Electronic Health Records as an emergency tool for rapid assessment of highly infectious diseases in Africa

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Abstract: **Several designs of Electronic Health Record (EHR) systems have been implemented in both developed and developing countries. The adoption of EHR systems is imperative as it can aid clinicians to monitor the adherence and also avoid the risk of getting infected as well as providing quality health care and information. This paper aims at reviewing the possibilities of using electronic data processing platforms in providing rapid solutions to curb the spread of infectious diseases in Africa. Information used in this review paper was mainly obtained from scientific electronic academic journals. Most significant challenges faced in recording and reviewing the information of Ebola patients are created during the isolation and treatment of these patients at the specialized installations, which are classified as Ebola Treatment Centers (ETCs) with rigorous infection control requirements. More significantly, health-related problems could potentially be resolved using EHR systems with additional benefits for research, surveillance and patient care. EHRs/EMRs can reduce human contact during the spread of highly infectious diseases like Ebola. However, further researches should be conducted to ascertain the prospect of using technology specifically EHRs or Electronic Paperless Platforms (EPP) in preventing the spread of infectious diseases in Africa.**

Keywords: **Health Records; Infectious Diseases; Medical Records; Health Informatics; Ebola; HIV/AIDS; Africa.**

1. INTRODUCTION

There have been so many instances of the spread of highly infectious diseases in Africa. For instance, the Ebola outbreak which occurred in West African in 2014 was extraordinary. This was evident in the rate it spread affecting individuals with almost 20,000 infection reported spread the end of 2014 alone. The massive infection reported cases led to the establishment of Ebola Treatment Centres (ETCs) across the countries involved. ETCs were specially designed facilities that provided effective health-care for alleged and medical laboratory confirmed Ebola clients while reducing the risk of cross-infection to workers and other clients. ETC staff faced several problems at the centers such as; the difficulty of working in individual protective cloth and equipment due to excessive heat and low vision especially during the night shift as well as the been unable to move material from extremely infectious client areas which was tagged as "Red Zone" to less risky/infectious areas also labelled as "Green Zone". The usual local paper-based data gathering was difficult for the above stated reasons. Therefore, ETCs were often limited in their capacity to collect data for effective care, monitoring patients progress, and research [1]. Most significant challenges faced in recording and reviewing the information of Ebola patients are created during the isolation and treatment of these patients at the specialized installations, which are classified as Ebola Treatment Centers (ETCs) with rigorous infection control requirements. In this regard, it was established during the West African Ebola epidemic which occurred from 2014 to 2016 and that the quality, quantity, and confidentiality of patient data were compromised by the paper-based data collection systems employed at the ETCs [2]. The adoption of Electronic Health Records (EHRs) systems is imperative as it can aid clinicians to monitor the adherence to antiretroviral therapy (ART) by HIV patients in limited resource settings. Besides, EHRs technology enables the identification of patients at risk of ART failure in future, especially the high risk individuals are most likely to

benefit from these limited resources[3]. This paper aims at reviewing the possibilities of using electronic data processing platforms in providing rapid solutions to curb the spread of infectious diseases in Africa. More significantly, health-related problems could potentially be resolved by using EHR systems with additional benefits for research, surveillance and patient care especially during an epidemic [2].

2.   METHOD

2.1 Selection of Relevant Literature

Information used in this review paper was mainly obtained from scientific electronic academic journal search engines (database) websites such as; Web of knowledge, Google Scholar, PubMed, Scopus, Science Direct, Springer, Sage, Biomed Central and other different sources of academic journals within the months of September, 2018. The information gathered covers most current and relevant academic articles. The paper mainly encompasses peer reviewed articles published in English language with African settings which were available online from 2014-2018. Generally, Google scholar and other databases (PubMed, Scopus, Science Direct, Medline, Springer, Sage, and Biomed Central) yielded about 125 results using the same text phrases. Relevant results from related literature were downloaded, sorted, read thoroughly and important information were fished out and sifted. Finally, the final relevant information was put together to compose this paper with the use of Mendeley Referencing Software.

Exclusion Criteria

✖ Studies which were not published in English.

✖ Studies that were out of context

✖ Studies which were too old and not relevant to the topic.

