, 441-443.

Renwick, C. (2013). Completing the circle of social sciences? William Beveridge and Social Biology at London School of Economics during the 1930s, *Philosophy of the Social Sciences*, 20, 1-19.

Rheinberger, H.-J. (2010). *An epistemology of the concrete: Twentieth-century histories of life*, Durham, NC: Duke University Press.

Rhys, J. (1934). *Voyage in the dark*, London: Constable.

Richards, M. (2008). Artificial insemination and eugenics: Celibate motherhood, eutelegenesis and germinal choice, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 39, 211-221.

Richmond, M. L. (2007). The cell as the basis for heredity, development, and evolution: Richard Goldschmidt's program of physiological genetics. In J. Maienschein & M. D. Laubichler (eds.), *From embryology to evo-devo: A history of developmental evolution* (pp. 169-211), Cambridge, MA: MIT Press.

Riddle, O. (1927). The accomplishments of the First International Congress for Sex Research. *Journal of Social Hygiene*, 13, 138-144.

Riley, D. (1981). 'The Free mothers': Pronatalism and working women in industry at the end of the last war in Britain. *History Workshop Journal*, 11, 59-118.

Ritchie, J. (1953). *History of the Laboratory of Royal College of Physicians of Edinburgh*, Edinburgh: Royal College of Physicians.

Rivett, G. (1986). *The development of the London hospital system 1823-1982*, London: King Edward's Hospital Fund for London.

Rivett, G. (1998). *From cradle to grave: Fifty years of the NHS*, London: King's Fund.

Roberts, M. (2007). *Paper houses: A memoir of the '70s and beyond*, London: Virago.

Roberts, R. E. (1938). Diagnosis of pregnancy. In S. C. Shanks (ed.), *A text-book of X-ray diagnosis by British authors*, *Vol. 2*, London: Lewis.

Robertson, A. (1977). Conrad Hal Waddington. 8 November 1905-26 September 1975, *Biographical Memoirs of Fellows of the Royal Society*, 23, 575-622.

Robertson, E. M. (1930). The practicability of the Aschheim-Zondek test for pregnancy, *Edinburgh Medical Journal*, 37, 124-132.

Robertson, F. (1948). Should a family be planned? *Picture Post*, 12 June 1948, 11-13.

Robertson, W. G. A. (1921). *Manual of medical jurisprudence and toxicology*, 4th ed., London: Black.

Robson, J. M. (1934a). Pregnancy diagnosis in theory and practice, *BMJ*, 1, 1063-1065.

Robson, J. M. (1934b). *Recent advances in sex and reproductive physiology*, London: Churchill.

Rock, J. (1932). Progress in obstetrics. *New England Journal of Medicine*, 206, 77-87.

Rodden, J., & Rossi, J. (2012). *The Cambridge introduction to George Orwell*, Cambridge: Cambridge University Press.

Rogers, L. (1937). *The truth about vivisection*, London: Churchill.

Rose, J. (2010). *The intellectual life of the British working classes*, 2nd ed., New Haven, CT: Yale University Press.

Rosenberg, C. E. (1990). Looking backward, thinking forward: The roots of hospital crisis. *Transactions & Studies of the College of Physicians of Philadelphia*, 12, 127-150.

Rosenberg, C. E. (ed.) (2003). *Right living: An Anglo-American tradition of self-help medicine and hygiene*, Baltimore, MD: Johns Hopkins University.

Rosenfeld, S., and Rosenfeld, V. W. (1944). The reaction of *Xenopus laevis* Daudin (the South African clawed frog) to human pregnancy serum, *Journal of Laboratory and Clinical Medicine*, 29, 527-529.

Ross, E. (1993). *Love and toil: Motherhood in outcast London*, New York: Oxford University Press.

Rothman, B. K. (1986). *The tentative pregnancy: Prenatal diagnosis and the future of motherhood*, New York: Viking.

Roussel Laboratories (1957). *Amenorone and amenorone forte*, London: Associated Houses.

Rudavsky, S. (1996). Separating spheres: Legal ideology v. paternity testing in divorce cases, *Science in Context*, 12, 123-138.

Rudloff, U., & Ludwig, H. (2005). Jewish gynecologists in Germany in the first half of the twentieth century. *Archives of Gynecology and Obstetrics*, 272, 245-260.

Russell, W. M. S., & Burch, R. L. (1959). *The principles of humane experimental technique*, London: Methuen.

Ryle, A. (1955). The unwanted pregnancy, *Medical World*, 82, 266-270.

Sage, L. (2000). *Bad blood*, London: Fourth Estate.

Samuels, S. (1966). The Left Book Club, *Journal of Contemporary History*, 1, 65-86.

