

# Synchronization of Patient Data Among Health Facilities Through Electronic Medical Records System: A Case Study of Kabgayi District Hospital

Charité Niyitegeka<sup>1\*</sup>, Thaoussi Uwera<sup>1</sup>, Noel Korukire<sup>2</sup>, Sani Nasiru<sup>1</sup>, Innocent Hakizimana<sup>3</sup>, Sunday François Xavier<sup>5</sup>, Jean Paul Niyoyita<sup>1</sup>, Pierre Claver Kayumba<sup>4</sup>

<sup>1</sup>Department of Health Informatics, College of Medicine and Health Sciences, University of Rwanda

<sup>2</sup>Department of Environmental Health Sciences, College of Medicine and Health Sciences, University of Rwanda

<sup>3</sup>Centre for Language Enhancement, University of Rwanda

<sup>4</sup>EAC Regional Centre of Excellence for Vaccines, Immunization and Health Supply Chain Management

<sup>5</sup>Department of Human Nutrition and Dietetics, College of Medicine and Health Sciences, University of Rwanda

**\*Corresponding author:** Charité Niyitegeka. Department of Health Informatics, College of Medicine and Health Sciences, University of Rwanda, Remera Campus, KG 11 Ave, 47, Kigali, Rwanda. Email: niyicharite@gmail.com

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## Abstract

### Background

The use of modern technology in healthcare system aims to increase the reliability, accessibility and productivity of delivered services. In most developing countries, particularly in sub-Saharan Africa, Electronic Medical Records (EMRs) has been dominated by paper-based system. In Rwanda, EMRs started in 2011 with a baseline of 8% and reached 50% in 2017 within 516 health facilities, but patient data synchronization among health facilities is still a problem. The aim of this research was to identify factors hindering EMRs implementation and propose applied solutions.

### Methods

A cross-sectional descriptive study design with qualitative and quantitative approach was used. A purposive method to select the research participants among the target population was also used.

### Results

It was found that, despite the improvement of hospitals' management and healthcare efficiency via EMRs system, factors affecting synchronization of patients' data among health facilities still persist. The study also revealed the need for the interoperability in the integration of EMRs system among health facilities.

### Conclusion

The OpenMRS EMR-based data synchronization can reduce gaps in HIV care. It avoids a duplication of patient identification number (PID) at the same health facility for more than one visit and missing data among health facilities. As part of implementable solutions for effective service delivery, cloud-based server and patient identification were suggested as solutions for much more success in Open MRS EMRs system.

Rwanda J Med Health Sci 2019;2(3):281-288.

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**Keywords:** Electronic Medical Record, Data synchronization, Cloud computing technology

## Introduction

The use of modern information technology in healthcare delivery aims to increasing the reliability, accessibility and productivity.[1] The implementation of Electronic Medical Record (EMR) can be traced back over few decades, and it has improved the effectiveness of service delivery in health sector. [2]In most developing technology, the package of modules that are required by an EMR system include patient registration, diagnostic imaging reports, scheduling an appointment, writing prescriptions, documenting patient encounters, requisitioning, documents management, and receiving laboratory and managing interoffice communications, clinical decision support, and billing.[3] The advantages of using EMR system are that it can support clinical

research, decision for drug ordering, and management of diseases like diabetes, heart failure and tuberculosis. EMRs constitute an easily simplified information communication between multiple locations such as laboratory to physician.[4] Like other countries, Rwanda has been implementing Electronic Medical Record (EMR) system as a strategic plan in e-health. [5] It is in this regard that the aim of this research paper is to identify factors affecting the process of synchronizing, storing and retrieving all patients' information through the EMR system but, still now the Open Medical Record System (OpenMRS) distributed by the Ministry of Health (MoH) does not enable to synchronize patients' medical records, that means the patients requesting services from the health facility can receive multiple patient identification codes (PID) in more than one visit

while the open MRS is web based system to be accessible online. Considering that 93.8% of health care facilities in Rwanda have been connected to internet,[6] the researchers were keen on investigating why the health facilities in Rwanda are not able to sharing the patients' information using an Open MRS Electronic Medical Record as system.