Inclusion Criteria

✔ Articles published in English

✔ Studies relevant to the topic

✔ Studies applicable to Africa EHRs/MHRs/HIMS/HIS

✔ Recent studies published within five years (2014-2019)
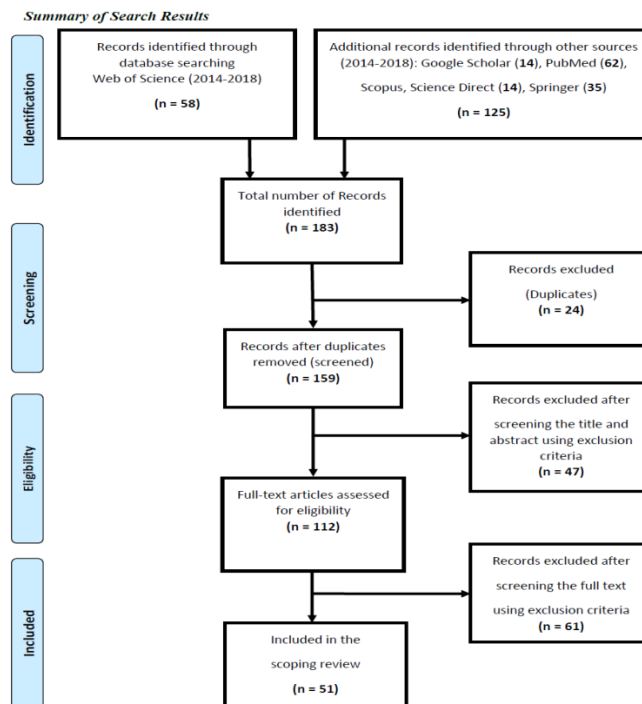
✔ Old but very relevant studies

Fig. 1 – The PRISMA flow diagram [3] depicting articles selection

2.2 Selection of articles included in the review

The process for the selection of the articles for review is indicated in Fig. 1[4]. A total of 51 articles (tables; 2, 3a, 3b, 4a, 4b, 4c, 4d, and 4e) were included in this report after duplicates exclusion and review of full-text articles (table 1) as well as the application of inclusion and exclusion criteria.

Table 1: Full-text articles assessed for eligibility by Countries

Country/Settings	Number of Articles(n=112)	Percentage (%)
South Africa	29	25.00
Kenya	27	23.28
Ghana	8	6.90
Tanzania	8	6.90
Malawi	7	6.03
Ethiopia	5	4.31
Sub-Sahara Africa	4	3.45
Uganda	4	3.45
Burkina Faso	2	1.72
Cameroon	2	1.72
Nigeria	2	1.72
Others	2	1.72
Rwanda	2	1.72
Senegal	2	1.72
Sierra Leone	2	1.72
WHO	2	1.72
Botswana	1	0.86
Congo	1	0.86
DR Congo	1	0.86
Egypt	1	0.86
Madagascar	1	0.86
Mozambique	1	0.86
Namibia	1	0.86
Zambia	1	0.86

3. RESULTS AND DISCUSSION

The full-text articles assessed for eligibility by countries is indicated in Table 1. In total 112 articles were selected for eligibility for inclusion in this review. The eight selected articles included in this report from South African setting are depicted in Table 2. The titles, objectives and the Authors of the various articles are also shown in Table 2. Tables 3a and 3b are the selected articles included from Kenyan region. In general, Tables 4a, 4b, 4c, 4d, up to 4e are the selected articles included by other countries in Africa apart from South Africa and Kenya since most of the countries recorded minimal number of articles from their region. Totally, 51 articles had been included in this review with the aim of identifying the prospect of EHRs/EMRs or electronic paperless record usage in preventing the spread of infectious diseases in the African Sub region.

