International Journal of Infectious Diseases 33 (2015) 109–113

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Better adherence to pre-antiretroviral therapy guidelines after implementing an electronic medical record system in rural Kenyan HIV clinics: a multicenter pre–post study☆

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ARTICLE INFO

Article history:
Received 24 December 2013
Received in revised form 30 May 2014
Accepted 3 June 2014

Corresponding Editor: Sheldon Brown, New York, USA

Keywords:
Electronic medical records
eHealth
HIV
Guideline adherence
Developing countries
Quality of care

SUMMARY

Introduction: The monitoring of pre-antiretroviral therapy (pre-ART) is a key indicator of HIV quality of care. This study investigated the association of an electronic medical record system (EMR) with adherence to pre-ART guidelines in rural HIV clinics in Kenya.
Methods: A retrospective study was carried out to assess the quality of pre-ART care using three indicators: (1) the performance of a baseline CD4 test, (2) time from enrollment in care to first CD4 test, and (3) time from baseline CD4 to second CD4 test. A comparison of these indicators was made pre and post the introduction of an EMR system in 17 rural HIV clinics.
Results: A total of 18 523 patients were receiving pre-ART care, of whom 38.8% in the paper group had had at least one CD4 test compared to 53.4% in the EMR group ($p < 0.001$). The adjusted odds of performing a CD4 test in clinics using an EMR was 1.59 (95% confidence interval 1.49–1.69). The median time from enrolment into HIV care to first CD4 test was 1.40 months (interquartile range (IQR) 0.47–4.87) for paper vs. 0.93 months (IQR 0.43–3.37) for EMR. The median time from baseline to first CD4 follow-up was 7.5 months (IQR 5.97–10.73) for paper and 6.53 months (IQR 5.57–7.87) for EMR.
Conclusion: The use of the EMR system was associated with better compliance to HIV guidelines for pre-ART care. EMRs have a potential positive impact on quality of care for HIV patients in resource-constrained settings.
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1. Introduction

Nearly two-thirds of the 34 million persons infected with HIV globally live in Sub-Saharan Africa (SSA).[1] As of December 2011, 70% of the 1.7 million HIV-related deaths occurred in SSA.[2] The high volume of patients in an environment that lacks adequate skilled human resources and equipment, adds to the dire need to invent ways to improve the quality of care for those infected with HIV. Despite the availability of diagnostic testing for HIV and the availability of highly active antiretroviral therapy (ART) since the mid 1990s, early mortality remains high among patients who access ART with advanced symptomatic disease and low baseline CD4.[3,4] Effective pre-ART patient monitoring and timely initiation of ART can potentially reduce HIV-related mortality.[5] The 2010 revision of the World Health Organization (WHO) guidelines on ART for HIV infection recommend using CD4 cell counts to monitor pre-ART care and determine patient eligibility for ART initiation.[6] Although the 2013 revision of the WHO guidelines recommending the use of viral load for patient monitoring were released in July 2013,[7] many countries are yet to adopt them.

Various studies have shown the benefits of electronic medical record (EMR) systems in delivering quality health care for chronic illnesses.[8–10] EMRs can be integrated into clinical practice to enhance guideline adherence. Despite the evidence of the benefits of EMRs, many health facilities that offer HIV care and treatment in SSA use paper-based records for patient data.[11] As the number of enrolled patients increases against a relatively fixed number of overworked health workers, the paper records become more prone

☆ *Disclaimer:* The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention or the Government of Kenya.

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http://dx.doi.org/10.1016/j.ijid.2014.06.004
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to error, less efficient, and ineffective in managing the complex longitudinal patient data. This situation can potentially compromise the quality of information used for patient care and thereby negatively affect patient outcomes. Due to these considerations, a number of health facilities in SSA are transitioning practice from the use of paper records to EMRs in order to improve patient monitoring and hence quality of care.[10]

The Kenyan Ministries of Health (MOH) and the US President's Emergency Plan for AIDS Relief (PEPFAR) have provided resources for the national rollout of EMRs at HIV, tuberculosis, and maternal and child health (MCH) clinics to improve data management for clinical decision-making and reporting.

The aim of this study was to assess the effect of the change from a paper-based to an electronic-based medical record system on CD4 testing among HIV-infected persons in the pre-ART care period.

2. Methods

We conducted a retrospective study to compare quality of care indicators before and after the introduction of an EMR system at 17 health facilities providing HIV care and treatment services in Nyanza Province, western Kenya. Study participants were patients aged 2 years and older receiving HIV care at the participating clinics, since the Kenyan HIV guidelines require that all children under 2 years of age should initiate ART irrespective of their immunological status. All the clinics had used paper-based records before transitioning to electronic records at varying times from January 2009 to February 2012.

