Measuring the effectiveness of maternal delivery services: A cross-sectional and qualitative study of perinatal mortality in six primary referral hospitals, Kenya [version 1; referees: 1 approved with reservations]

Richard Ayah¹, Dismas Ongore¹, Alfred T.O. Agwanda²

¹School of Public Health, College of Health Sciences, University of Nairobi, Nairobi, Kenya
²Population Studies and Research Institute, University of Nairobi, Nairobi, Kenya

Abstract
Background: The effective performance of hospitals is critical to overall health system goal achievement. Global health system performance frameworks are often used as part of global benchmarking, but not within low and middle-income countries as part of service delivery performance measurement. This study explored the utility of perinatal mortality as a measure of hospital effectiveness.

Methods: A cross sectional, mixed methods study of six primary referral hospitals, differentiated by ownership, was conducted from 10th June to 9th October 2015. Monthly summary hospital data of maternal delivery services (MDS) were abstracted to determine the perinatal mortality. Tests of associations were used to correlate bed turnover, skilled staffing, method of delivery and perinatal mortality. Additionally, 40 questionnaire interviews were held with hospital board members and the management team to assess the availability of standard operating procedures (SOP) in MDS. Qualitative data was analysed thematically.

Results: All six hospitals reported having SOP in managing MDS. The average perinatal mortality rate for all the hospitals was 24.63 per 1,000 live births. However, a perinatal death was 2.6 times more likely in public hospitals compared to private hospitals (29.8 vs 11.4 per 1,000 births respectively). The average caesarean section rate for all hospitals was 25.9%, but the odds of a caesarean section were 1.67 higher in a private hospital compared to a public hospital (P<0.001 95% CI: 1.58-1.77). Perinatal mortality was also associated with bed turnover ratio (R squared 0.260, P=0.001), and skilled staff availability (R squared 0.064, P<0.001).

Discussion: The high perinatal mortality reported in public hospitals may be due to high bed turnover and relatively low caesarean section rate. Input measures of performance such as reporting standards of care and staffing levels are not useful performance indicators. Perinatal mortality as a performance indicator may be an ideal measure of the effectiveness of hospitals.
Keywords
Health system effectiveness, Hospital performance, perinatal death

Corresponding author: Richard Ayah (ayah@uonbi.ac.ke)

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Introduction
The hospital sector represents approximately 45–69% of government health expenditure in sub-Saharan Africa and the effective performance of the sub-sector is therefore critical to overall health system goal achievement. Globally considerable efforts have been made to develop health system performance (HSP) assessment frameworks that take into consideration the peculiarities of health systems and the multiplicity of stakeholders in health with different perspectives. But HSP benchmarking is often done between countries as part of a global health comparison, rather than being used at a subnational level, where policymakers in low income countries with high disease burden seek to understand how well the delivery of healthcare meets the needs of citizens.

In Kenya, overall health status is measured by indicators including life expectancy, and under-five and maternal mortality. However, health system performance is measured mainly through process input indicators such as health per capita spend and human resource availability. This disconnect leads to poor performance accountability defined as “demonstrating and accounting for performance in the light of agreed-upon performance targets focusing on services, outputs and results”. An ideal health system performance indicator would link hospital process and outcomes to overall health system effectiveness, allow for hospital comparisons, be sensitive to outcomes under the control of the health system and ensure provider accountability.

Maternal delivery service (MDS) indicators and outcomes, such as skilled delivery levels, coverage of caesarean sections and neonatal mortality, are sensitive indicators of the effectiveness of the whole health system. The core impact indicators are also well defined; however the Every Newborn Action Plan (ENAP), launched in 2014, recognised that efforts are needed to improve data quantity and quality, with only 17 countries that have a policy for reporting and reviewing stillbirths and neonatal deaths.