Sarkar, S. (1996). Lancelot Hogben, 1895-1975, *Genetics*, 142, 655-660.

Sauerteig, L. D. (2009). Representations of pregnancy and childbirth in (West) German sex education books, 1900s-1970s. In L. D. H. Sauerteig & R. Davidson (eds.), *Shaping sexual knowledge: A cultural history of sex education in twentieth century Europe* (pp. 129-60), New York: Routledge.

Shea, J. & Warrack, A. J. N. (1963). The haemagglutination inhibition and the Hogben test in pregnancy, *Journal of Clinical Pathology*, 16, 581-584.

Schiebinger, L. (2000) Exotic abortifacients: the global politics of plants in the 18th century, *Endeavour*, 24, 117-121.

Schlich, T. (2010). *The origins of organ transplantation: Surgery and laboratory science, 1880s-1930s*, Rochester, NY: University of Rochester Press.

Schlünder, M. (2005). „Die Herren der Regel/n? Gynäkologen und der Menstruationskalender als Regulierungsinstrument ‚weiblicher Natur'", In C. Borck, V. Hessund, & H. Schmidgen (eds.), *Maß und Eigensinn. Versuche im Anschluß an Georges Canguilhem* (pp. 157-195), Fink: München.

Schmulovitz, M. J., & Wylie, J. B. (1935). Chemical diagnosis of pregnancy by detection of estrin in urine, *Journal of Laboratory & Clinical Medicine*, 21, 210.

Schneck, P. (1997). Selmar Aschheim (1878-1965) und Bernhard Zondek (1891–1966): zum Schicksal zweier jüdischer Ärzte und Forscher an der Berliner Charité. *Zeitschrift für ärztliche Fortbildung und Qualitätssicherung*, 91, 187-194.

Schneider, W. (2003) Blood transfusion between the wars, *Journal of the History of Medicine and Allied Sciences*, 58, 187-224.

Schot, J., & A. A. de la Bruheze (2003). The mediated design of products, consumption, and consumers in the twentieth century. In N. Oudshoorn & T. Pinch (eds.), *How users matter: The co-construction of users and technology* (pp. 229-245), Cambridge, MA: MIT Press.

Schreiber, C. A., Sammel, M., Hillier, S. L., & Barnhart, K. T. (2009). A little bit pregnant: Modeling how the accurate detection of pregnancy can improve HIV prevention trials, *American Journal of Epidemiology*, 169, 515-521

Schumpeter, J. A. (2003). *Capitalism, socialism and democracy*, London: Routledge (first published 1943).

Schuster, N. H. (1983). *A clinical pathologist day by day, 1916-1960*, London.

Schwabacher, H. (1950). Review of one year's work in Watford Pregnancy Diagnostic Centre, *BMJ*, 5 August, 328-330.

Schwabacher, H. (1951). The laboratory diagnosis of pregnancy, *Medical Press*, 18 July, 82-86.

Schwabacher, H. (1956). The laboratory diagnosis of pregnancy, *Postgraduate Medical Journal*, 32, 392-397.

Scott, D. H. (1936). *The new people's physician: A compendium of practical information on personal health and domestic hygiene*, 5 vols., London: Waverley.

Scott, L. D. (1940). The concentration and detoxification of human urine for biological pregnancy diagnosis, *British Journal of Experimental Pathology*, 21, 320-324.

Scott, L. D. (1945). A brief survey of the biological pregnancy tests with particular reference to the *Xenopus laevis* toad test, *Surgo: Glasgow University Medical Journal*, 12, 23-25.

Seaman, A. C. (2011). Making and marketing mothers: Guides to pregnancy in modern Japan. In J. Bardsley & L. Miller (eds.), *Manners and mischief: Gender, power, and etiquette in Japan*, Berkeley, CA: University of California Press.

Seigel, M. (2014). *The rhetoric of pregnancy*, Chicago: University of Chicago Press.

Seaward, J. (1961), Pregnancy test... a modern scientific achievement, *Woman*, 24 June, 27.

Sengoopta, C. (2006). *The most secret quintessence of life: Sex, glands, and hormones, 1850-1950*, Chicago: University of Chicago Press.

Shampo, M. A. (2001). Tests, signs, and indications of pregnancy, *Journal of Pelvic Surgery*, 7, 133-135.

Shapiro, H. A. & Zwarenstein, H. (1933a). A rapid test for pregnancy on *Xenopus laevis*, *Proceedings of the Royal Society of South Africa*, 18 October (in *Transactions of the Royal Society of South Africa*, 1934, 22, 3, lxxv, abstracted in *Nature* 133, 339).