Table 2: Selected articles included from South African setting

No.	Title	Authors & Year	Objective
1	The Electronic Trauma Health Record: Design and Usability of a Novel Tablet-Based Tool for Trauma Care and Injury Surveillance in Low Resource Settings	Zargaran et al., 2014	Design of an electronic application capable of supporting clinical care and injury surveillance
2	Electronic Medical Record (EMR) Technology Acceptance by Healthcare Professionals in South Africa	Mammen & Weeks, 2014	cost effective healthcare service delivery to all South Africans.
3	Using a Hybrid Electronic Medical Record System for the Surveillance of Adverse Surgical Events and Human Error in A Developing World Surgical	G. Laing et al., 2015	develop a hybrid electronic medical record (HEMR) system for the accurate collection and integration of data into a structured

No.	Title	Authors & Year	Objective
	Service		morbidity and mortality (M&M) meeting.
4	Nurses behaviour pre and post the implementation of data capture using tablet computers in a rural clinic in South Africa	Wright, O'Mahony, Kabuya, Betts, & Odama, 2015[5]	The intention was to determine if there were any differences in the activities and workloads between the two methods of data capture.
5	an open-access mobile compatible electronic patient registers for rheumatic heart disease ('eregister') based on the World heart Federation's framework for patient registers	Van Dam et al., 2015	To assess the feasibility and potential benefits of producing an electronic RHD patient register.
6	Electronic Medical Records in low to middle income countries: The case of Khayelitsha Hospital, South Africa	Ohuabunwa, Sun, Jean Jubanyik, & Wallis, 2015	to evaluate the ability and completeness of the EMR at Khayelitsha Hospital (KH) to capture all Emergency Centre (EC) encounters classified as trauma.
7	An importance-performance analysis of hospital information system attributes: A nurses' perspective	Cohen, Coleman, & Kangethe, 2016	to identify priorities for managerial intervention based on user evaluations of the performance of the HIS attributes as well as the relative importance of these attributes to user satisfaction and productivity outcomes.
8	Electronic Health Records in the Cloud: Improving Primary Health Care Delivery in South Africa	Cilliers & Wright, 2017	to identify the major reasons why the cloud has not been used to implement EHRs for the South African public health care system, and to provide recommendations of how to overcome these challenges.

Table 3a: Selected articles included from Kenyan setting

No.	Title	Authors & Year	Objective
9	A comparison of smartphones to paper-based questionnaires for routine influenza sentinel surveillance, Kenya, 2011–2012	Njuguna et al., 2014	compared the quality, cost and timeliness of data collection between smartphone data collection system and the paper-based system.
10	Electronic medical record systems are associated with appropriate placement of HIV patients on antiretroviral therapy in rural health facilities in Kenya: a retrospective pre-post study.	Oluoch et al., 2014	assessed the effect of transitioning from paper-based to an EMR-based system on appropriate placement on ART among eligible patients.
11	Developing a National-Level Concept Dictionary for EHR Implementations in Kenya Aggrey	Keny, Wanyee, Kwaro, Mulwa, & Were, 2015	to develop common terminology standards to assure semantic interoperability of EHRs in Kenya.
12	Feasibility of an innovative electronic mobile system to assist health workers to collect accurate, complete and timely data in a malaria control programme in a remote setting in Kenya	Soti et al., 2015	to pilot feasibility of Fionet, an innovation that integrates diagnostics, data capture and cloud services, in its malaria control programme to demonstrate usability and feasibility by primary level workers in a remote setting in Kenya.
13	Usability and feasibility of a tablet-based Decision-Support and Integrated Record-keeping (DESIRE) tool in the nurse management of hypertension in rural western Kenya	Vedanthan et al., 2015	To conduct iterative usability and feasibility testing of a tablet-based Decision Support and Integrated Record-keeping (DESIRE) tool, a technology intended to assist rural clinicians taking care of hypertension patients at the community level in a resource-limited setting in western Kenya.
14	Implementation of a cloud-based electronic medical record for maternal and child health in rural Kenya	Haskew, Rø, Saito, et al., 2015	implemented a novel cloud-based electronic medical record system in a maternal and child health outpatient setting in Western Kenya.
15	Better adherence to pre-antiretroviral therapy guidelines after implementing an electronic medical record system in rural Kenyan HIV clinics: a multicenter pre–post study	Oluoch, Kwaro, et al., 2015	investigated the association of an electronic medical record system (EMR) with adherence to pre-ART guidelines in rural HIV clinics in Kenya.
16	Implementation of a Cloud-Based Electronic Medical Record to Reduce Gaps in the HIV Treatment Continuum in Rural Kenya	Haskew, Rø, Turner, et al., 2015	implemented a novel cloud-based electronic medical record system in an HIV outpatient setting in Western Kenya.