As a consequence, we noticed limited interoperability of government systems where many health facilities work in isolation and the EMR system used in some health facilities still provide a multiple patient identification (PID) numbers in one or many health facilities, and they are still relying on paper based system.[2] There is a strong need to investigate on the synchronization of patient data among health facilities through Electronic Medical Records system in Rwanda; no such research, however, has been described in Rwandan health literature. Therefore, the purpose of this research was to identify factors impeding the implementation of the Open MRS, and propose implementable solutions leading to smooth operationalization of patients' data synchronization between health facilities.

## Methods

This research was cross sectional quantitative and qualitative study at Kabgayi district Hospital and sixteen health centres under Kabgayi Hospital supervision, in Muhanga District, Southern province, Rwanda. The study area was selected purposively. Purposive selection of the area was due to their perceived knowledge and involvement in Open MRS EMR system. Researchers selected ARV/ HIV Department and health centres staff because they have successfully implemented Open MRS (EMRs) in ARV/HIV service.

As for the sample of the target population, due to low number of participants, purposive sampling was used to select 42 participants at the study site including EMR IT manager, Medical specialist, Nurses, Data managers and Titular of the health centres participating in the study.

Regarding data collection tool for this study, a three-part structured questionnaire adapted and modified from Msukwa[7] was used. In addition, meetings were arranged to meet with the Open MRS users and explain to them the purpose, goals and implementation of this research study. All interviews were conducted from participants' work place and they were in English as respondents were able to use it. Thus, after informational meetings with participants in research, written informed consent with participants' signatures were obtained. Then, the researchers collected information from EMR IT managers, Medical specialist and Nurses who were purposively selected.

A pre-test of the questionnaire was given to the EMR-IT managers, Medical specialist and Nurse in order to check the validity of questions in the Rwandan context. The questionnaire was administered as researchers-

assisted instrument. The data collection was achieved using questionnaire with closed-ended and a few open-ended questions. Data were coded in SPSS version 21.0 for quantitative analysis.

For the qualitative data, it was collected thorough in-depth interview with four key informants including the EMR IT manager, the ICT Officer, the Titular of the Health Centre and a Medical Specialist. These keys informants were selected because they were the heads of the services and system administrators who always access Open MRS system. The researchers requested for and were granted permission from all study participants to audio record the interview in order to facilitate accurate data acquisition and its analysis. Transcription of each interview recording was completed at the end of each interview day. For the data collection tool, it was accomplished by using a fishbone diagram or Ishikawa diagram invented by Kaoru Ishikawa[8] and analysed using the root cause and effects diagram to categorize the potential causes of the problem of the synchronization of patient data through Open MRS and solutions were proposed based on the factors.[7–10] Analysis was accomplished by initially identifying the main themes which were interpreted to examine the meaning of the words spoken and actions elicited.

Validity of the data analysis was enhanced by continuous assessment of interview transcripts, frequently replaying of the recording, and reviewing thoroughly the field notes. Commonly, the researchers utilized debriefing session after the interview process to help increase validity and continuity. As for key issues on ethical considerations, the study participants were allowed to withdraw at any time during the interview process without fear of consequences, as their participation in this study was entirely voluntary in nature. The identity of the participants was kept anonymous and the records were securely stored in locked storage cabinets to ensure confidentiality. Still on ethical matters, the researchers received three ethical clearances respectively from the Ministry of Health (MoH), the National Health Research Committee (NHRC) and Institutional Review Board of the University of Rwanda/ College of Medicine and Health Sciences (IRB).

## Results

### Demographic characteristics of the participants

A total of 42 questionnaires were distributed with response rate of 39 (93%). The minimum age group was 26-30 years while the maximum age group was 30-35. All this was calculated as grouped in data in SPSS 21.0 since that is how it was collected. The majority of the participants 16 (41.0%) were age group 30-35 years or younger. As for the gender of the respondents, females were 24 (61.5%) versus 15 males (38.5%). Data entry clerk represented the largest percentage of respondents at 20 (51.3%) compared to all other professionals namely clinician, nurses, medical specialist, social assistant,

EMR-IT manager and supervisors. Nineteen (48.7%) participants had more than two years of working experience using EMR (Open MRS). Table 1 shows a summary of the demographic information of the study.

