# Integrating Electronic Medical Records Data into National Health Reporting System to Enhance Health Data Reporting and Use at the Facility Level

Bigten R. Kikoba[1] , Ellen Kalinga[2(✉)], and Juma Lungo[2(✉)]

[1] College of Informatics and Virtual Education, University of Dodoma, Dodoma, Tanzania
bigtenkikoba@gmail.com
[2] College of Information and Communication Technologies, University of Dar es Salaam, Dar es Salaam, Tanzania
ellenakchale@gmail.com, jlungo@udsm.ac.tz

Abstract. A well organized and coordinated health reporting system is critical for improved health system and health care services delivery. For a long time, the Tanzanian Government has been committed to support global efforts to improve the quality of health data for increased accountability and evidence-based decision-making by introducing electronic medical records (EMR) systems at facility level and computerize a national reporting system (district health information system (DHIS2)). It is also committed to ensure decision makers have access to high quality routine data from providers of services at health facilities to those responsible for running health programmes at the health ministry (MOHCDGEC, 2017). However, data collection and reporting at facility level is error prone and task demanding due to the manual processes of collecting, aggregating, and sharing data, as a result rarely data are used to monitor programmes and make decisions beyond individual patient care. With the introduction of electronic medical records system, the goal of the paper is to ensure decision-makers have access to high-quality health data that are generated at the facilities, and they value and routinely use the data for decision-making. In doing so, the paper envisages improved practices around data collection, reporting and use and institutionalization of data through integrations of EMR and DHIS2.

Keywords: Data integration · Data use · District health information system · Health data reporting · EM-DHIS2 integration

1 Introduction

In sustainable development era, evidence-based planning and decision making receives higher recognition in global health agenda. A need to promote sustainable outcomes, demands better use of resources through better planning and practices. Better health systems performance and outcomes require availability and use of quality health data systems. In most developing countries the collection, compilation [1] and [2].

According to Toohey et al. [3] one of the causes of poor data use is fragmentation of health information systems and uncoordinated and integrated health information across distributed, heterogeneous and disparate information systems.

Over the past 10 years, Tanzania had undergone several efforts to strengthen Health Information System (HIS) and Health management information systems (HMIS) so as to improve quality of data reported and enhance data use and information lead decision making in all levels. HMIS is responsible for collecting, recording, storing and processing routine health data for policy-making, planning, implementation and evaluation of health programs. To strengthen HMIS interventions in the country with the focus is on the use of electronic information systems to facilitate data collection, analysis, interpretation and use in the health sector [4]. In so doing, the ministry in collaboration with the National Health Information System Project (HISP) team of the University of Dar es salaam, introduced District Health Information System version two (DHIS2) as a tool for collecting, analyzing and visualizing health data electronically. Through the DHIS2, the ministry links all health systems and health related data at one point.

Also, there have been hospitals initiatives to adopt and use Electronic Medical Records systems (EMRs) for clinical and service managements at the facility level. Normally, health institutions adopt the electronic medical records with the expectations that data collected as part of routine practice will be available for service delivery and data quality improvement within hospitals.

Despite these efforts, data use practices are very limited at lower levels of the health system, especially at community and facility level, data collection and reporting at facility level is error prone and task demanding due to the manual processes of collecting, aggregating, and sharing data, as a result rarely data are used to monitor programmes and make decisions beyond individual patient care.

The goal of the paper is to ensure decision-makers have access to high-quality health data that are generated at the facilities, and they value and routinely use the data for decision-making. In so doing, the paper envisages improved practices around data collection, reporting and use and institutionalization of data through integrations of EMR and DHIS2. According to [5] integrating EMR data to routine system of health data reporting is realistic and produce a valuable clinical practice platform to improve service evaluation and delivery outcomes [6].

2   Literature Review

2.1   Data Reporting and Use at the Facility Level

According to the Performance of Routine Information System Management (PRISM) analytical framework of health information system performance that identifies three main determinants of the use of health information: The technical aspects of data processes and tools, the behavior of individuals who produce and/or use data, and the system/organizational context that supports data collection, availability and use [7]. According to [8] technical determinants of data use relate to technical aspect of data collection, analysis, interpretation and workers skills gap to use data. Organizational determinants relate to the availability/absence of organizational context that supports

data use, such as clear roles and responsibilities related to data use; operating procedures, guidelines tools that support data use and adequate financial support for data use. [9] and [10] reported that behavioral constraints relate to poor attitudes towards the decision-making process, such as attitudes towards data and information, motivation to use data in the decision-making process, and incentives and disincentives to using data to make decisions.