Roughly one third of 363 interventions in the Kenya Essential Package for Health focus on reproductive health. Despite the focus, Kenya did not meet the Millennium Development Goal (MDG) target for maternal deaths of 147 per 100,000 live births by 2015, and little advancement has been made in reducing mortality among newborns, which now accounts for 45% of all child deaths. Facility-based delivery has gained traction as a key strategy for reducing perinatal mortality in developing countries. In Kenya, healthcare provision is devolved to the 47 counties, which provide care to geographical defined populations. In the delivery of MDS, primary referral hospitals are expected to provide comprehensive emergency obstetric care, which includes all basic emergency obstetric care interventions and caesarean sections.

Efforts to reduce maternal mortality and morbidity in low-resource settings often depend on global standards and indicators to assess obstetric care. However these standards often do not take into account the local context especially in terms of skill and resource availability. Moreover, using a national average does not provide timely and accurate measurements of levels and trends at local levels, which are crucial to assess progress, allow benchmarking and provide policymakers with the data to prioritize the areas of greatest need.

Objective
This study explored the utility of perinatal mortality as a measure of hospital effectiveness in six primary referral hospitals in Kenya.

Methods
Study setting
A cross-sectional study of six primary referral hospitals in Kiambu and Nairobi Counties differentiated by ownership was conducted. In 2013, Kiambu County was estimated to have a population of 1,838,397 including 59,191 pregnant women. In Kiambu, there were six faith-based, one private and four government hospitals. Nairobi County’s population in 2013 was estimated at 3,554,261 including 172,143 pregnant women. Nairobi had four faith-based, seven private and two government hospitals. Kiambu and Nairobi Counties were chosen for this study because compared to the national averages (32%), health facilities in Kiambu and Nairobi counties (40% and 48%, respectively) had above average maternal health service readiness. Census data analysis of the county Maternal Mortality Ratio (MMR) estimated Kiambu and Nairobi at 230 and 212 per 100,000 live births, respectively, roughly half the national average (495 per 100,000).

All the level four health facilities, that is primary referral hospitals, were picked from the list of hospitals in the two counties. The hospitals were grouped according to ownership, public (government), not for profit, faith-based and for profit hospitals. In the two counties there were six public, eight private and ten faith-based hospitals. Hospitals that did not offer maternal delivery services were excluded. A list of all public hospitals was developed and computer generated random numbers were used to select three government hospitals, which were selected and then matched by bed capacity with two faith-based and one for profit hospitals across both counties.

Data collection
Data was collected from 10th June to 9th October 2015. Monthly summary hospital data of patients who had been admitted to the maternity unit of each selected hospital in the period 1st January 2014 – 31st December 2014 were abstracted between 10th June and 9th October 2015 to determine: number of patients admitted, type of delivery, skilled staff per 1,000 deliveries, length of stay, bed capacity, bed turnover ratio, caesarean section rate, number of perinatal deaths, perinatal mortality per 1,000 live births.

Additionally, 40 questionnaire interviews were held with board members and members of the hospital management team to assess the availability of standard operating procedures in MDS. In each hospital, a minimum of three board members (including the chair, chief executive and one other), and ensuring that at least one third of members were interviewed. For each hospital management team, the medical superintendent, hospital nursing officer in charge, administrator and nurse in charge...
of maternity unity were interviewed. Consequently, the combined participants from the six facilities provided at least 40 interviewees - an adequate medium size sample pool of interviews (Baker and Edwards, 2012). Informed written consent was sought with interviews audio recorded except where participants were uncomfortable, only field notes were taken (Supplementary File 1). The length of stay was determined by abstracting dates of admission and discharge from 200 randomly selected patient files from each hospital.

**Data analysis**
Effectiveness of MDS was defined as the extent to which the hospital manages all major causes of maternal and newborn mortality as measured by the perinatal mortality rate. The World Health Organization defines perinatal mortality as the “number of stillbirths and deaths in the first week of life per 1,000 total births”. The perinatal mortality rate was calculated as: (No. of perinatal deaths / total No. of births (still births + live births)) x 1000.