Shapiro, H. A., & Zwarenstein, H. (1933b). Metabolic changes associated with endocrine activity and the reproductive cycle in *Xenopus laevis*. 1. The effects of gonadectomy and hypophysectomy on the calcium content of the serum, *Journal of Experimental Biology*, 10, 186-195.

Shapiro, H. A., & Zwarenstein, H. (1934). A rapid test for pregnancy on *Xenopus laevis*, *Nature*, 133, 762.

Shapiro, H. A., & Zwarenstein, H. (1935). A test for the early diagnosis of pregnancy on the South African clawed toad (*Xenopus laevis*), *South African Medical Journal*, 23 March, 202-205.

Shapiro, H. A., & Zwarenstein, H. (1946), The *Xenopus* test for pregnancy, *BMJ*, 2, 752.

Sharman, A. (1947). Antuitrin S intradermal pregnancy test, *BMJ*, 2, 1199.

Sharman, A. (1938). The Antuitrin S test for the diagnosis of pregnancy, *Journal of Obstetrics and Gynaecology of the British Empire*, 45, 82-83.

Sharman, A. (1963). Immunological pregnancy tests, *Lancet*, 7 December 1963, 1224-1225.

Sharman, A. (1964). How do you know you are pregnant? *Family Doctor*, May 1964, 290-292.

Sharman, A. & Pearston, T. (1964). Immunological tests for pregnancy, *Journal of Medical Laboratory Technology*, 21, 271.

Sharman, A. (1965) Immunological tests for pregnancy, *Triangle*, 7, 66.

Sharpey-Schafer, E. (1930). Research in animal genetics, *BMJ*, 2, 30-32.

Shea, J., & Warrack, A. J. N. (1963). The haemagglutination inhibition and the Hogben test in pregnancy, *Journal of Clinical Pathology*, 16, 581-584.

Shepherd, R. (1994). *Iain Macleod: A biography*, London: Hutchison.

Sher, N. (1946). Causes of delayed menstruation and its treatment: An investigation in the Women's Auxiliary Air Force, *BMJ*, 1, 347-349.

Sheridan, D. (1994). Using the Mass Observation Archive as a source for women's studies, *Women's History Review*, 3, 101-113.

Shuttleworth, E. M. (1963). Evaluation of the Prepuerin pregnancy test, *Lancet*, 5 October, 699-700.

Siddall, A. C. (1928a). A suggested test for pregnancy based on the action of gravid female blood serum on mouse uterus: Preliminary report, *JAMA*, 4 February, 380-381.

Siddall, A. C. (1928b). The hormone test for pregnancy: Report II, *JAMA*, 91, 779-782.

Silberman, M. (2009). The perfect storm: late nineteenth-century Chicago sex radicals: Moses Harman, Ida Craddock, Alice Stockman and Comstock obscenity laws, *Journal of the Illinois State Historical Society*, 102, 324-367.

Silverman, M., Lydecker, M, & Lee, P. R. (1992). *Bad medicine: the prescription drug industry in the Third World*, Stanford, CA: Stanford University Press.

Silverstein, A. (2009). *A history of immunology*, 2nd ed., London: Academic Press.

Simakova, E. (2013). *Marketing technologies: Corporate cultures in technological change*, London: Routledge.

Sinding, C. (2002). Making the unit of insulin: Standards, clinical work, and industry, 1920-1925, *Bulletin of the History of Medicine*, 76, 231-270.

Singer, J. M., & Plotz, C. M. (1956). The latex fixation test: I. Application to the serologic diagnosis of rheumatoid arthritis, *American journal of medicine*, 21, 888-892.

Singleton, V. & Michael, M. (1993). Actor-networks and ambivalence: General practitioners in the UK cervical screening programme, *Social Studies of Science*, 23, 227-264.

Slack, J. M. (2002). Conrad Hal Waddington: The last Renaissance biologist? *Nature Reviews Genetics*, 3, 889-895.

Sleigh, C. (2012). *Frog*, London: Reaktion Books.

Slinn, J. (1996). Research and development in the UK pharmaceutical industry from the nineteenth century to the 1960s, in R. Porter & M. Teich (1995). *Drugs and narcotics and history* (pp. 168-186), Cambridge: Cambridge University Press.

Slinn, J. (2005), Drug-guzzlers or medicine junkies? Regulating the cost and consumption of prescription pharmaceuticals in the UK 1948-1967, *Business History*, 47, 352-366.

Sloan, A. W. (1979). Highlights of physiological research at the University of Cape Town, 1912-1978. *South African Medical Journal*, 24 November, 974-976.

Smith, A. (1996). *The New statesman: Portrait of a political weekly, 1913-1931*, London: Cass.