Table 3b: Selected articles included from Kenyan setting

No.	Title	Authors & Year	Objective
17	Barriers and facilitators to Electronic Medical Record (EMR) use in an urban slum	Jawhari, Keenan, et al., 2016	This study sought practical insights about facilitators and barriers to EMR implementation in urban slum environments.
18	People, Process and Technology: Strategies for Assuring Sustainable Implementation of EMRs at Public-Sector Health Facilities in Kenya.	S. G. Kang'a, Muthee, Liku, Too, & Puttkammer, 2016	Strategies for Assuring Sustainable Implementation of EMRs at Public-Sector Health Facilities in Kenya
19	Assessing the impact of a primary care electronic medical record system in three Kenyan rural health centers	Tierney et al., 2016	designed, implemented, and assessed the impact of a primary care electronic medical record (EMR) in three rural Kenyan health centers.
20	A National Standards-Based Assessment on Functionality of Electronic Medical Records Systems Used in Kenyan Public-Sector Health Facilities	S. Kang'a et al., 2017	To enforce the EMRs minimum requirements for delivery of quality HIV services, the Kenya Ministry of Health (MoH) developed EMRs standards and guidelines.
21	The impact of routine data quality assessments on electronic medical record data quality in Kenya	Veronica Muthee et al., 2018	Routine Data Quality Assessments (RDQAs) were developed to measure and improve facility-level electronic medical record (EMR) data quality.
22	Assessment of select electronic health information systems that support immunization data capture – Kenya, 2017	Namageyo-Funa, Aketch, Tabu, MacNeil, & Bloland, 2018	This article reports on the findings of an assessment of select EHIS with immunization components in Kenya, specifically related to system design, development, and implementation.
23	Implementing an Open Source Electronic Health Record System in Kenyan Health Care Facilities: Case Study	Muinga et al., 2018	aimed to present a descriptive case study of the implementation of an open source electronic health record system in public health care facilities in Kenya.

Table 4a: Selected articles included by Countries/Settings

No.	Title	Authors & Year	Objective	Settings/Country
24	Why sub-Saharan Africa lags in electronic health record adoption and possible strategies to increase its adoption in this region	Odekunle, Odekunle, & Shankar, 2017	This study sought to identify factors that affect the adoption of an EHR in sub-Saharan Africa and strategies to improve its adoption in this region.	Sub-Saharan Africa
25	Assessing the Coverage of E-Health Services in Sub-Saharan Africa - A Systematic Review and Analysis	Adeloye, Adigun, Misra, & Omoregbe, 2017	To review publicly available literature on e-Health in sub-Saharan Africa (sSA) towards providing information on existing and ongoing e-Health initiatives in the region.	Sub-Saharan Africa
26	Improving the quality of health information: a qualitative assessment of data management and reporting systems in Botswana	Ledikwe et al., 2014	assessment was conducted to identify strengths and weaknesses of the health data management and reporting systems that capture and transfer routine monitoring and evaluation (M&E) data in Botswana.	Botswana

| 27 | Health Professionals readiness to implement electronic medical record system at three hospitals in Ethiopia: a cross sectional study | Biruk, Yilma, Andualem, & Tilahun, 2014 | to assess health professionals' readiness and to identify factors that affect the acceptance and use of electronic medical recording system in the pre-implementation phase at hospitals of North Gondar Zone, Ethiopia. | Ethiopia |