This paper draws its focus on technical constraints of data use. Technical constraints refer to the technical aspects of data use addressing challenges of data collection, reporting, analysis and interpretation, human capacity (in terms of numbers and skill sets), and the existence of quality data [8].

2.2   HIS Integration Technologies

According to IBM report 2002, data integration is defined as the combination of technical and business processes used to combine data from disparate sources into meaningful and valuable information [11]. Data integration is about coordinating data from different sources and make it meaningful available for decision makers. Information use is made easier if its use is ritualized and routines are set up as part of the "information culture" [11]. One strategy of improving HIS is to use simple automated analysis tools at facility level to allow local data use [12] Moreover, there is significant relationship between availability of data systems and data use the need for integration of health systems [13, 14].

In order to support different perspective of HIS integration, various approaches have been proposed. These include data exchange standards and protocols [15], middleware technologies, unified models [16], domain specific standards and medical coding [17]. These approach goes with the contemporary approaches such as semantic integration. Toohey [3] state that despite of these distinct approaches, interoperability relies on the common agreement between the participating information systems and the components (boundaries) involved. There are several technical HIS integration solutions developed under those approaches, which are: Message-Oriented Integration, Application-Oriented Integration, Middleware-Oriented Integration and Coordinated-Oriented Integration.

The message-oriented integration, the one adopted in this study, refers to the use of different messaging standards to exchange data between health information systems [18]. This involves the use of text messages or multimedia message protocols through HIS databases, for instance in using APIs and EDI [3]. Toohey [3], argue that messaging integration approach provide effective way to solve the basic integration challenges. Also, the implementation still varies and is vendor dependent. Examples of message-based approach integration in HIS is seen in the use of the Digital Imaging and Communication in Medicine (DICOM) messages, HL7 (the American National Standards Institute (ANSI) accredited Standards and XML DTD and HL7 documents.

3 Methodology

3.1 Research Design

The study adopted sequential exploratory design approach by involving first gathering qualitative data to explore a phenomenon and then collecting quantitative data to explain relationship found in the qualitative data [19, 20] as indicated on Fig. 1.

Qualitative data was collected during situational analysis to capture detailed information on reporting practices at facilities that are using EMR system. The assumption was that facilities with EMR report differently to facilities that a manual oriented. Therefore, qualitative data informed the study about reporting approaches used by hospitals with ERM system, availability of data into ERMs, type of ERM systems used by facilities and their reporting challenges and opportunity where by data were collected through semi-structured interview, document review, observation and review of software systems.

Statistical data were given as comparison, demonstrating how two systems differ in figures on similar dataset/indicator and so justify the need to integration to solve the problem of data use due to data accuracy and availability at the facility level. Questionnaires were used during evaluating the integration. Vertical integration approach was used.
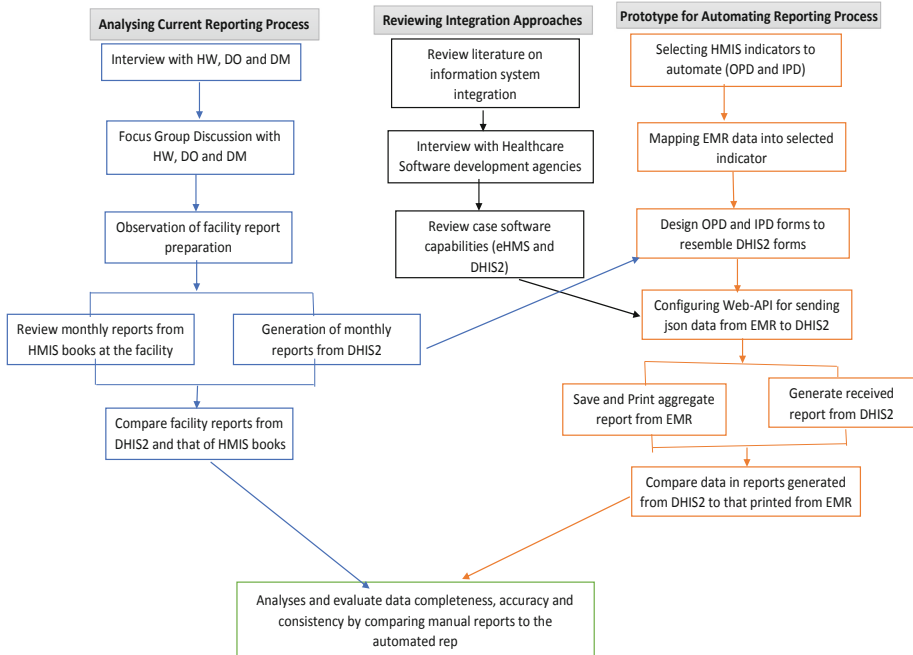