Smith, A. (2009). Thomas Bassett Macaulay and the Bahamas: Racism, business and Canadian sub-imperialism, *Journal of Imperial and Commonwealth History*, 37, 29-50.

Smith, D. F., Diack, H. L., Pennington, T. H., & Russell, E. M. (2005). *Food poisoning, policy, and politics: Corned beef and typhoid in Britain in the 1960s*, Woodbridge: Boydell Press.

Smith, F. J. (1905). *The principles and practice of medical jurisprudence*, 5th ed., London: Churchill.

Smith, P. G. (1966). Pregnancy tests, *Sunday Telegraph*, 27 Marchl.

Smith, R. G. (1993). The development of ethical guidance for medical practitioners by the General Medical Council, *Medical History*, 37, 56-67.

Smith, R. G. (1994). *Medical discipline: The professional conduct jurisdiction of the General Medical Council, 1858-1990*, Oxford: Clarendon Press.

Smith, S. (1925). *Forensic medicine: A text-book for students and practitioners*, London: Churchill.

Smith, S. (1931). *Forensic medicine: A text-book for students and practitioners*, 3rd ed., London: Churchill.

Smith, S. (1934). *Taylor's Principles and practice of medical jurisprudence*, 9th ed., London: Churchill.

Smithells, R. W. (1965). The problem of teratogenicity, *Practitioner*, 194, 104-110.

Snell, J. F. (1963). *Macdonald College of McGill University: A history from 1904-1955*, Montreal: McGill University Press.

Solomons, J. (1966). Pregnancy testing, *New Statesman*, 15 April 1966, 538.

Soloway, R. (1990). *Demography and degeneration: Eugenics and the declining birthrate in twentieth-century Britain*, Chapel Hill: University of North Carolina Press.

Soloway, R. (1995). 'The perfect contraceptive': Eugenics and birth control research in Britain and America in the interwar years, *Journal of Contemporary History*, 30, 637-665.

Soskin, S., Wacntel, H. & Hechter, D. (1940). The treatment of delayed menstruation with prostigin: A therapeutic test for early pregnancy, *JAMA*, 14, 2090.

Soto-Laveaga, G. (2009). *Jungle laboratories: Mexican peasants, national projects, and the making of the Pill*, Durham, NC: Duke University Press.

Spensky, M. (1992). Producers of illegitimacy: Homes for unmarried mothers in the 1950s. In C. Smart (ed.) *Regulating womanhood: Historical essays on marriage, motherhood and sexuality*. London: Routledge.

St John, J. (1990). *William Heinemann: A century of publishing, 1890-1990*, London: Heinemann.

Stacey, M. (1992). *Regulating British medicine: The General Medical Council*, Chichester: Wiley.

Stallworthy, J. (1951). Treatment of threatened abortion, *Practitioner*, 166, 118-123.

Stephens, (1910). *Woman and marriage: A handbook*, London: T. Fisher Unwin.

Stern, C. D. (2000). Conrad H. Waddington's contributions to avian and mammalian development, 1930-1940, *International Journal of Developmental Biology*, 44, 15-23.

Stevens, R. (1966). *Medical practice in modern England: The impact of specialization and state medicine*, New Haven: Yale University Press.

Stevenson, D. (1966). Pregnancy testing, *New Statesman*, 8 April, 501-502.

Stevenson, J. (1984). *British society, 1914-45*, London: Allen Lane.

Stevenson, J., and Cook, C. (2010), *The slump: Britain in the Great Depression*, 3rd ed., Harlow: Longman.

Stewart, J. (2003). The National Health Service in Scotland, 1947-74: Scottish or British? *Historical Research*, 76, 389-410.

Stewart, J. (2010). Sickness and health. In L. Abrams & C. G. Brown (eds.), *A history of everyday life in twentieth-century Scotland* (pp. 228-254), Edinburgh: University of Edinburgh Press.

Stockham, A. B. (1918). *Tokology: A book for everywoman*, rev. ed., London: Fowler.

Stolberg, M. (2007). The decline of uroscopy in early modern learned medicine (1500-1650), *Science and medicine*, 12, 313-336.

Stolberg, M. (2009). *Die Harnschau: eine Kultur- und Alltagsgeschichte*, Köln: Böhlau.

Stone, H. M., & Stone, A. (1936). *A marriage manual: A practical guide-book to sex and marriage*, London: Gollancz.

Stone, J. E. (1932). *Hospital organization and management: Including planning and construction*, London: Faber & Faber.

Stopes, M. C. (1920). *Radiant motherhood: A book for those who are creating the future*, London: Putnam's Sons.

Stopes, M. C. (ed.) (1929). *Mother England: A contemporary history self-written by those who have had no historian*, London: Bale.