**Table 1. Participants’ demographic information (n=39)**

Variables	Characteristics	Frequency	%
Age (years)	26-30	4	10.3
	30-35	16	41.0
	36-40	13	33.3
	41+	6	15.5
Gender	Male	15	38.5
	Female	24	61.5
Work position	Nurse	9	30.0
	Clinician	1	2.6
	Data entry clerk	20	51.3
	Medical specialist	1	2.6
	EMR_IT manager	1	2.6
	Supervisor	6	15.5
	Social assistant	1	2.6
Working experience (months)	13-18	9	23.1
	18-24	16	41.0
	24+	14	35.9

**Perception of the participants towards the efficiency of the Open MRS Versus paper-based system recording**

Common factors identified in the study of evaluating the user’s perception on the synchronization of patient data using Open MRS EMR and paper-based medical records consisted of the speed of results and experience, implementation and period of using a paper-based system in sharing patient data, the period of using Open MRS EMR, accuracy and effectiveness of records, which increased patient confidentiality and enhanced faster data sharing. The findings of this study showed a positive impact on the perception on the synchronization of Open MRS EMR by the study participants as compared to using paper-based medical records.

The experience and perceptions of the participants towards the efficiency of the Open MRS Versus paper-based system recording are shown in table 2. By comparing the accuracy and effectiveness of data in both systems, 31 (79.5%) declared Open MRS EMR more accurate and effective to use while 8 (20.5%) voted the paper-based records. The participants also compared the confidentiality of Open MRS EMR and paper-based record to use where 33 (84.6%) preferred to use Open MRS EMR versus 3 (7.7%) who preferred paper-based medical records and 3 (7.7%) preferred to use both systems. Regarding the speed of both systems while sharing data, 36 respondents (92.3%) viewed Open MRS as faster in data sharing.

**Table 2. Perception of the participants towards the efficiency of the Open MRS Versus paper-based system recording (n=39)**

Variable	Characteristics	Number of respondents	%
Paper-based medical records before	Yes	39	100
If yes, how long period using paper-based medical records (months)	6-12	2	5.1
	13-18	9	23.1
	19-24	13	33.3
	24+	15	38.5
How long using EMR (OpenMRS)	6-12	7	17
	13-18	11	28.2
	19-24	17	43.6
	24+	4	10.3
Accurate and effective	EMR (Open MRS)	31	79.5
	Paper-based	8	20.5
Confidentiality	EMR (Open MRS)	33	84.6
	Paper-based	3	7.7
	Both	3	7.7
Faster in data sharing	EMR(Open MRS)	36	92.3
	Paper-based medical	3	7.7

The qualitative results showed that the majority of the participants articulated a positive experience concerning the efficiency of the Open MRS EMR. All the

participants reported that Open MRS EMR enhanced work performance in the different tasks of the services. For example,

“Using Open MRS EMR, we do not have to go into warehouse to look for patient files which take long time to find; just now search in the computer and all the information concerning patients appears on the monitor” P#2

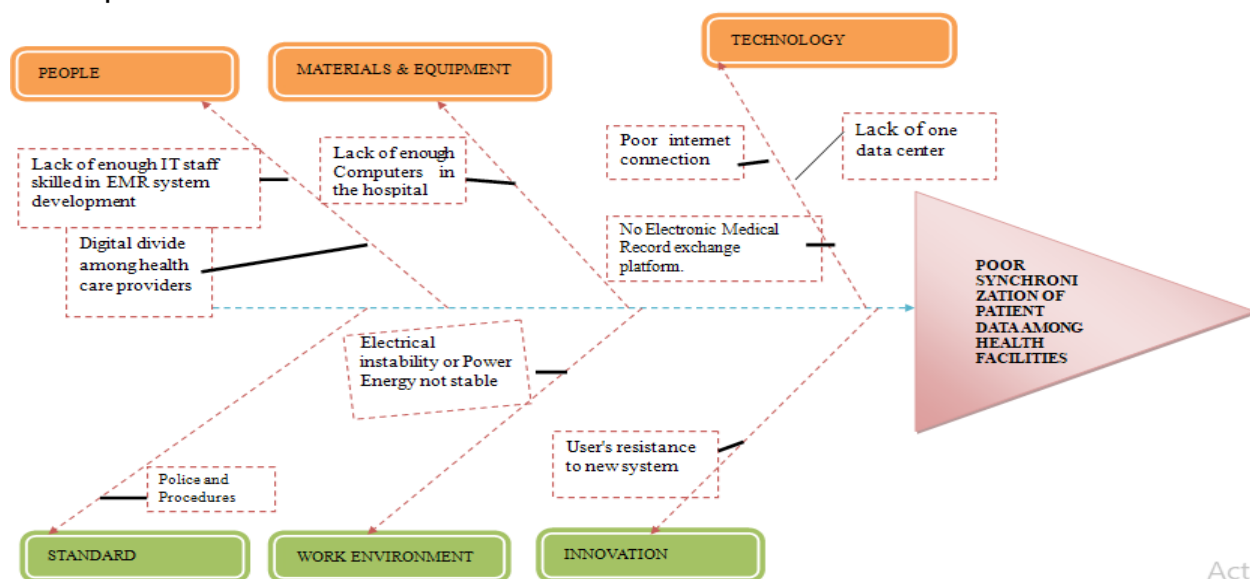
“We can consult and receive many patients in a short period of time” P#1

