HIV treatment and monitoring patterns in routine practice: a multi-country retrospective chart review of patient care [version 2; referees: 2 approved with reservations]

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Abstract

Background: A study of patient records in four HIV clinics in three sub-Saharan African countries examined routine clinical care patterns and variations.

Methods: Clinic characteristics were described, and patient data extracted from a sample of medical records. Data on treatment, CD4 count and viral load (VL) were obtained for the last visit in the records, dates mainly between 2015 and 2017, patient demographic data were obtained from the first clinic visit.

Results: Four clinics, two in Nigeria, one in Zambia and one in Uganda, all public facilities, using national HIV treatment guidelines were included. Numbers of patients and health professionals varied, with some variation in stated frequency of testing for CD4 count and VL. Clinical guidelines were available in each clinic, and most drugs were available free to patients. The proportion of patients with a CD4 count in the records varied from 84 to 100 percent, the latest median count varied from 269 to 593 between clinics. 35% had a record of a VL test, varying from 1% to 63% of patients. Lamivudine (3TC) was recorded for more than 90% of patients in each clinic, and although there was variation between clinics in the choice of antiretroviral therapy (ART), the majority were on first line drugs consistent with guidelines. Only about 2% of the patients were on second-line ARTs. In two clinics, 100% and 99% of patients were prescribed co-trimoxazole, compared with 7% and no patients in the two other clinics.

Conclusions: The wide variation in available clinic health work force, levels and frequency of CD4 counts, and VL assessment and treatment indicate sub-optimal adherence to current guidelines in routine clinical care. There is room for further work to understand the reasons for this variation, and to standardise record keeping and routine care of HIV positive patients.
Keywords
HIV, quality of care, variation, Public Health

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Introduction
In addition to choice of appropriate drugs, best practice management of patients with HIV requires monitoring response to treatment and disease progression. This includes tracking clinical immunological, and virological data on patients at diagnosis and on follow-up. There is a rich literature guiding HIV treatment, and guidelines are developed and updated regularly as new evidence comes to light (see http://www.who.int/hiv/pub/guidelines/en/ for an historic list of guidelines produced by the World Health Organisation). The implementation of standardized protocols for treatment and investigations may vary in resource constrained countries, with differences in resources available for such services. For example, the current guidelines for antiretroviral therapy (ART) requires all patients on ART to have viral load test at six months and 12 months, implementation might vary based on availability of resources to support viral load testing. While a number of reports of current treatment and testing practice are available from resource-limited settings, these are mainly in the context of patients enrolled in research centres or in research studies. Such settings often have substantially more resources than routine clinical practices, and as such practice patterns may differ from routine practice, where issues such as clinic and patient resources or drug stock-outs can affect care. This study was designed to explore variation in the evaluation, treatment, care and follow-up among patients diagnosed with HIV in routine care settings in low- to middle-income countries.

Methods
Interest in participating in this study was sought among the Masters of Public Health Alumni of Peoples-uni. A protocol was developed by those who responded (Supplementary File 1), and a retrospective cohort was created via standardized record review.

A data collection instrument was developed, based on previous research and publications and management guidelines. A spreadsheet was created with coding instructions (Supplementary File 2). In addition, data on the characteristics of the setting for each facility were collected in early 2017 by each investigator in consultation with local clinic staff, and entered onto an online survey form (Supplementary File 3). This included country and city, hospital or other healthcare facility, number of patients seen, and what diagnostic, treatment, referral and follow-up facilities are available. Clinic and patient data were de-identified to maintain confidentiality. Four clinics from three countries in sub-Saharan Africa chose to participate in the study.

For clinic BA, a public hospital clinic in northern Nigeria, patients were selected in sequence of attendance as new patients, starting January 1, 2013 for whom records were also available over the next two years. Patient demographics were those obtained at the first visit, and CD4 count and ART treatments were recorded at each visit, with analysis relating to data recorded at the most recent visit.

For clinic EV, a public hospital clinic also in Nigeria, all existing patients were re-tested with an ELISA method in 2013/14, and patients were randomly selected for this study among those who tested positive at that time. CD4 count and treatments recorded were those at the latest visit, and patient demographics were those in the records from their first visit.

For clinic MW, a public community-based clinic in Zambia, patients were randomly selected from those present on the patient registry in 2015/16. At that time, patients were reviewed for the need to start on highly active antiretroviral therapy (HAART) based on CD4 count, and the ART regime recorded was that started as a result of that review at that time. Data on patient demographics were those present in the records, often this would be prior to the date of entry to this study.