Correlations and tests of associations of chi-square (X2) were used to show the relationships between MDS patients, bed turnover, average length of stay, skilled delivery staff, bed capacity and patient outcomes of normal, caesarean section; and perinatal mortality. Data was analysed using the Statistical Products and Service Solutions (SPSS) and MS-Excel.

Qualitative data was analysed thematically, by manually reviewing the transcripts. Using priori codes emanating from the questionnaire, a code book (Supplementary File 2) was developed that provided a working analytical framework that was then used to code the transcripts. Two independent coders reviewed the transcripts and consequently agreed on emergent codes and resultant thematic findings.

**Ethical statement**
Ethical clearance was obtained from the Ethics and Research Committee of Kenyatta National Hospital and University of Nairobi (P128/03/2015). To facilitate carrying out the study, administrative consent was obtained from both Kiambu County and Nairobi County to facilitate access to the hospitals. Before starting data collection at each hospital, written consent was obtained from each facility in-charge. Respondents in the study were asked to provide informed written consent before being interviewed.

**Results**
The six hospitals ranged in maternity bed capacity from 13 – 70 with a median of 55 beds. Total deliveries in the calendar year ranged from 381 at the 13 maternity bed private hospital to 8,279 at a 70 bed public hospital. The bed turnover ratio ranged from 29 – 163 with a median of 80. The lowest number of perinatal deaths was 1, while the highest was 208. The average length of stay varied from 0.7 to 5.1 days and was associated with perinatal mortality P<0.001, 95% CI: 0.6472–0.7542 (Table 1).

The average caesarean section rate for the all the hospitals was 25.9%. When the public hospitals (P) were grouped together and compared to the private [for profit (PFP) and faith based organisation hospital (FBO)], public hospitals had caesarean section rates of 18.4%, 23% and 27.1%, (P2-Kiambu, P3-Nairobi and P1-Kiambu, respectively), while the private hospital caesarean sections rates were 31.6%, 42.5% and 43.4% (FBO1-Kiambu, FBO2-Kiambu, FBO1-Kiambu, respectively). The odds of a caesarean section were 1.67 higher in a private hospital compared to a public hospital (P<0.001 95% CI: 1.5833-1.7763). The number of perinatal deaths per 1,000 live births in private hospitals were 2.62, 9.91, 13.15 (PFP-Nairobi, FBO2-Kiambu, FBO1-Kiambu, respectively), while in the public hospitals they were 25.12, 29.74, 39.17 (P2-Kiambu, P3-Nairobi, P1-Kiambu, respectively) (Table 2).

The perinatal death rate was 2.6 times higher in public hospitals (29.76 per 1,000 births) compared to private hospitals (11.39 per 1,000 births). The number of skilled delivery staff

<table>
<thead>
<tr>
<th>Hospital-County</th>
<th>Maternity Beds</th>
<th>Bed Turnover Ratio</th>
<th>Average Length of Stay (days)</th>
<th>Skilled delivery staff per 1000 patient</th>
<th>Delivery by spontaneous vaginal delivery</th>
<th>No of perinatal deaths</th>
<th>Total deliveries</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFP-Nairobi</td>
<td>13</td>
<td>29</td>
<td>2.9</td>
<td>235</td>
<td>223</td>
<td>1</td>
<td>381</td>
</tr>
<tr>
<td>P1-Kiambu</td>
<td>25</td>
<td>163</td>
<td>2.3</td>
<td>4</td>
<td>2,978</td>
<td>160</td>
<td>4,085</td>
</tr>
<tr>
<td>P3-Nairobi</td>
<td>55</td>
<td>97</td>
<td>2.1</td>
<td>22</td>
<td>4,090</td>
<td>158</td>
<td>5,312</td>
</tr>
<tr>
<td>FBO1-Kiambu</td>
<td>62</td>
<td>64</td>
<td>5.1</td>
<td>15</td>
<td>2,257</td>
<td>52</td>
<td>3,955</td>
</tr>
<tr>
<td>FBO2-Kiambu</td>
<td>54</td>
<td>47</td>
<td>3.1</td>
<td>34</td>
<td>1,428</td>
<td>25</td>
<td>2,522</td>
</tr>
<tr>
<td>P2-Kiambu</td>
<td>70</td>
<td>118</td>
<td>0.7</td>
<td>7</td>
<td>6,754</td>
<td>208</td>
<td>8,279</td>
</tr>
</tbody>
</table>