“Patient data are recorded on a Patient Health Record encounter form, eliminating duplicate documentation in multiple clinic logbooks” P#3

### Factors affecting the patients’ data synchronization between district hospital and health centres.

By using a root-cause analysis technique regarding the factors affecting synchronization of patients’ data among health facilities as shown by the respondents, they were grouped into 6 categories namely people (staff), materials and equipment, technology, standards, working environment, and innovation.

The impact of each factor on using EMR is highlighted in figure 1.



**Figure 1. Factors leading to poor synchronization of the patients’ data among the health facilities through the use of EMRs**

The researchers further evaluated respondents on factors affecting the patients’ data synchronization between district hospital and health centres. From the interviews’ responses, most of the participants reported that the lack of competences in IT skills, power cut-offs, lack of computers and IT managers in some health facilities as main factors to impede the EMRs implementation. Quoted from their interview, “The lack of staff with IT skills related to EMR system development and deployment is a big challenge” P#2

“A lower number of computers in the hospital services is a hindrance to effective use of the EMR system” P#4

“The main challenges is the electrical system at the facilities. They are either outdated and need to be refurbished or they are not up to standard. This results in networking equipment damage or malfunction.” While some exclaimed “Technology cannot be efficient without electricity, when there is no electricity we cannot do anything.”

P#1

Still on the issue of facilities while using EMR system, the key informants further expressed their views: “very few health centers lacked computers and IT manager to accommodate computers” P#4

Problems of synchronization of patient’s data and

incomplete data entry, low reporting by CHWs in some health centers were also identified as challenges. On the qualitative interviews the respondent reported : “If the system requires maintenance often they would have to wait for only one EMR-IT Manager from district hospital that serves more than one health centers” “Another option is to approach private workers at an increased cost” P#1

A study conducted in 2007, reported that a challenge in using an EMR in developing country setting is that data synchronization where the sites need local copies of data repository and handle unreliable internet connectivity meanwhile data from all sites need to be combined in a central repository to allow tracking of transferred patients to another facility. The results shows that for synchronized patient data a tool is required to synchronize data and handle data entry conflicts, by allowing seamless use of local Open MRS servers and replicated data by providing offline access to a parent Open MRS repository.[11]

**Perception of the respondents for an implementable solution of the synchronization of patient data through the Open MRS EMR system**

The findings of the study in the table 3 indicated the perception of the respondents in handling the issue of the Open MRS EMR synchronization for implementable solutions. All 39 (100%) of the respondents agreed on synchronized Open MRS EMR data in the level of the department considering the perceived quality of care and decision making that had improved a hundred percent since the introduction of Open MRS EMR. Although these findings show total agreement of using Open MRS EMR, the respondents reported that the servers of the Open MRS EMR were not interconnected to another health facility. All 39 (100%) of the respondents indicated that EMR system generate one unique identifier for each patient in users of the system. In this regard, the respondents indicated the methods used to synchronize the patients records: 27 (69.2%) of the respondents used paper-based records and 6 (15.4%) of the respondents used an email attachment for synchronization of the patient records, while 6 (15.4%) of the respondents synchronized patient records by used USB flash driver. Still on the issue of data synchronization, 35 (89.7%) of the respondents said that Open MRS EMR had the ability to synchronize the patients records among two health facilities while 4 (10.3%) of the respondents reported that Open MRS EMR hadn't any ability to