For clinic AM, a public hospital based clinic in Uganda, the sampling frame was the register of all clients on active ART, and every third patient file was retrieved from files ordered according to clinic appointment date. The CD4 counts and ART regimes recorded were for the most recent measures in the records, and patient demographics were those in the records from their first visit.

Measurement of study factors
Data on individual patients were extracted from medical records, including age, gender, and baseline clinical data at diagnosis and follow-up. Clinical information included clinical, immunological and virological information on patients at diagnosis and on follow-up, prescription of ART and other drug choices, important co-infections and/or co-morbidities.

Measurement of outcome factors
Details of the tests ordered and their results, and treatments ordered were extracted from medical records. Individual patients were not contacted. Data were obtained from the records, and no attempt was made to validate the information. Missing data were recorded as missing, and not explored further.

A pilot study tested the feasibility of the data collection and the method of recording on to a spreadsheet. Data were collected by a research assistant in each setting, using the spreadsheet, from examination of individual records.

Ethics requirements
As a retrospective patient records study, consent was not requested from individual patients. Ethics approval was sought and obtained in each setting from the appropriate authority (see Ethical approval and consent section). Considerable care was taken not to reveal the identity of any individual and all data were de-identified. The spreadsheet for the recording of data only had an
identification number, and the key to the identity of each patient was kept separately to maintain confidentiality. To further this, the clinics names and exact locations have been removed.

**Sample size considerations**
Each centre was asked to obtain information from at least 100 patients.

**Data analysis**
Descriptive statistics were used to characterise the study population. Data distributions were assessed, checking for skewness and kurtosis. Data summary statistics were generated. Categorical variables were summarized using proportions while continuous variables were summarized using medians and interquartile ranges. Due to differences in data extraction across sites, no statistical analyses comparing across sites was conducted. All analyses were conducted in Stata 14.1 (StataCorp, College Station, TX) and R version 3.3.0 (The R Foundation for Statistical Computing).

**Results**
Ten alumni expressed interest in participating, three centres were able to pilot the data collection instrument and four centres in three countries participated in the data collection for the study. Overall, data were abstracted for 600 patients.

Table 1 shows the characteristics of the 4 clinics. The number of patients seen per month varied from 500 to 4200, and the number of doctors, nurses, and allied health professionals available at the clinics varied from 1 to 50, 10 to 65, and 6 to 45 respectively. There was some variation in the stated frequency of testing for CD4 count (either every three or six months) and for measurement of viral load. Each clinic had availability of clinical guidelines, and most drugs were available free of charge to patients. All clinics have access to ART and co-trimoxazole.

Table 2 shows the patient characteristics and test results. Age, gender and body mass index (BMI) were similar between clinics, with overall median age of 31 years, 62% were female and median BMI was 20. The proportion of patients with a CD4 count in the records varied from 84 to 100 percent, and the latest median count varied from 269 to 593 between the clinics. 209 (35%) had a record of a viral load test with 81% of them having a viral load of less than 50 copies/µL. Only 23 (19%) of 119 patients had records of AIDS defining illnesses. Figure 1 shows the variation in the distribution of the CD4 counts in each of the four clinics. As reported in the records, 58% of the latest CD4 counts were from 2016 or 2017, 27% from 2015, and the remaining 15% earlier; 95% of the viral load tests were from 2016 or 2017. There was no information about the timing of the reports being given to the patients themselves.

Table 3 shows the treatment regimes. Lamivudine (3TC) was recorded for more than 90% of patients in each clinic, but otherwise there was considerable variation between clinics in the choice of ART. Tenofovir disoproxil fumarate (TDF) was prescribed for 317 (53.9%) of studied patients. Efavirenz