PFP=Private for Profit Hospital; P=Public Hospital; FBO=Faith-based Organisation Hospital
available per 1,000 patients were as follows: P1-Kiambu, 4; P2-Kiambu, 7; FBO1-Kiambu, 15; P3-Nairobi, 22; FBO2-Kiambu, 34; FBO2-Kiambu, 235. Despite the wide range of skilled delivery staff availability, there was an association between the skilled staff availability and the perinatal mortality (R squared 0.260, P<0.001). The bed turnover ratio and perinatal mortality were associated (R squared 0.064, P<0.001).

Methods of monitoring standards of care
From the 40 interviews conducted the following information was found. All six hospitals reported having standard operating procedures in managing MDS. Three of the facilities, P2-Kiambu, P1-Kiambu and FBO2-Kiambu, reported having annual work plans. All six hospitals had a scheme of service and code of conduct for their employees. None reported having been inspected by the national Ministry of Health, but county health teams had visited all the hospitals in the past year except for PFP hospital. With respect to inspection by a non-MOH regulator such as the National Environmental Agency, only FBO2-Kiambu and PFP-Nairobi had interactions (Table 3).

Maintaining standards of care
All the hospitals reported having SOPs in managing maternal delivery services. All had a scheme of service and code of conduct for their employees. None reported having been inspected by the national ministry of health, but county health teams visited.

"...I want to say that the county comes to the ground very often and especially to check and monitor maternal outcomes and hold discussion...which we do with them..." (Hospital Management Team Member, FBO1-Kiambu).

Half the facilities reported having annual work plans. With respect to following external regulations only the non-government hospitals were subjected to some inspection by non ministry of health regulator such as NEMA. Of interest is that the hospitals with the worst perinatal mortalities reported to have the same number of methods to maintain standards of service as the hospital with the best mortality figures (Table 2).

Respondents at senior management level also reported a lack of engagement with ministry of health at county and national level in strategy development of maternal delivery services.

"...The county ministry of health have not given us an opportunity to contribute towards the formation of the county health strategy...we would want to be equal partners in provision of strategy and implementation strategy...we will go for discussions...they will set a circular and we are told from now on xyz will be happening and you are not involved..." (Hospital Management Team Member, FBO2-Kiambu.

Discussion
County referral hospitals play an increasingly significant role in maternal delivery services. Kenya recorded an increase in the proportion of facility based deliveries from 44% in 2008 to 61% in 2014\cite{20}. A total of 186,688 deliveries in 2014 occurred in such facilities, roughly 15% of all deliveries in Kenya\cite{21}. In this study the total number of deliveries were 24,534 in 2014. The average length of stay for patients admitted for maternal delivery services was just under 2.7 days (median 2 days). This is in line with global practice; in a 92 country review of hospital the mean length of stay after child birth ranged from 1.3 to 6.6 days with the majority of women staying too short a time to receive adequate postnatal care\cite{22}. However, the average masked considerable differences between the different hospitals, with the public hospitals discharging patients in less than 24 hours compared to two days for private hospitals. Developing countries have reported neonatal infection rates 3–20 times that of developed countries due to poor intra-partum and postnatal infection-control practices\cite{23}. Neonatal infection in the first week of life account for 26% of neonatal deaths in sub-Saharan Africa\cite{24}. The short time available to monitor the mother and newborn could explain the association between the high bed turnover ratio in the public hospitals and high perinatal mortality.