Sturdy, S. (2007). Knowing cases: Biomedicine in Edinburgh, 1887-1920, *Social Studies of Science*, 37, 659-689.

Sturdy, S. (2011). Looking for trouble: Medical science and clinical practice in the historiography of modern medicine, *Social History of Medicine*, 24, 739-757.

Sturdy, S., & Cooter, R. (1998). Science, scientific management, and the transformation of medicine in Britain, *c*.1870-1950, *History of Science*, 36, 421-466.

Stürzbecher, M. (1997). *125 Jahre Krankenhaus Moabit 1872-1997*, Berlin: Weidler.

Summerfield, P. (1998). *Reconstructing women's wartime lives: Discourse and subjectivity in oral histories of the Second World War*, Manchester: Manchester University Press.

Summerfield, P., & N. Crockett (1992). 'You weren't taught that with welding': Lessons in sexuality in the Second World War, *Women's History Review*, 1, 435-454.

Sutherland, I. N. (1962). Representations of national, regional, and local statistics. *British Journal of Preventive and Social Medicine*, 16, 30-39.

Sutton, M. (1992). *'We didn't know aught': A study of sexuality, superstition and death in women's lives in Lincolnshire during the 1930s, '40s and '50s*, Stamford: Paul Watkins.

Sweetman, D. (1993). *Mary Renault: A biography*, Londo: Chatto & Windus.

Szreter, S. (1996). *Fertility, class and gender in Britain, 1860-1940*, Cambridge: Cambridge University Press.

Szreter, S., & K. Fisher (2010). *Sex before the sexual revolution: Intimate life in England 1918-1963*, Cambridge: Cambridge University Press.

Tabery, J. (2006). Looking back on Lancelot's laughter, *Mendel Newsletter*, 15, 10-17.

Tabery, J. (2008). R. A. Fisher, Lancelot Hogben, and the origin(*s*) of genotype-environment interaction, *Journal of the History of Biology*, 41, 717-761.

Tansey, (1989). The Wellcome Physiological Research Laboratories, 1894-1904: The Home Office, pharmaceutical firms and animal experiments, *Medical History*, 33, 1-41.

Tansey (1990). The early history of the Wellcome Research Laboratories, 1894-1914, in J. Libenau, G. J. Higby, & E. C. Stroud (eds.), *Pill peddlers: Essays on the history of the pharmaceutical industry* (pp. 91-106), Madison, WI: American Institute of the History of Pharmacy.

Tansey, E. M. (1994). Protection against dog distemper and dogs protection bills: The Medical Research Council and anti-vivisectionist protest, 1911-1933, *Medical History*, 38, 1-26.

Tansey, E. M. (2008). Keeping the culture alive: The laboratory technician in mid-twentieth-century British medical research, *Notes and Records of the Royal Society*, 62, 77-95.

Tausk, M. (1984). *Organon: The story of an unusual pharmaceutical enterprise*, Oss, Netherlands: Akzo Pharma.

Tenney, B. (1954). Advances in obstetrics and gynaecology, *Practitioner*, 173, 360-366.

Thane, P., & Evans, T. (2012). *Sinners? Scroungers? Saints?: Unmarried motherhood in twentieth-century England*, Oxford: Oxford University Press.

Thesing, C. (1935). *School of biology*, London: Routledge (translated from the German by Eden and Cedar Paul).

Thistlethwaite, T. (1997). *Independent and bloody minded: The story of the Medical Journalists' Association, 1967-97*, London: Medical Journalists' Association.

Thomas, M. (1997). *Post-war mothers: Childbirth letters to Grantly Dick-Read, 1946-1956*, Rochester, NY: University of Rochester Press.

Thomson, A. L. (1975). *Half a century of medical research*, 2 vols., London: HMSO.

Thurtle, D. (1940a). Abortion: Right or wrong, *Eugenics Review*, 32, 10-16.

Thurtle, D. (1940b) *Abortion: Right or wrong?* London: T. W. Laurie.

Tinkler, P. (1995). *Constructing girlhood: Popular magazines for girls growing up in England, 1920-50*, London: Taylor & Francis.

Tone, A. (1996). Contraceptive consumers: Gender and the political economy of birth control in the 1930s, *Journal of Social History*, 29, 485-506.

Tone, A. (2000). Black market birth control: Contraceptive entrepreneurship and criminality in the gilded age, *Journal of American History*, 87, 435-459.

Tone, A. (2001). *Devices and desires: A history of contraceptives in America*, New York: Hill & Wang.

Tone, A. (2002). Making room for rubbers: Gender, technology, and birth control before the pill, *History and Technology*, 18, 51-76.