Table 4b: Selected articles included by Countries/Settings

No.	Title	Authors & Year	Objective	Settings/Country
28	Modeling antecedents of electronic medical record system implementation success in low-resource setting hospitals	Tilahun & Fritz, 2015	this study aims to fill this gap by examining the constructs and relationships of the widely used DeLone and MacLean (D&M) information system success model to determine whether it can be applied to measure EMR success in those settings.	Ethiopia
29	A National Medical Information System for Senegal: Architecture and Services	Camara, Diallo, Lo, Tendeng, & Lo, 2017	proposed a National Medical Information System for Senegal (SIMENS).	Senegal
30	A Usability Study of a Mobile Health Application for Rural Ghanaian Midwives Olivia	Vélez, Okyere, Kanter, & Bakken, 2014	A mobile health (mHealth) application known as mClinic was designed to support midwife access to the Millennium Village-Global Network.	Ghana
31	Quality of documentation of electronic medical information systems at primary health care units in Alexandria, Egypt.	Noureldin, Mosallam, & Hassan, 2014	study aimed to assess the quality of documentation in the electronic medical records at primary health care units in Alexandria, Egypt and to elicit physician's feedback on barriers and facilitators to the system.	Egypt
32	Health workers' knowledge of and attitudes towards computer applications in rural African health facilities	Sukums, Mensah, Mpembeni, Kaltschmidt, et al., 2014	To report an assessment of health providers' computer knowledge, experience, and attitudes prior to the implementation of the QUALMAT electronic CDSS.	Burkina Faso, Ghana, and Tanzania
33	Promising adoption of an electronic clinical decision support system for antenatal and intrapartum care in rural primary healthcare facilities in sub-Saharan Africa: The QUALMAT experience	Sukums, Mensah, Mpembeni, Massawe, et al., 2014	This study aimed to describe health workers' acceptance and use of the eCDSS for maternal care in rural primary health care (PHC) facilities of Ghana and Tanzania and to identify factors affecting successful adoption of such a system.	Ghana and Tanzania

Table 4c: Selected articles included by Countries/Settings

No.	Title	Authors & Year	Objective	Settings/Country
34	Challenges to implementing a National Health Information System in Cameroon: perspectives of stakeholders	Ngwakongnwi, Atanga, & Quan, 2014	The purpose of this study was to assess the implementation of the NHIS by documenting experiences of individual stakeholders, and to suggest recommendations for improvement.	Cameroon
35	Scale-up of networked HIV treatment in Nigeria: Creation of an integrated electronic medical records system	Chaplin et al., 2015	development of an electronic medical records system (EMRS) put in place at the beginning of a large HIV/AIDS care and treatment program in Nigeria.	Nigeria

36	Factors influencing the use of electronic health records among nurses in a teaching hospital in Nigeria.	Peter, Omolola, Ikono, & Abiola, 2018	this study investigated knowledge of EHR, access to electronic recording devices, awareness of an EHR named Made-In-Nigeria Primary Healthcare and Hospital Information System (MINPHIS).	Nigeria
37	Using Electronic Medical Record Data to Improve HIV Patient Monitoring, Clinical Decision-Making, and Quality Improvement: Lessons from Rwanda	Karema et al., 2015	describe the use of Electronic Medical Record data for evidence-based clinical decisions and improved HIV patients monitoring in rural Rwanda	Rwanda
38	Design and development of an EMR for Ebola Treatment Centers in Sierra Leone using OpenMRS	Jazayeri et al., 2015	used the OpenMRS platform to rapidly develop an EMR system for the recently opened Kerry Town, Sierra Leone Ebola Treatment Centre.	Sierra Leone
39	Electronic medical records in humanitarian emergencies – the development of an Ebola clinical information and patient management system	Jobanputra et al., 2016	describe a project MSF established with software developers and the Google Social Impact Team to develop context-adapted tools to address the challenges of recording Ebola clinical information.	Sierra Leone
40	Development and Deployment of the OpenMRS-Ebola Electronic Health Record System for an Ebola Treatment Center in Sierra Leone	Oza et al., 2017	used the OpenMRS platform and Agile software development approaches to build OpenMRS-Ebola.	Sierra Leone