synchronize the patient's records. Thirty-three (84.6%) of the respondents were challenged with the access of the previous patient records when they receive a patient from other health facilities while 6 (15.4%) of the respondents were challenged to use different patient identifier (PID). Looking at the techniques used to share the patient information obtained in the Open MRS from other facilities, 14 (35.9%) of the respondents used USB flash driver, and 5 (12.8%) of the respondents used email attachment, while 20 (51.3%) of the respondents used the printed paper based. As for the types of network use in EMR data sharing, 14 (35.4%) of the respondents used modem connection while 25 (64.6%) used an internet from cable connection. For the appropriate security network proposed in the sharing of the Open MRS EMR, after being explained the importance of two types of security networks, 15 (38.5%) of the respondents preferred to use virtual private network while 21 (53.8%) opted cloud server network in the EMR data sharing. On the issue of backing up data once needed, the findings indicated that 27(69.2%) of the respondents showed it was easy for them to make EMR backup when using Open MRS, while 11 (28.2%) of the respondents had difficulties to make EMR backup. All 39 (100%) of the respondents said that EMR data sharing help the provider to do the follow-up to the patient records although they all reported having a problem of policies and procedures to synchronize patient data electronically among two health facilities.

**Table 3. Perception of the respondents for an implementable solution of the synchronization of patient data through the Open MRS EMR system (n=39)**

Variable	Characteristics	Number of respondents	%
Paper-based medical records before	Yes	39	100.0
Sharing EMR data helps you in decision making	Yes	39	100.0
EMR local server in your catchment is interconnected to other facilities?	No	39	100.0
EMR server system in your facility generates one unique identifier?	Yes	39	100.0
Which methods used to synchronize The patient's record?	Paper based record	27	69.2
	Email attachment	6	15.4
	USB flash driver	6	15.4
EMR has the ability to synchronize the Patients records among two facilities	Yes	35	89.7
	No	4	10.3
What challenges to EMRs when you receive Patients from other facilities?	Previous records	33	84.6
	Different unique identifier	6	15.4
Which techniques use to share the information obtained from EMRs at other facilities?	USB flash driver	14	39
	Email attachment	5	12.8
	Printed paper based	20	51.3
Which type of network used in EMR data sharing	Modem connection	14	35.9
	Internet cable	25	64.1
Easy to make backup in your facility or hospital?	Yes	27	69.2
	No	11	28.2
EMR data sharing helps you to do follow up of patient records?	Yes	39	100.0
Do you have policies and procedures to synchronize patient data electronically Among health facilities?	No	39	100.0

The qualitative results showed that the participants expressed negative causes and effects regarding the efficiency of the synchronization of Open MRS EMR. All participants reported that Open MRS EMR were managed in local server (level of health facility). For example:

*"The servers of EMRs are managed within each facility while Open MRS was designed as web-based system that means the patients requesting a service at a health facility can receive multiple patient identification code (PID) in more than one visit while the Open MRS EMR is a web-based system to be accessible online"*

**P#3.**

Most of the participants indicated that frequent power cut posed a challenge in using the Open MRS EMR system that was affecting synchronization of patient data with different location. In one of their views *"The main challenges is the electrical system at the facilities. They are either outdated and need to be refurbished or they are not up to standard. This results in networking equipment damage or malfunction."* While some exclaimed *"Technology cannot be efficient without electricity, when there is no electricity we cannot do anything."* **P#4**

The researchers further evaluated other factors affecting synchronization of Open MRS EMR, through the respondents perceptions related to the implementable solution of EMR in the in-depth interviews. Most of the participants reported that there was a cause that affects the synchronization after the deployment of the Open MRS EMR. *"Lack of enough IT staff skilled in EMR system development for the low number of skilled staffs in the system analysis and development and low level of end user input during system design"* **P#2 and P#3**

*"Security, privacy and confidentiality of patient records are more sensitive in data sharing that needs enough confidentiality"* **P#1**