### Table 1. Characteristics of the 4 participating clinics.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital or community</td>
<td>Hospital</td>
<td>Hospital</td>
<td>Community</td>
<td>Hospital</td>
</tr>
<tr>
<td>Public or private</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
</tr>
<tr>
<td>HIV screening</td>
<td>Separate clinic</td>
<td>In clinic</td>
<td>In clinic</td>
<td>In clinic</td>
</tr>
<tr>
<td>Number of patients per month</td>
<td>500</td>
<td>4200</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Number of doctors</td>
<td>6</td>
<td>50</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Number of nurses</td>
<td>10</td>
<td>65</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Number of allied health professionals</td>
<td>21</td>
<td>45</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Access to HIV clinical guidelines</td>
<td>Yes, National, Electronic</td>
<td>Yes, National, Electronic and paper</td>
<td>Yes, National, Paper</td>
<td>Yes, National, Electronic and paper</td>
</tr>
<tr>
<td>CD4 count</td>
<td>Yes, each 3 months</td>
<td>Yes, each 3 months</td>
<td>In central lab, each 6 months</td>
<td>Yes, transported to lab, each 6 months</td>
</tr>
<tr>
<td>Viral load</td>
<td>Yes, each year</td>
<td>Yes, on referral, occasionally</td>
<td>Yes, on referral, when indicated</td>
<td>Yes, each 6 months for adolescents, yearly for adults</td>
</tr>
<tr>
<td>Drugs available free</td>
<td>All ART, Co-trimoxazole</td>
<td>All</td>
<td>All (IDV and ATV not free)</td>
<td>All</td>
</tr>
<tr>
<td>CD4 to start treatment</td>
<td>&lt;350</td>
<td>&lt;350</td>
<td>&lt;350</td>
<td>&lt;350</td>
</tr>
<tr>
<td>Referral</td>
<td>Yes, TB</td>
<td>Yes, complicated eg multi-drug resistance</td>
<td>Yes, if fail treatment</td>
<td>Yes, patients with other medical conditions</td>
</tr>
</tbody>
</table>

ART antiretroviral therapy
IDV indinavir
ATV atazanavir
Table 2. Patient characteristics.

<table>
<thead>
<tr>
<th></th>
<th>BA (N=100)</th>
<th>EV (N=100)</th>
<th>MW (N=100)</th>
<th>AM (N=300)</th>
<th>Overall (N=600)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (median, IQR)</td>
<td>32 (28 to 40)</td>
<td>28 (21 to 37)</td>
<td>33 (29 to 39)</td>
<td>31 (23.5 to 38)</td>
<td>31 (24 to 38)</td>
</tr>
<tr>
<td>Female sex</td>
<td>57 (57%)</td>
<td>62 (62%)</td>
<td>55 (55%)</td>
<td>197 (66%)</td>
<td>371 (62%)</td>
</tr>
<tr>
<td>BMI at presentation¹</td>
<td>22.8 (19.5 to 31.2)</td>
<td>No data</td>
<td>19.5 (17.9 to 21.8)</td>
<td>20.0 (18.3 to 22.2)</td>
<td>20.0 (18.2 to 22.3)</td>
</tr>
<tr>
<td>Number of patients w/CD4 count data</td>
<td>100</td>
<td>94 (94%)</td>
<td>84 (84%)</td>
<td>279 (93%)</td>
<td>558 (93%)</td>
</tr>
<tr>
<td>Latest CD4 Count (median, IQR)</td>
<td>269 (177 to 461)</td>
<td>593 (390 to 880)</td>
<td>307 (169 to 471)</td>
<td>499 (321 to 691)</td>
<td>436 (267 to 471)</td>
</tr>
<tr>
<td>Proportion of patients w/viral load</td>
<td>14 (14%)</td>
<td>6 (6%)</td>
<td>1 (1%)</td>
<td>188 (63%)</td>
<td>209 (35%)</td>
</tr>
<tr>
<td>Latest viral load</td>
<td>&lt;50 (&lt;50%)</td>
<td>50-9,999 (50-9,999)</td>
<td>10,000-99,999 (10,000-99,999)</td>
<td>&gt;99,999 (&gt;99,999)</td>
<td></td>
</tr>
<tr>
<td>AIDS defining illness</td>
<td>2/2 (100%)</td>
<td>7/21 (33%)</td>
<td>14/96 (15%)</td>
<td>No data</td>
<td>23/119 (19%)</td>
</tr>
</tbody>
</table>

Missing BMI data: AM: 3/300, BA: 81/100, EV: 100/100, MW: 14/100 (total 198/600)

Figure 1. Distribution of CD4 counts in each of the four clinics.
(EFV) was prescribed for 326 (55%) of the patients, making combination of TDF/3TC/EFV the most common ART combination used by studied patients. In two clinics, 100% and 99% of patients were prescribed co-trimoxazole prophylaxis, compared with 7% and no patients in the two other clinics. There were 6 patients on lopinavir and 8 on atazanavir (second line treatment choices).