Table 4d: Selected articles included by Countries/Settings

No.	Title	Authors & Year	Objective	Settings/Country
41	Barriers to using eHealth data for clinical performance feedback in Malawi: A case study	Landis-Lewis et al., 2015	The aims of this study were to identify and describe barriers to using EMR data for individualized audit and feedback for healthcare providers in Malawi and to consider how to design technology to overcome these barriers.	Malawi
42	Integrating family planning services into HIV care: use of a point-of-care electronic medical record system in Lilongwe, Malawi	Tweya et al., 2017	To assess trends in the use of contraceptive methods after implementing an electronic medical record (EMR) system	Malawi
43	Use of an electronic medical record to monitor efficacy of diabetes care in out-patients in a central hospital in Malawi: Patterns of glycaemic control and lessons learned	Allain et al., 2017	this paper we report on the first 3 years experience with the diabetes EMRs.	Malawi
44	Developing a point-of-care electronic medical record system for TB/HIV co-infected patients: experiences from Lighthouse Trust, Lilongwe, Malawi	Tweya et al., 2016	N/A	Malawi
45	Factors affecting the utilization of electronic medical records system in Malawian central hospitals	Msiska, Kumitawa, & Kumwenda, 2017	This study assessed factors that affect the use of EMRs in Malawi, particularly at Queen Elizabeth and Kamuzu Central Hospitals.	Malawi
46	Strengthening pharmaceutical systems for palliative care services in resource limited settings: piloting a mHealth application across a rural and urban setting in Uganda	Namisango, Ntege, Luyirika, Kiyange, & Allsop, 2016	An electronic application was implemented as part of palliative care services at two settings in Uganda	Uganda
47	Situating mobile health: a qualitative study of mHealth expectations in the rural health district of Nouna, Burkina Faso	Duclos et al., 2017	this study investigates the expected benefits, challenges and limitations associated with mHealth	Burkina Faso

Table 4e: Selected articles included by Countries/Settings

No.	Title	Authors & Year	Objective	Settings/Country
48	Cost-effectiveness of an electronic clinical decision support system for improving quality of antenatal and childbirth care in rural Tanzania: an intervention study	Saronga et al., 2017	this study aimed at assessing cost-effectiveness of the system in Tanzania.	Tanzania
49	Assessing Electronic Medical Record System Implementation at Kilimanjaro Christian Medical Center, Tanzania	Mtebe, Nakaka, International, & Alliance, 2018	this study assessed EMR systems implementation through adopting some elements of the Technology Organization Environment (TOE) framework.	Tanzania
50	Usability and feasibility of a mobile health system to provide comprehensive antenatal care in low-income countries: PANDA mHealth pilot study in Madagascar	Benski et al., 2017	The objective of the study was to assess the usability and feasibility of a mobile health system (mHealth) to provide high-quality ANC, according to World Health Organization (WHO) recommendations.	Madagascar
51	Scaling-up health information systems to improve HIV treatment: An assessment of initial patient monitoring systems in Mozambique	Hochgesang et al., 2018	This assessment was conducted in order to 1) characterize data collection and reporting processes and PMS resources available and 2) provide evidence-based recommendations for harmonization and sustainability of PMS.	Mozambique

3.1 Acceptance of EHRs/EMRs in Africa

The use of EHRs has been reported to be beneficial in different settings through health surveys. Notably, Bloomfield *et al.*, employed EHRs data repository (2014) as a secondary data in assessing the impact of blood pressure levels had on AIDS related deaths in HIV seropositive of Kenyan adults[6]. Usually, the EMRs implementation in Sub-Saharan African countries with low resource settings looks bright and promising[7]. In order to improve the acceptance of EHRs in Africa, government officials should play a massive role in making sure the availability of an enabling environment for EHRs implementation[8]. This is because a research conducted in Botswana by Ledikwe *et al.*, 2014 suggested EMR systems as one of the ways to improve the quality of health information management issues via proper monitoring and evaluation [9]. However, few studies have been conducted in the last five years on EMRs usage and benefits in Botswana, which makes assessment of EHRs acceptance in this country to be difficult. In a related study, researchers in Kenya posited that EMRs improved quality coupled with completion of data gathering on time by health professionals in mostly hard-to-reach areas in the country [10] [11]. Exemplary, health workers in Ethiopia showed their readiness for the implementation of HER systems[12] with the Ethiopian Health Institutions employing the DeLone and MacLean (D&M) health information management system (HIM) model in their hospitals[13]. Likewise, Senegal has adopted an integrated electronic health data platform known as "National Medical Information System for Senegal (SIMENS)" which was proposed by Camara *et. al.*, 2017. This platform is built to be integrative in order to support health-care activities via an EHR system with a web portal and a mobile phone version. Conceptually, the SIMENS layout suggests application integration of data and services can enable inter-operability and decision making [14]. On the other hand, frontline health-care system workers in rural Ghana, viz., nurses and midwives have unfettered permission to vital records such as the client populace in the facilities[15]. However, it has been reported elsewhere that the methods of capturing data mainly via pen and paper limit data accessibility or usability for effective program evaluation or patient care monitoring[15]. Thus, through EHR systems, nurses and midwives are presented with a possible mechanism to enhance their roles in the provision of tools for collection, exchange, and viewing of patient data while enabling the clinicians to possibly receive information and clinical decision support[15]. The overall acceptance of EHRs in Africa is progressively rising and we think that if it is properly and wholly adopted, it would help African countries' health services to rapidly assess and utilize the data generated during an epidemic situation.