*"Digital divide among healthcare providers where some doctors and nurses don't have enough skills in ICT and also lack of a regular and structured EMR training program for end users"* **P#4**

*"Some health facilities are not connected to fiber, usually they use modem and also insufficient infrastructure"* **P#3**

## Discussion

### Demographic characteristics

Research results showed that the majority of the participants 16 (41%) were in the range of 30-35-years-old; 13 (33.3%) were 36-40-years-old; 6 (15.4%) were 41-years-old and above, and 4 (10.3%) were 26-30 years old and less. Literature shows older people have fewer positive attitudes and greater nervousness than young counterparts towards EMRs and it also shows more resistance to newer technologies than the young people.[12] In the current study, participants aged below 40 years; 29 (74.3%) were more engaged to use Open MRS EMR system in every day work compared to those who were above 40 years old more likely to mix both recording systems.

### Perception of the participants towards the efficiency of the Open MRS versus paper-based system

The Open MRS system was implemented in the Rwandan healthcare sector since 2006 and since then has improved in facilitating clinic services including easy reporting tools, maintaining the privacy of patient's information, easy correction of mistakes, adding some information easily, keeping safely the patient's health information and improving care to the patient[11] with a focus on implementation of Open MRS EMR. As the result of implementing electronic health records in 2 East African countries namely Tanzania, Uganda and also in northern Nigeria, the literature indicates that use of Open MRS is supporting in maternal and reproductive health as well as in improvement of HIV/AIDS care in the countries stated above.[13] In the evaluation literature, a health information system is one of essential building blocks in the healthcare system. An EMR as a part of HIS should provide a reliable and timely information to help in evidence-based decision making at all levels of the healthcare system. The main emphasis is on how clinical performance change.[14]

Open MRS EMR has proven to be efficient and effective worldwide. A perception on synchronization of patient's data among health facilities through electronic medical records system has validated and supported the increased efficacy and accuracy of the medical records as compared to a paper-based records system in Rwandan health sector. The age of respondents showed younger participants perceived that the Open MRS EMR was faster in data sharing with 36 (92.3%), accurate and effective with 31 (79.5%), and more confidentiality with 33 (84.6%) in using EMR than a paper-based record system. The findings on the qualitative interview with respondents demonstrated that a perception on synchronization of patient data using Open MRS EMR system had in fact reduced issues of increased waiting time, increased the efficiency of medical record keeping and transporting, and helped facilitate accurate billing. Responses included *"The is no more loss of patients' files at each level of the facilities and highlighted the burden of patient information management in low resource environments"* **P#1, P#3**. The current study of the implementation of Open MRS EMR is supported by Sahay study conducted in 2016 and Akanbi study conducted in 2011. These studies reported on 'Big Data and Public Health: Challenges and Opportunities for Low and Middle Income' and on 'Use of Electronic Health Records in sub-Saharan Africa: Progress and challenges'. [15,16] This research study of the synchronization of the Open MRS EMR system will contribute not only to improve the efficiency but also the quality of healthcare in Rwanda.

## **Perception of the respondents for an implementable solution to synchronize patient data through the Open MRS EMR system**

Open MRS EMR has been adopted in different departments in different countries and highlighted the burden of patient information management in low resource environments. Rwanda Health Information Exchange (RHIE) is an example of system for aggregating health information consistently and promote the information reuse by patients, providers and decision makers.[15] Synchronization of patient data using Open MRS EMR has improved the quality of care in Kabgayi hospital as reported by 39 (100%) of the participants in the current study. Thirty-nine percent of the participants reported that Open MRS EMR local server is not interconnected to other facilities, and, as a consequence, this affected the sharing of patient data within two or more health facilities. The literature indicates that the problem of interconnectivity of the IT department in Jordan hospital is generally due to lack of Information and Communication Technology (ICT) infrastructure, that could affect a successful implementation of nationwide e-health program.[17]