While most patients had a CD4 count in the records, there was a wide spread of latest CD4 counts, with both within- and between-centre variation in the CD4 counts. Only one in three patients had a record of viral load at any time during the course of treatment, and most of these had an undetectable level (<50 copies/µL). Some of the absence of viral load might be poor record keeping, and the high proportion of undetectable results might reflect an absent rather than a low test result, and hence not an indicator of treatment success. Over the years the CD4 threshold for commencing ART had been lowered, as can be seen in Table 4, with the most current guideline requiring a “test and treat approach” ie eliminating CD4 threshold as a prerequisite for commencement of ART. While this guideline is based on sound evidence, it adds an unanticipated number of potential eligible patients for ART care, with attendant strain on countries with an already fragile economy. The low frequency of viral load test results might also reflect resource limitations.

Most patients were on TDF/3TC/EFV drug regimen, which is consistent with current guideline advice for first line treatment. Only 2% of the patients were on second-line ART, varying from 9% to less than 1% between clinics. It is likely that most of the studied patients are still on a potent first line ART judging from 9% to less than 1% between clinics. It is likely that most of the studied patients are still on a potent first line ART judging from 9% to less than 1% between clinics. It is likely that most of the studied patients are still on a potent first line ART judging from 9% to less than 1% between clinics.

The variation in the use of co-trimoxazole, from almost universal in two clinics, to negligible in the other two clinics, is an extreme example of the variation we identified. The reason for this variation despite the guideline recommendation is not clear, but it is possible that it is a result of local clinic policy settings, possibly related to concerns about increasing antibiotic resistance. Variation in the use of co-trimoxazole has been found in other resource-limited settings, while efforts are being made to improve the rates of use.

### Table 3. Antiretroviral therapy (ART) Regimens.

<table>
<thead>
<tr>
<th>ART regimen contains</th>
<th>BA (N=100)</th>
<th>EVT (N=94)</th>
<th>MW (N=99)</th>
<th>AM (N=295)</th>
<th>Overall (N=588)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZT zidovudine</td>
<td>28 (28.0%)</td>
<td>87 (92.6%)</td>
<td>0</td>
<td>113 (38.3%)</td>
<td>228 (38.8%)</td>
</tr>
<tr>
<td>TDF tenofovir</td>
<td>70 (70.0%)</td>
<td>3 (3.2%)</td>
<td>90 (90.9%)</td>
<td>154 (52.2%)</td>
<td>317 (53.9%)</td>
</tr>
<tr>
<td>lamivudine</td>
<td>10 (10.0%)</td>
<td>0</td>
<td>5 (5.2%)</td>
<td>0</td>
<td>15 (2.6%)</td>
</tr>
<tr>
<td>NVP nevirapine</td>
<td>90 (90.0%)</td>
<td>94 (100%)</td>
<td>94 (95.0%)</td>
<td>276 (93.6%)</td>
<td>554 (94.2%)</td>
</tr>
<tr>
<td>IDV indinavir</td>
<td>24 (24.0%)</td>
<td>91 (96.8%)</td>
<td>0</td>
<td>111 (37.6%)</td>
<td>226 (38.4%)</td>
</tr>
<tr>
<td>RTV ritonavir</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>d4T stavudine</td>
<td>0</td>
<td>0</td>
<td>6 (6.4%)</td>
<td>0</td>
<td>6 (1.0%)</td>
</tr>
<tr>
<td>ABC abacavir</td>
<td>2 (2.0%)</td>
<td>0</td>
<td>9 (9.1%)</td>
<td>9 (3.1%)</td>
<td>20 (3.4%)</td>
</tr>
<tr>
<td>LPV lopinavir</td>
<td>3 (3.0%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ATV atazanavir</td>
<td>0</td>
<td>0</td>
<td>6 (6.4%)</td>
<td>0</td>
<td>6 (1.0%)</td>
</tr>
<tr>
<td>EFV efavirenz</td>
<td>6 (6.0%)</td>
<td>1 (1.1%)</td>
<td>9 (9.1%)</td>
<td>1 (0.3%)</td>
<td>8 (1.4%)</td>
</tr>
<tr>
<td>Co-trimoxazole</td>
<td>100(100%)</td>
<td>7 (7.5%)</td>
<td>0</td>
<td>292 (98.9%)</td>
<td>399 (66.6%)</td>
</tr>
</tbody>
</table>

### Discussion

Data were collected in a standardised way, with data on treatment regimes and CD4 counts relating to the latest information in the records (dates mainly between 2015 and 2017). While we initially planned to collect data on a cohort of patients enrolled two years before data collection in each clinic, this did not prove feasible and patients had presented to the clinics at variable times.