3.2 The application of EHRs/EMRs in cases of Ebola in West Africa

During the Ebola outbreak, an extensive adaptable OpenMRS-Ebola EHR was built for low resource setting health emergency[2]. This tool was designed purposely to deal with the data collection challenges especially in extremely infectious environments that needed robust prevention of infection as well as control measures, which can interoperate with other EHR systems[2]. Therefore, the EMRs are well suited to address the unique data challenges in Ebola treatment centres. Based on this assertion, 'OpenMRS' platform was applied to quickly deploy an EMR application for data collection at the Ebola Treatment Centre in Sierra Leonean Kerry Town[16]. Additionally, this applicatory EHR system could address the unmet need of recording the data of patients prior to communicating between the infectious and non-infectious zones, as well as notably designed to make it more practicability among body of workers with protective equipment. Besides, this platform was interoperated with some other fundamental eHealth platforms in Sierra Leone with extension to other sites and diseases [16]. Through this data collection tool, the Ebola epidemic in West African had infected twenty-eight thousand five hundred and ninety-eight (28598) individuals and caused eleven thousand two hundred and ninety-nine (11299) deaths of infected individuals by November in the year 2015 in the three most affected countries (Sieraa-Leone, Liberia and Nigeria. Usually, the outbreak of the disease necessitated rapid innovation and adaptation with respect to data collection and sharing. This is because the scaling up of the usual beds (20 up to 30) at Ebola management centres (EMCs) by 'Médecins sans Frontières' (MSF) to hundred (100) up to three hundred (300) beds with over three hundred (300) professionals in some other settings culminating in challenges in client and clinical statistics administration [17]. This data collection challenge further resulted from difficulties in working safely with high number of Ebola patients[17]. To solve this problem, software program designers and a Google Social Impact Team designed framework-adapted tools to tackle the problems related to recording diagnosis and records of Ebola patients [17]. The advantage of these electronic data processing platforms is to aid in curbing the spread of Ebola as the EHRs/EMRs can reduce the human contact during outbreak of these diseases. Also, the platforms provide rapid access to data required to unearth preventive measures at Ebola prone areas in West Africa. Thus, this finding suggests that the implementation of integrated and interoperable EHRs/EMRs in Africa can help curb the spread of highly infectious diseases in the Sub region.