The current study, as shown by thirty-nine percent of the participants (100 %) indicates that EMR server system within the hospital catchment area, generates one patient unique identifier (PUI) for the better privacy and patient data security. This is in conformity with the other literature study indicating that in patient data act law with the logs actively monitored to avoid any unlicensed accesses to patient medical data.[18] The key informants further expressed negative changes on the sharing patient data among two health facilities is seen with Open MRS EMR in the interview in which the servers of EMRs are managed into each facility while Open MRS were designed as web-based system that means when the patients requesting a service to health facility can be assigned multiple patient identification code (PID) in more than one visit P#3. In this study, it is shown that, when there is a need to synchronize the patient data between two health facilities, 27 (69.2%) used paper-based record, 6 (15.4%) shared by using email attachment and 6 (15.4%) used USB flash driver. The current study also indicates that 35 (89.7%) have the ability to synchronize patients records among two health facilities and 4(10.3%) indicates that EMR was not able to synchronize the patients' records.

Comparing these finding with other results in similar studies, a study in 2015 conducted in Kenya by Haskew reported that the implementation of a Cloud-Based Electronic Medical Records to reduce gaps in HIV treatment continuum in rural Kenya had enhanced data sharing at different levels of health care to inform clinical and public health decision-marking.[19] The total 2169 and 764 patient records had missing data

pre-implementation and post implementation of EMR-based data verification and clinical decision support respectively. In the current study, the participants reported that a type of network uses in EMR data sharing 25 (64.1%) use the modem connection and 14 (35.9%) use internet cables in EMR data sharing. The study conducted in five sub-Saharan African countries showed that to make a patient follow-up, there is need to use modems and cellular networks where BHOMA clinics access the internet to securely synchronize records to a central server.[14] Similarly, in this current research study, most of the participants synchronized the patient data using Open MRS EMR system: 21 (53.8%) use cloud server network as an appropriate type of security network in EMR data sharing and 15 (38.5%) use virtual private network as an appropriate type of security network.

A study conducted on the Cloud Computing at National e-health services as the data centre solution architecture reported to the currently objective of the study by implementable solution of the synchronizing of the patient data through the EMR system, proposing building a national e-health cloud server to overcome many of the challenges confronting the success of Hakeem the core of the National e-Health System (NHS) for the provision of e-Health as a Service[17] with a focus on implementation solution of the Open MRS EMR system. Similarly, in the current research study, all of the participants (100%) reported that the EMR data sharing help them to do a follow up of patients and many of the participants, i.e. 27 (69.2%) indicated that it was easy for them to make a back-up, while 11 (28.2%) had difficulties to make a back-up. These findings are closely similar to the study conducted on the benefits and challenges of EMR implementations in low resource settings.[20]

The synchronization of the patient data using Open MRS EMR needs the policy and procedure as emphasized by respondents in the interview where the participants stated “the clinical coding systems and the integration of IT in healthcare system is a more complex process, the standards available for electronic health systems are called International Standard Organizational (ISO) like Logical Observation Identifiers Names and Codes (LOINC) standards, Health Level Seven (HL7) standards, Systematized Nomenclature of Medicine (SNOMED) standards and International Classification of Diseases (ICD-10) standards” . These views are compared with the research study Privacy and Data Security of Electronic Patient Records (EPR) Sharing. [18]

## Conclusion

Open MRS EMR-based data synchronization can reduce gaps in HIV care, including duplication of patient identification number (PID), data missing and with promoting healthcare, increasing health information systems that facilitate communication by improving the quality of care. Cloud-based model of Open MRS EMR implementation eliminates the necessity for local hospital infrastructures and has the possibility to enhance data synchronization at different stages of healthcare to inform the healthcare professionals to share a decision-making. In addition, Open MRS EMRs data are shared successfully among health facilities by the system generating Patient Unique Identifier. To be more successful, there is a strong need to enhance IT skills for staff using EMRs system, improve electricity stability in health facilities, avail computers and reliable internet connectivity in order to allow technology help sharing Open MRS EMR among health facilities.

## Acknowledgement

Our gratitude goes to the management of Kabgayi District Hospital and all the participants in the research for facilitating this study and providing requested data.

## Conflict of interest

All authors report no conflict of interest.

## Authors' contribution

CN was responsible for the study conception, design, and data analysis. JPN, SFX, NK, TU and PCK contributed in searching literature to support the data analysis and discussion, NS contributed in reviewing comments while IH contributed to the drafting, proofreading as well as editing of the manuscript.

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