This study found modest documentation of clinical activities, with a wide variation in available clinic health work force, frequency of CD4 counts and levels and viral load assessment. The two clinics in Nigeria had markedly different caseloads. The centre with the high caseload is one of the oldest in Nigeria and provides incentives to this population of patients (free medical care to family members, distribution of food supplements and sometimes fares, etc.). Differences in case load may reflect population distribution and heterogeneity in HIV prevalence, or that patients may seek care far away from their base to avoid stigmatization. Variation in case load can lead to differences in efficiency and quality of care, and potentially could have implications for care outcomes. However determining its impact on outcome would a require a properly powered longitudinal study.

**Dataset 1. De-identified data collected from clinical records used to create Tables 2 and 3 and Figure 1**

http://dx.doi.org/10.5256/f1000research.15169.d20633

Scheme used to code the data is available as Supplementary File 2.
### Table 4. Summary of key features of World Health Organisation guidelines.

<table>
<thead>
<tr>
<th>TIME</th>
<th>REFERENCE</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Scaling up antiretroviral therapy in resource-limited settings: guidelines for a public health approach¹</td>
<td>ART treatment if:&lt;br&gt;• CD4 ≤200 cells/mm³ WHO stage I, II, or III&lt;br&gt;• OR&lt;br&gt;• WHO Stage IV AIDS-defining illness, irrespective of CD4 count&lt;br&gt;• First line therapy ZDV/3TC/EFZ or ZDV/3TC/NVP</td>
</tr>
<tr>
<td>2006</td>
<td>Antiretroviral therapy for HIV infection in adults and adolescents. Recommendations for a public health approach (2006 revision)²</td>
<td>• All adolescents and adults including pregnant women with HIV infection and CD4 counts ≤500 cells/mm³, should start ART,&lt;br&gt;• First line treatment NRTI AZT or TDF combined with either 3TC or FTC; NNRTI, either EFV or NVP, should be added</td>
</tr>
<tr>
<td>2010</td>
<td>Antiretroviral therapy for HIV infection in adults and adolescents. Recommendations for a public health approach: 2010 revision³</td>
<td>• All adolescents and adults including pregnant women with HIV infection and CD4 counts ≤350 cells/mm³, should start ART,&lt;br&gt;• First-line therapy should consist of an NNRTI + two NRTIs, one of which should be AZT or TDF&lt;br&gt;• Second-line ART should consist of a ritonavir-boosted protease inhibitor (PI) plus two NRTIs, one of which should be AZT or TDF&lt;br&gt;• Irrespective of CD4 cell counts, patients coinfected with HIV and TB should be started on ART&lt;br&gt;• Irrespective of CD4 cell counts or WHO clinical stage, patients who require treatment for HBV infection should start ART.</td>
</tr>
<tr>
<td>2013</td>
<td>Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach¹</td>
<td>• As a priority, ART should be initiated in all individuals with severe or advanced HIV clinical disease (WHO clinical stage 3 or 4) and individuals with CD4 count ≤350 cells/mm³&lt;br&gt;• ART should be initiated in all individuals with HIV with CD4 count &gt;350 cells/mm³ and ≤500 cells/mm³ regardless of WHO clinical stage&lt;br&gt;• ART should be initiated in all individuals with HIV regardless of WHO clinical stage or CD4 cell count in the following situations:&lt;br&gt;• Individuals with HIV and active TB disease (strong recommendation, low-quality evidence).&lt;br&gt;• Individuals coinfected with HIV and HBV with evidence of severe chronic liver disease&lt;br&gt;• Partners with HIV in serodiscordant couples should be offered ART to reduce HIV transmission to uninfected partners (strong)</td>
</tr>
<tr>
<td>2015/6</td>
<td>Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach - Second edition⁵</td>
<td>• Retesting prior to enrollment in care ART should be initiated in all adults living with HIV, regardless of WHO clinical stage and at any CD4 cell count&lt;br&gt;• As a priority, ART should be initiated in all adults with severe or advanced HIV clinical disease (WHO clinical stage 3 or 4) and adults with a CD4 count ≤350 cells/mm³&lt;br&gt;• ART should be started in all TB patients living with HIV regardless of CD4 count&lt;br&gt;• Preferred first line ART regimen TDF + 3TC (or FTC) + EFV&lt;br&gt;• Combinations of ATV and LPV are the preferred boosted PI options for second-line ART&lt;br&gt;• Routine viral load monitoring can be carried out at 6 months, at 12 months and then every 12 months thereafter if the patient is stable on ART to synchronize with routine monitoring and evaluation reporting&lt;br&gt;• CD4 count every 6 months until in settings where routine viral load monitoring is available, until are stable on ART&lt;br&gt;• Viral load is recommended as the preferred monitoring approach to diagnose and confirm treatment failure</td>
</tr>
</tbody>
</table>