Dataset 1. Effectiveness of maternal delivery services and perinatal mortality in six primary referral hospitals

http://dx.doi.org/10.5256/f1000research.14862.d206064

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Caesarean section rate</th>
<th>No of perinatal deaths</th>
<th>Perinatal mortality rate/1000 live births</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFP-Nairobi</td>
<td>41.5%</td>
<td>1</td>
<td>2.62</td>
</tr>
<tr>
<td>P1-Kiambu</td>
<td>27.1%</td>
<td>160</td>
<td>39.17</td>
</tr>
<tr>
<td>P3-Nairobi</td>
<td>23.0%</td>
<td>158</td>
<td>29.74</td>
</tr>
<tr>
<td>FBO1-Kiambu</td>
<td>31.6%</td>
<td>52</td>
<td>13.15</td>
</tr>
<tr>
<td>FBO2-Kiambu</td>
<td>43.4%</td>
<td>25</td>
<td>9.91</td>
</tr>
<tr>
<td>P2-Kiambu</td>
<td>18.4%</td>
<td>208</td>
<td>25.12</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>25.9%</strong></td>
<td><strong>100</strong></td>
<td><strong>24.63</strong></td>
</tr>
</tbody>
</table>
Previous studies have shown strong associations between patient mortality and low staffing levels. However, there was weak association between the ratio of skilled birth attendant and patients, indicating that perhaps primary referral hospitals had met the threshold of minimum number of staff required. This finding contrasts with a study that found that the presence of a doctor at birth reduced maternal and infant mortality. Since staffing numbers weakly predicted mortality rates, it can be hypothesised that the quality of clinical decision making in not identifying mothers requiring caesarean sections was poorer in those hospitals with relatively low caesarean section rates.

All the hospitals in this study reported having at least two, with a median of three, methods of monitoring standards of care, including SOPs in managing maternal delivery services. Public hospitals in particular had more methods compared to private, though none reported having Ministry of Health oversight. This finding may appear to contradict an assessment of the quality of maternity care in an Indian metropolitan city that concluded that public hospitals practices fell short of evidence-based guidelines, while there was relative overuse of interventions in private hospitals. However, it is known that reporting having certain quality improvement methodologies is not enough to lead to an outcome of high standards of care without an imbedded culture of quality improvement. It is possible that a weakness in the health system building blocks of leadership and health information are the weak links in not enabling health workers to champion the process of improvement and use of best practice guidelines to monitor performance.

In this study, none of the hospitals reported having been inspected by the national Ministry of Health, but county health teams had visited the three public hospitals. Despite these visits and the reporting of available protocols to ensure quality of care, the public hospitals reported worse perinatal outcomes. Quality-of-care audits have been promoted as useful in identifying and changing suboptimal care, and therefore reducing perinatal mortality; however a study in South Africa, did not demonstrate that quality-of-care audits improved perinatal mortality. However, in the monitoring of external non medical regulations only the non-government hospitals were
subjected to inspection by a non ministry of health regulator such as the National Environmental Agency, symptomatic of many policies in developing countries where there are often conflicting existing laws and legislations and overlapping bureaucratic mandates leading to policy implementation failure. This uneven treatment of hospitals does not augur well for policymakers and hospital boards efforts to relate hospital performance to overall health system effectiveness.

Study limitations
Focusing on a specific service such as MDS allows for greater comparison between hospitals because patient heterogeneity, which can be a major factor in measuring effectiveness, is reduced. This study chose mortality as the health outcome because it is relatively easy to measure and therefore likely to achieve valid results. However, the study relied on hospital records, and therefore there may have been elements of underreporting. Perinatal mortality includes live births and still births, which is a comprehensive indicator for assessing outcomes of both intrapartum and immediate post-partum care services; however without perinatal audit systems in place, there is often underreporting of stillbirths.