Tone, A. (2012). Medicalizing reproduction: The pill and home pregnancy tests. *Journal of Sex Research*, 49, 319-327.

Topley, W. W. C. (1917). The examination of the blood. In T. W. Eden & C. Lockyer (eds.), *The new system of gynaecology*, vol. 1 (pp. 191-214). London: Macmillan.

Tropp, L. (2013). *A womb with a view: America's growing public interest in pregnancy*. Santa Barbara, CA: ABC-CLIO.

Trunk, A. (2009). Two hundred blood samples from Auschwitz: A Nobel laureate and the link to Auschwitz. In S. Heim, C. Sachse & M. Walker (eds). *The Kaiser Wilhelm Society under National Socialism* (pp. 120-44), Cambridge: Cambridge University Press.

Tümmler, G., Riβmann, A., Meister, R., Schaefer, C. (2014). Congenital bladder exstrophy associated with Duogynon hormonal pregnancy tests—Signal for teratogenicity or consumer report bias? *Reproductive Toxicology*, 45, 14-19.

Udry, J. R., Keovichit, S., Burnright, R., Cowgill, D. O., Morris, N. M., & Yamarat, C., Pregnancy testing as a fertility measurement technique: A preliminary report on field results, *American Journal of Public Health*, 61, 344-352.

Usborne, C. (2007). *Cultures of abortion in Weimar Germany*, New York: Berghahn Books.

Vaitukaitis, J. L. (2004). Development of the home pregnancy test, *Annals of the New York Academy of Sciences*, 1038, 220-222.

Valier, H. K., & Timmermann, C. (2008). Clinical trials and the reorganization of medical research in post-Second World War Britain, *Medical History*, 52, 493-510.

van Abbé, N. J. (1949). Pregnancy diagnosis, *Pharmaceutical Journal*, 23 July, 78.

van de Velde, T. H. (1931). *Fertility and sterility in marriage: Their voluntary promotion and limitation*, London: Heinemann.

van de Walle, E., & Renne, E. P. (eds.) (2001). *Regulating menstruation: beliefs, practices, interpretations*, Chicago: University of Chicago Press.

van den Belt, H. (2011). The collective construction of a scientific fact: A re-examination of the early period of the Wassermann reaction (1906-1912), *Social Epistemology*, *25*, 311-339.

van Sittert, L. (2008). Leap frog: Pregnancy testing and the market biogeography of the African clawed frog (*Xenopus laevis*), *c*.1940-1970, unpublished paper presented at the Royal Geographical Society conference, London.

Vanderplank, F. (1935). The effects of pH on breeding, *Aquarist and Pondkeeper*, *6*, 135-136.

Vanderplank, F. L. (1939a). *Xenopus laevis*: Light as stimulus to breeding, *Aquarist and Pondkeeper*, 9, 183-184.

Vanderplank, F. L. (1939b). *Xenopus muelleri* (Peters), *Aquarist Pondkeeper*, 9, 263-266.

Versluis, A. (2008). Sexual mysticisms in nineteenth century America: John Humphrey Noyes, Thomas Lake Harris, and Alice Bunker Stockham. In W. J. Hanegraaff & J. J. Kripal (eds.), *Hidden intercourse: Eros and sexuality in the history of Western esotericism* (pp. 333-55), Leiden: Brill.

Vincent, D. (1998). *The culture of secrecy: Britain, 1832-1998*, Oxford: Oxford University Press.

Visscher, J. P., & Bowman, D. E. (1934). Chemical determination of pregnancy. *Experimental Biology and Medicine*, 31, 460-461.

Voge, C. I. B. (1929). A simple chemical test for pregnancy, *BMJ*, 2, 829-830.

Volkov, S. (2001). Jewish scientists in Imperial Germany (Parts I and II), *Aleph* 1, 215-281.

von Schwerin, A., Stoff, H., & Wahrig, B. (eds.) (2013). *Biologics, a history of agents made from living organisms in the twentieth century*, London: Pickering & Chatto.

von Villiez, A. (2009). Mit aller Kraft verdrängt. Entrechtung und Verfolgung 'nicht arischer' Ärzte in Hamburg 1933 bis 1945, Hamburg: Dölling und Galitz Verlag.

Wall, R. (2011). Using bacteriology in elite hospital practice: London and Cambridge, 1880-1920, *Social History of Medicine*, 24, 776-795.

Walsh, V. (1984). Invention and innovation in the chemical industry: Demand-pull or discovery-push, *Research Policy*, 13, 211-34.

Warrack, A. J. N. (1963). Latex test for pregnancy, *BMJ*, 5 October, 869.