3.3 Use of EHRs/EMRs in HIV/AIDS, Tuberculosis and Other cases

A previous reports suggested the development and adoption of electronic Trauma Health Record (eTHR) in a cape Town trauma centre in South Africa [18]. This pilot testing proved that eTHR was effective at a first-level trauma unit in Cape Town which allowed for the creation of a real-time and self-populating trauma database [18]. In support of this, Laing *et al*., in 2015, reported the development of a hybrid electronic medical record (HEMR) system particularly for accurate collection and integration of data. Likewise, the HEMR system has been shown to provide the requisite platform within the South African healthcare services for scaling the adverse events incidence [19]. The usage of user-friendly electronic register is considered as cost-effective, mobile and compatible platform for treatment and prevention of Rheumatic Heart Disease (RHD) based on sanctioned materials by the World Heart Federation [20]. More importantly, this paperless RHD patient register is inherent with several practical benefits [20]. Notably, EMRs improved the quality of care for HIV/AIDS patients via appropriate placement of ART-qualified and eligible individuals on treatment in confined resource settings in Africa [21]–[23]. Besides, it has been reported that EMR-based data verification and CDSS could reduce HIV care gaps, such as missing of data coupled with ART eligibility. The requirement for local clinical infrastructure can be removed through the implementation of a cloud-based model EMR, which has the possibility of enhancing data safety and sharing [24], [25]. This is because the use of EMR information can improve patient monitoring and evidence-based clinical decisions. These findings therefore suggest that EMR can serve as a potential source and reference for HIV clinical record keeping, reporting, decision-making, and data-driven analysis [26]. Tweya *et al*., 2016, posited that patient management can be improved by an EMR systems, which in turn result in the enhancement of TB/HIV integrative services thereby ameliorating decision-making by providers [27]. Meanwhile, the application of EMRs for integrated health-care is promising and positive invention in the treatment and care of TB/HIV patients in Malawi [28]. Thus, the integration of EHRs for non-communicable diseases (NCDs) and HIV from different sites would provide a powerful database with the potential to provide a unique understanding of epidemiology, efficient service planning and improved care of those afflicted by deadly diseases [29].

4. CHALLENGES OF EHRS/EMRS IMPLEMENTATION IS AFRICA

Even though the prospect of implementing EHR/EMR is superb, there are variety of unique systems, software programs and societal problems and the advocates of these platforms may address prior to their good use in limited resource areas in not-too-distant future (Jawhari et al., 2016). The EHR systems implementation has been observed to be very challenging process in even the developed countries[31]. For instance, in low- income countries like Kenya, an open source electronic

application could offer some relief from expensive software licensing [31]. Nevertheless, well-known challenges in Sub-Saharan Africa such as clinical and administrative buy-in, lack of adequately trained users, and inadequate provision of on-going technical support[31]. In this regard, strategies such as creation of local funding teams, use of local development resources, and roll out in smaller health facilities before extension to bigger hospitals are being explored to overcome these challenges [31]. The frontline health professionals like nurses are willing to use EHR systems, albeit the lack of the required practical training, equipment and conducive environment which have affected their reported interest (Peter et al., 2018). Based on this assertion, it has been recommended that user-related, institutional and societal factors should be examined appropriately and supported for successful implementation of EHR to improve healthcare delivery in developing countries such as Nigeria and Ghana [32]. In another study, it was established that some barriers, viz., disruptions to care processes, indicator lifespan performance provider rotations and acceptance of ehealth by user restricted the use of HER or EMR data to assess medical care overall performance comments [33]. Moreover, poor ICT infrastructure, lack of participation during system development, lack of policies and standards, and lack of IT directorate were the factors identified to contribute to the failure of EMR systems implementation at Kilimanjaro Christian Medical Center (KCMC) in Tanzania [34]. Generally, reasons such as high procurement and maintenance costs of the EHR systems, inadequate/unreliable supply of electricity and poor internet connectivity, lack of financial incentives and priorities as well as user-limited computer skills that deter the implementation of EHRs in Sub-Saharan Africa [35]. Despite these drawbacks, it has been forecasted that as the ICT infrastructure continue to improve in Sub-Saharan Africa, the number of EHR/EMR systems adopted in many hospitals will continue to increase [34].

5.   CONCLUSION

The potential for EHRs to facilitate clinical care, monitoring and evaluation are evident and, with better design and access to computer work stations for all clinicians. EHRs/EMRs could be useful for all infectious diseases' rapid assessment. It is also apparent that clinicians using electronic systems need ongoing training, mentorship and supervision. Electronic data processing platforms could help in curbing the spread of Ebola via the provision of rapid access to data when needed to unearth preventive measures at the Ebola prone areas in West Africa. This suggests that the implementation of an integrated and interoperable EHRs/EMRs in Africa can aid in controlling the spread of infectious diseases in the sub region. EHRs/EMRs can also reduce the human contact during the spread of highly infectious diseases like Ebola. This review therefore suggests that further researches should be conducted to ascertain the prospect of using technology specifically EHRs or electronic paperless platforms (EPP) in preventing the spread of infectious diseases in Africa.

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