2.1. Study setting

Nyanza Province has the highest HIV burden among Kenya's eight provinces, with a prevalence of 14.9%; it is home to about a third of all HIV-infected persons in Kenya.[12] EMRs were installed at 17 health facilities that had electricity and adequate security for computers. The 17 clinics, which were providing HIV care and treatment to about 39 203 active patients as of September 2012, (PEPFAR semi-annual report for Kenya) are all located in rural settings and encounter common challenges including inadequate staffing and weak infrastructure; the latter includes frequent electric power interruptions and unreliable Internet access. The studied facilities fall into three categories, as established by the Government of Kenya, namely: district hospitals ($n = 4$), which are level 4 (headed by a physician and providing both inpatient and outpatient services); health centers ($n = 11$), which are level 3 (headed by a clinical officer who is equivalent to a physician assistant; these provide a limited number of services compared to district hospitals); and dispensaries ($n = 2$), which are level 2 (headed by a nurse and providing only limited outpatient services).

2.2. Pre-ART care

Pre-ART care is provided during the period between a confirmed HIV-positive test and eligibility for ART initiation based on Kenyan ART guidelines. Pre-ART care is offered at no cost to the patient in many SSA countries. During the pre-ART care period, HIV-infected patients receive a range of clinical services, including the provision of co-trimoxazole prophylaxis, multivitamins, screening for TB and other opportunistic infections, and routine laboratory monitoring; key among these are CD4 cell count measurements every 6 months and viral load tests. The CD4 cell count serves as the most important laboratory indicator of the degree of immunosuppression among HIV patients and is the most important prognosis indicator for patients starting ART.[3,4,13] The CD4 test is now widely available in health facilities in SSA for the routine monitoring of HIV disease progression and response to treatment.

2.3. Paper-based patient monitoring system

The paper-based system entailed the recording of patient details on an MOH-approved Comprehensive Care Clinic Card (MOH 257) (Appendix). MOH 257 holds demographic and contact details of the patient, treatment support data, HIV testing and treatment history, allergies, HIV treatment eligibility and regimen (first- or second-line), vital signs, treatment outcomes, laboratory results including CD4, co-infections, and an appointment date for the next visit. Observations for each visit are recorded in a single column on a paper chart (see Appendix).

Scheduling patient visits for each clinic day was done manually from the MOH 257 where the follow-up visit date was recorded. Analyses such as tracking of patient clinic visit appointments, trends in measurements such as vital signs and treatment progress including CD4 cell counts, statistical summaries for hospital administration use, and MOH reporting were all conducted manually. Clinicians reviewed the individual patient's treatment history based on filed paper notes during routine clinic visits.

2.4. Electronic medical record (EMR) system

The EMR system rolled-out in the 17 facilities is called the Comprehensive Care Centre Patient Application Database (C-PAD) and was developed in 2007.

Data management entails clinicians recording information on paper forms (MOH 257), as was the case for the paper-based system, followed by data entry by a data clerk into the EMR on the same day as the clinic visit or the next day. Mandatory variables such as demographic data, vital signs, medications, and key laboratory measurements must be entered into the computer for the continuation of system operation. It takes about 10 min to enter the records of a new patient and about 5 min to update the records of a revisit patient if all required information is available. Data clerks make immediate follow-up with the clinicians to provide any missing data. Weekly reviews of EMR-generated patient summary reports are used to flag patients with conditions that need follow-up – for example, patients with no baseline CD4 result or those whose follow-up CD4 tests are overdue. Data entry by data clerks is common practice in many SSA countries as clinics transition from the use of paper to electronic systems. Clinicians interact with the EMRs through the weekly patient summary reports or by directly reviewing individual patient data on the EMR in addition to the paper records.

For this study, pre-EMR data from the paper forms (MOH 257) were entered retrospectively for all patients who initiated treatment prior to the installation of the EMR system, and compared to electronic data for patients enrolled in HIV care after the installation of the EMR.

2.5. Outcome measures

We assessed the effect of EMR use on the following factors, which are key in pre-ART care: (1) performing a baseline CD4 test, (2) time from enrolment into HIV care to the first (baseline) CD4 test, and (3) time from the first to the second CD4 test.

Each patient enrolled in HIV care should undergo baseline CD4 testing. The shorter the time from enrolment into HIV care to baseline CD4 testing, the better the compliance with HIV treatment guidelines.[13] According to the HIV treatment guidelines, a repeat CD4 test should be performed for every patient at least once every 6 months. For each site, the date of C-PAD installation was used to

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