Warrack, A. J. N. (1965). The laboratory diagnosis of early pregnancy. *Practitioner*, 194, 731-737.

Warrack, A. J. N., & Richards, H. (1967). Pregnancy tests and proteinuria, *Lancet*, 29 April 1967.

Watkins, E. S. (1998). On the Pill: A social history of contraceptives, 1950-1970, Baltimore, MD: Johns Hopkins University Press.

Watkins, E. S. (2007). *The estrogen elixir: A history of hormone replacement therapy in America*, Baltimore, MD: Johns Hopkins University Press.

Way, S. (1937). Antuitrin S Intradermal pregnancy test, *BMJ*, 2, 1142-1143.

Webster, C. (1988). *The health services since the war, Vol. 1. The National Health Service before 1957: Problems of health care*, London: HMSO.

Webster, C. (1996). *Health services since the war, Vol. 2. Government and health care: The National Health Service 1958-1979*, London: HMSO.

Webster, C. (2002). *The National Health Service: A political history*, Oxford: Oxford University Press.

Weeks, J. (2012). *Sex, politics and society: The regulation of sexuality since 1800*, 3rd ed., Harlow: Pearson.

Weindling, P. (2009a). Medical refugees in Britain and the wider world, 1930-1960: Introduction, *Social History of Medicine*, 22, 451-459.

Weindling, P. (2009b) Medical refugees and the modernisation of British medicine, 1930- 1960, *Social History of Medicine*, 22, 489-511.

Weir, L. (2006). *Pregnancy, risk and biopolitics: On the threshold of the living subject*, Routledge: London.

Weisman, A. I. (1941a). *Spermatozoa and sterility: A clinical manual*, New York: Hoeber.

Weisman, A. I. (1941b). *You Too Can Have a Baby. A plan for parenthood*, New York: Liveright.

Weisman, A. I., & Coates, C. W. (1943). Rabbits for food or pregnancy testing. *Journal of the American Medical Association*, 121, 1109.

Weisman, A. I., & Coates, C. W. (1944b). *The South African frog (*Xenopus laevis*) in pregnancy diagnosis: A research bulletin*, New York: New York Biologic Research Foundation.

Weisz, G. & Olszynko-Gryn, J. (2010). The theory of epidemiologic transition: The origins of a citation classic, *Journal of the History of Medicine and Allied Sciences*, 65, 287-326.

Weldon, C., du Preez, L. H., Hyatt, A. D., Muller, R., Speare, R. (2004). Origin of the amphibian chytrid fungus, *Emerging Infectious Diseases*, 10, 2100-2105.

Wells, A. L. (1937). *Tropical aquariums, plants and fishes*, London: Frederick Warne.

Wells, G. P. (1978). Lancelot Thomas Hogben, 9 December 1895-22 August 1975. *Biographical Memoirs of Fellows of the Royal Society*, 24, 183-221.

Werskey, G. (1971) *The visible college: A collective biography of British scientists and socialists of the 1930s*, London: Allen Lane.

White, C. L. (1970). *Women's magazines 1693-1968*, London: Michael Joseph.

Whitfield, N. (2013). Who is my donor? The local propaganda techniques of London's Emergency Blood Transfusion Service, 1939-45, *Twentieth Century British History*, Advance Access published January 25, 2013, doi: 10.1093/tcbh/hws043.

Wide, L. (1962). An immunological method for the assay of human chorionic gonadotrophin, *Acta Endocrinologica*, 41, Supplementum 70, 1-111.

Wide, L. (2005). Inventions leading to the development of the diagnostic test kit industry: From the modern pregnancy test to the sandwich assays, *Upsala Journal of Medical Science*, 110, 193-216.

Wide, L., & Gemzell, C. A. (1960). An immunological pregnancy test, *Acta Endocrinologica*, 35, 261-267.

Wiesner, B. P. (1931). Pregnancy diagnosis station: Report on second year's working, *BMJ*, 1, 860-861.

Wiesner, B. P. (1932). Pregnancy diagnosis station: Report on third year's working, *BMJ*, 2, 759.

Wiesner, B. P. (1933). Pregnancy diagnosis: Report of forth year's working, *BMJ*, 2, 296.

Wiesner, B. P. (1936). *Sex*, London: Thornton Butterworth.

Wiesner, B. P., &, Sheard, N. (1933). *Maternal behaviour in the rat*, Edinburgh: Oliver & Boyd.

Wilde, S. (2009). Truth, trust, and confidence in surgery, 1890-1910: Patient autonomy, communication, and consent, *Bulletin of the History of Medicine*, 83, 302-330.

Williams, A. S. (1997). *Women & childbirth in the twentieth century: A history of the National Birthday Trust Fund, 1928-93*, Stroud: Sutton.