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ART antiretroviral therapy<br>AZT zidovudine : ZDV retrovir<br>3TC lamivudine<br>EFV (EFZ) efavirenz<br>NVP nevirapine<br>NNRTI Nucleotide analog reverse transcriptase inhibitor<br>TDF tenofovir disoproxil fumarate<br>FTC emtricitabine<br>HBV Hepatitis B virus

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While each clinic reported having access to treatment guidelines, those current at the time of the data collection do not appear to have been universally followed. The guidelines also do change regularly, as shown in Table 4. For example in relation to the frequency of CD4 count monitoring and the CD4 count threshold at which treatment should be started have changed since the time relating to the study data - new guidelines recommend starting treatment regardless of the CD4 count\textsuperscript{12,13}. Some discrepancy between WHO guidelines and actual implementation in practice may arise from the time it takes to implement new guidelines, or due to lack of resources to immediately initiate all patients with HIV on ART. We see considerable between-clinic variation in a number of key management strategies reported by the clinics, from the recording of CD4 counts, median CD4 counts on treatment, and treatments used. This variation is consistent with a previous survey of stated management practices in 6 sub-Saharan countries\textsuperscript{13,14}. The management of patients in routine clinical care has been shown to differ from that seen in clinical trials\textsuperscript{15}, as well as to lead to worse clinical outcomes, although it is beyond the scope of our study to explore outcomes. Findings of variation from standard management practice has previously been reported from routine care settings in other parts of sub-Saharan Africa including Ethiopia\textsuperscript{16}, Uganda\textsuperscript{17} and Tanzania\textsuperscript{18}, mostly in single isolated centres. Here we present combined data on health system related measures across multiple sub-Saharan African HIV treatment sites.

In the absence of standardised record keeping systems, it is difficult to make clear comparisons of management and outcome in routine clinical care. Our findings suggest that there is room for further work to understand the reasons for these record gaps, and to standardise the record keeping in routine care of HIV positive patients\textsuperscript{19–21}. The potential of electronic medical records to improve records could be explored\textsuperscript{22}.

Our study has a number of limitations. First, this study was an analysis of data extracted from existing medical records, which are prone to error including missing data. We have found missing data where it should ordinarily not be missing. We cannot comment on other factors that may have contributed to missing data, such as whether tests were not done or if they were not recorded. Second some of the variation between centres may be due to differences in patient populations which we were unable to capture, even though we selected clinics involved in routine clinical care. Third, participation in the study was restricted to few countries, and to individual clinics, which may not be representative of the national picture in these countries. A prospective cohort study on representative samples would provide a more robust study design with more detailed quantitative data to delineate care dynamics and to provide longitudinal data to better understand how clinical practice in these settings is linked to patient outcomes.

Conclusions
We demonstrate a wide variability in compliance with HIV treatment guidelines in four routine care settings in sub-Saharan Africa, as well as gaps in the records available. The findings of this study may provide an explanation for heterogeneous HIV treatment outcomes across sub-Saharan Africa. In spite of the limitations, these data underscore the need for an in-depth study to address compliance with HIV treatment guidelines and best practice. While electronic medical record implementation might be a challenge for many HIV care points in sub-Saharan Africa, our findings emphasize the need for more robust interim paper-based medical record keeping.

Ethics approval and consent
Ethics approval was sought in each setting from the appropriate authority. For two of the centres, research ethics committees gave approval. In two of the centres, the ethics committees stated that they did not require formal approval from them, however approval to access records was obtained from the relevant District Health Office/r. Details for each clinic as follows:

Clinic BA: Ethics approval obtained from Aminu Kano Teaching Hospital Research Ethics Committee.
Clinic EV: Ethics approval obtained from Research and Ethics Committee of State House Medical Centre, Abuja.
Clinic MW: University of Zambia Biomedical Research Ethics Committee contacted and advised to notify the Lusaka District Health Office (LDHO) who gave approval.
Clinic AM: Eastern Uganda AIDS Support Organization (TASO) contacted who recommended no need for an approval but rather write to the Amuria District Health Officer (DHO) for permission to have access to the hospital records, which was given.