Conclusions and recommendations
The study demonstrates that the average perinatal mortality in primary referral hospitals was high with considerable variation between public and private hospitals. This is despite all the hospitals reporting having various methods of maintaining standards of care. While there was considerable variance in size and patient numbers among the hospitals, staffing levels were not associated with perinatal mortality, suggesting that the quality of clinical decision making as measured by the caesarean section rate was a factor in improving outcomes. Given the heterogeneity of primary referral hospitals, the use of perinatal mortality as a performance indicator to measure the effectiveness of maternal delivery services and hold hospitals to account in relation to the entire health system is recommended.

Data availability
Dataset 1: Effectiveness of maternal delivery services and perinatal mortality in six primary referral hospitals. DOI, 10.5256/f1000research.14862.d20606

The datasets generated and/or analysed during this study, other than those provided herein, are not publicly available as ethical restrictions apply to publicly sharing the qualitative interviews transcripts due to potentially identifiable information detailed in the transcripts. Excerpts of the data are however available from the corresponding author on reasonable request and approval by the Kenyatta National Hospital/University of Nairobi- Ethics Review Committee (KNH/UoN-ERC) by contacting ayah@uonbi.ac.ke or uonknh_erc@uonbi.ac.ke.

Competing interests
No competing interests were disclosed.

Grant information
The author(s) declared that no grants were involved in supporting this work.

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The authors would like to acknowledge the Boards of the hospitals, study participants, Kenneth Mutai and Kellen Karimi.

Supplementary material
Supplementary File 1: Hospital governance questionnaire.

Click here to access the data.

Supplementary File 2: Code Book Perinatal Mortality.

Click here to access the data.

References
Open Peer Review

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Version 1

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Faith Yego
Department of Health Policy and Management, Moi University School of Public Health, Eldoret, Kenya

The study provides perinatal mortality as a performance indicator for measuring the effectiveness of hospitals. This study is important since most studies usually rely on maternal mortalities as indicators. However, since most perinatal deaths are underreported, especially in developing countries, the findings of this study provide a basis for documenting these deaths to report them to use the data to come up with interventions to improve service delivery.

The literature review is current and accurately presented. However, some references need to be checked and corrected for 11,14,15, 16, 20, 42.

The methodology is appropriate and scientifically sound.

Statistical analysis is adequate though a review by a statistician would be recommended. Study findings are adequately presented in tables however some issues indicated below need to be clear:

It would be good to know what tier the public hospitals (p1, P2 and P3) were to explain certain factors like caesarean section rates based on patient turnover and hospital level. If they are referral hospitals then high CS rates could be due to the kind of emergency cases they receive.

What is the difference between PFP and FBO? Aren’t they both private just that one is for profit and the other not for profit? This would help clarify the odds ratio for caesarean section rates.

Since the study relied on hospital records, it would be important to understand how they handled missing data and how what impact it had on their findings.

Authors should provide a table showing correlations and test of associations

Discussion

The link between high CS rates and “because of financial incentives” is unclear whether there is a proven causal relationship between the two to justify the statement.

The authors mention in the final paragraph on Pg. 6 about inspection of health facilities by the MOH. Since these facilities are under the County government, and with devolution there are structures in place to ensure inspection of health facilities and roles are clear for national and County government. The
statement provided in this paragraph may need to be revised to consider the current structures that are in
place to monitor and regulate the County hospitals and clearly bring out the role of national government in
these facilities.

Recommendations for future/further research needs to be provided.

*Revise some grammatical errors in text

Is the work clearly and accurately presented and does it cite the current literature?  Yes

Is the study design appropriate and is the work technically sound?  Yes

Are sufficient details of methods and analysis provided to allow replication by others?  Yes

If applicable, is the statistical analysis and its interpretation appropriate?  Partly

Are all the source data underlying the results available to ensure full reproducibility?  Yes

Are the conclusions drawn adequately supported by the results?  Yes

**Competing Interests:** No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that
it is of an acceptable scientific standard, however I have significant reservations, as outlined
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