Williams, D. L. (1994). Dr. Edward Elkan: Pioneer in lower vertebrate pathobiology, *Journal of Zoo and Wildlife Medicine*, *25*, 117-118.

Williamson, H. (1913). The value of Abderhalden's test for pregnancy, *Journal of Obstetrics and Gynaecology of the British Empire*, 24, 211-217.

Wilmot, S. (2007). From 'public service' to artificial insemination: Animal breeding science and reproductive research in early twentieth-century Britain, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 38, 411-441.

Wilson, A. (1995). *The making of man-midwifery: Childbirth in England, 1660-1770*, London: UCL Press.

Wilson, G. S. (1948). The Public Health Laboratory Service: Origins and development of public health laboratories, *BMJ*, 10 April, 677-682.

Wilson, G. S. (1951). The Public Health Laboratory Service, *BMJ*, 7, 146-152.

Wilson, J. (1996). Dr Isaacson, Twiggy and me: A memoir of North-West London in the 1960s, *Jewish Quarterly*, 43, 14-17.

Winkelstein, A. (1942). Prostigmine methylsulfate and delayed menstruation, *American Journal of Obstetrics and Gynecology*, 44, 231.

Woolgar, S. (1991). Configuring the user: The case of usability trials. In J. Law (ed.), *A sociology of monsters: Essays on power, technology and domination* (pp. 58-99), London: Routledge.

Worboys, M. (2004). Private clinical laboratories in Britain: The Clinical Research Association, 1894-1914, unpublished paper presented at the American Association for the History of Medicine Annual Conference, Madison, Wisconsin.

Worboys, M. (2007). Was there a Bacteriological Revolution in late nineteenth-century medicine? *Studies in History and Philosophy of Biological and Biomedical Sciences*, 38, 20-42.

Worpole, K. (1983). *Dockers and detectives*, London: Verso.

Wright, H. B. (1949a). Pregnancy diagnosis laboratory, *Pharmaceutical Journal*, 16 July, 59.

Wright, H. B. (1949b). Pregnancy diagnosis, *Pharmaceutical Journal*, 6 August, 115.

Wright, R. (1942). What you don't know won't hurt you, *Harpers Magazine*, December, 58-61.

Wright, W. M., & Wolf, C. G. L. (1930). The serological diagnosis of cancer. Part I, *Journal of Cancer Research*, 14, 370-393.

Young, D. S., Berwick, M. C., & Jarett, L. (1997). Evolution of the William Pepper Laboratory, *Clinical Chemistry*, 43, 174-179.

Young, I. M. (1984). Pregnant embodiment: Subjectivity and alienation, *Journal of Medicine and Philosophy*, 9, 45-62.

Young, R. H. (2009). The history of British gynaecological pathology, *Histopathology*, 54, 144-155.

Yoxen, E. (1986). Form and strategy in biology: Reflections on the career of C. H. Waddington. In T. J. Horder, J. A. Witkowski, & C. C. Wylie (eds.), *A History of Embryology* (pp. 309-329), Cambridge: Cambridge University Press.

Zilboorg, C. (2001). *The masks of Mary Renault: A literary biography*, Columbia, MO: University of Missouri Press.

Zondek, B. (1931). *Die Hormone des Ovariums und des Hypophysenvorderlappens*, Berlin: Springer.

Zondek, B. (1942). Simplified hormonal treatment of amenorrhea, *JAMA*, 118, 705.

Zwarenstein, H. (1985). The frog pregnancy test: The first of its kind in the world, *Adler Museum Bulletin*, 11, 9-10.

Zwarenstein, H. & Shapiro, H. A. (1933). Metabolic changes associated with endocrine activity and the reproductive cycle in *Xenopus laevis*. III. Changes in the calcium content of the serum associated with captivity and the normal reproductive cycle. *Journal of Experimental Biology*, 10, 372-378.

Zweiniger-Bargielowska, I. (2000). *Austerity in Britain: Rationing, controls, and consumption, 1939-1955*, Oxford: Oxford University Press.

Zweiniger-Bargielowska, I. (2005). The culture of the abdomen: Obesity and reducing in Britain, circa 1900-1939, *Journal of British Studies*, 44, 239-273.

Zweiniger-Bargielowska, I. (2007). Raising a nation of 'good animals': The New Health Society and health education campaigns in interwar Britain, *Social History of Medicine*, 20, 73-89.

Zweiniger-Bargielowska, I. (2011). Fair shares? The limits of food policy in Britain during the Second World War. In I. Zweiniger-Bargielowska, R. Duffett, & A. Drouard (eds.), *Food and war in twentieth century Europe*. Farnham: Ashgate.