Informed consent was not obtained from individual patients since this was a records study with appropriate institutional approval, strict confidentiality arrangements, and no patient contact, as stated in the manuscript.

Data availability
Dataset 1. De-identified data collected from clinical records used to create Table 2 and Table 3 and Figure 1. Scheme used to code the data is available as Supplementary File 2. 10.5256/f1000research.15169.d206333

All data underlying the survey responses from clinic informants for Table 1 are available as part of the article.

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

Acknowledgements
Thanks to Rebecca Oyomopito for help with designing the data collection instrument, Ado Abubakar for help with piloting the instrument, and Krishna Shrinivas for help through Statistics Without Borders.
Supplementary material

Supplementary File 1 – Study protocol
Click here to access the data.

Supplementary File 2 – Data coding scheme
Click here to access the data.

Supplementary File 3 – Written from of online survey
Click here to access the data.

References

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Department of Population Health, Faculty of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

The paper is well written, however in some instances the authors have used outdated references. In the case of Nigeria where there are 2 health facilities with different caseloads per month, the authors could also enlighten us on the impact of having a high and low case load as presented.

The authors should also enlighten us on whether the records indicate the dates when the CD4 count and viral load tests were taken and when they were reported back. I suppose this of great importance since, there are reports of patients who have their blood samples taken and never receive results.

1) Is The study design appropriate and is the work technically sound?
The study design and the work is technically, as the authors endeavoured to analyse multi-country settings

2. Are sufficient details of methods and analysis provided to allow replication by others?
The methods and analysis were sufficient, however in the case of Nigeria where there are 2 health facilities with different case loads per month; the authors could also enlighten us on the impact of having a high and low case load as presented.

3. If applicable, is the statistical analysis and its interpretation appropriate?
The statistical analysis was appropriate, although the authors should also enlighten us on whether the records indicate the dates when the CD4 count and viral load tests were taken and when they were reported back. I suppose this of great importance since, there are reports of patients who have their blood samples taken and never receive results.

4. Are the conclusions drawn adequately supported by the results?
The authors however need to address the issues that have been raised above.

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

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?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Partly

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 above.

Richard Heller, People's Open Access Education Initiative (Peoples-uni), Australia

Thank you for your generally positive comments. In the revised version submitted, we have added four recent references, and given further details on the dates of CD4 counts and viral load tests (although we have no data on the time that the results were reported to the patients). We have also discussed the reasons that the two Nigerian clinics might have different caseloads and the potential impact of this.

Competing Interests: No competing interests were disclosed.

Thomas Crellen, Mahidol Oxford Tropical Medicine Research Unit (MORU), Bangkok, Thailand

This article by Musa and colleagues uses a snapshot of patient records from four HIV clinics in Nigeria, Zambia and Uganda to describe the variability in a number of patient measures. Data are not reported longitudinally and all analysis is descriptive.

The most useful part of this report is to show that ordinary clinics in countries with some of the highest HIV burdens globally do not confirm with WHO guidelines. For instance, only commencing ART when CD4 cells <350/ul. Further, the high amount of missing data in viral loads suggest there are logistical or cost challenges to routine testing.

It is perhaps unsurprising that clinics in different countries vary in their patient characteristics and levels of reporting. The variability in CD4 counts is not particularly informative as it is not linked to length of time.
under ART. No research questions are addressed.

Table 2 should be amended as some percentage values are missing and figures are presented to different numbers of significant figures.

Despite the descriptive nature of the study, the authors are to be commended on presenting hard to access data from routine health care settings in sub-Saharan Africa. I hope that they will be able to take longitudinal data in the future and better understand how clinical practice in these settings is linked to patient outcomes.

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?
Partly

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

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Referee Expertise: Epidemiology, regression modelling, pathogen genomics

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 above.

Author Response 22 Sep 2018

Richard Heller, People's Open Access Education Initiative (Peoples-uni), Australia

Thank you for your positive comments on the paper. In the revised version submitted, we have tried to emphasise the points you make, and have amended Table 2 as requested.

Competing Interests: No competing interests were disclosed.
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