Fig. 1. Research methods

3.2   Study Area

Five hospitals: Amana, Muhimbili, Tumbi, Morogoro and Mnazi mmoja hospitals selected for review. The selection criteria based on the availability of both EMR and DHIS2 systems. Since the study intended to design an integration prototype. The study collected data through semi-structured interview with open-ended questions, document review, Observation and review of software systems. Questionnaire were applied during evaluate of the prototype's integration. A total of 43 people was involved: 27 (62%) were from Health Facilities, 8 (19%) from software development organizations, and 8 (19%) management personnel.

3.3   Development Approach

As a starting point, current HMIS data collection and reporting practices at facilities that are using EMR system were analyzed. This included knowing hospital using ERM system, availability of data into ERMs, type of ERM systems used by facilities and their reporting procedures and tools. The study investigated different integrated and interoperability approaches as well as HIS Integration Technologies. It investigated integration approaches applied by health information developing companies in Tanzania.

On HIS integration technologies, the study adopted the messaging-oriented approach through the use of defined Web API. The DHIS2 system is designed with multiple Rest APIs that allow easy integration with other systems. Point to point (peer to peer) integration method to implement EMR – DHIS2 integration prototype was as well adopted because of the nature of HMIS reporting processes, where by a focal person at the hospital is the one who forward data into the DHIS2. So, the integration does not change the process, it only improves the reporting circle.

The development was done by coding the OPD and IPD reporting module into the eHMS through summarizing and mapping 500 eHMS data elements to resemble the DHIS2 forms (OPD and IPD data elements). PHP were used to programme a Web API, which fetch data from MySQL database into a json report. The study implemented a HMIS report template for OPD and IPD that query the aggregate data from the eHMS into json format, then transferred into DHIS2 through REST web API.

The evaluation was done using quantitative methods i.e. questionnaire and report reviews to see their effectiveness and usefulness of the EMR – DHIS2 integration. The developed OPD and IPD data set forms was adopted into the eHMS system used at Amana Region Referral Hospital. But the interoperability was developed into the local machine not fully implemented at the facility. Therefore, the effectiveness evaluation was based on the OPD and IPD forms designed and implemented into eHMS and GoT-HOMIS in relation to DHIS2 reporting.

4   Case Description

4.1   HIMS Reporting Tools

Despite efforts to introduce data systems in Tanzania, the review noted a number of challenges are still hindering data reporting and their data use. This was echoed the key challenges include; inadequate coordination on ICT matters among ministries, departments, and agencies (MDAs), as well as partners, etc., a fragmented landscape of e-Health pilot projects and stakeholders, numerous data and health information systems (HIS) silos thus lack of interoperability/data exchange among the systems, lack of ICT infrastructure such as computers, network and internet services to access the systems, lack of ICT workers to properly develop, implement and support the systems, inadequate training for data users, lack of guidelines on research and use of data and information, and poor data quality such as inaccessible, incomplete, missing or untimely data.

There are Fifteen (15) HMIS books/registers for collecting and analyzing different pieces of health information. HMIS books are subdivided into five main groups as indicated in Table 1. At the level of each hospital, departmental registers are used to collect data.

Table 1.   HMIS manual reporting tools

Reporting tool	Tool description
HMIS Guideline Book 1	It is used as an instruction manual and reference to other books/registers
Data Collection Books Books No. 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, and 15	These books are used to collect data on different aspects of health
Tally Sheet Forms	Each HMIS register/book should have a tally sheet These forms are used to track data for analysis which will be used jointly with each register. This is then used in report writing
Monthly Report Forms Book No. 10	The HMIS uses monthly report forms to collect data each month. The forms are in duplicate, one copy is sent to the district while the other is kept at the health facility
Facility and Hospital Record Book. No. 2	This is used to document important records of the facility or hospital. It has various charts or tables with information about the facility

Author's visits to health facilities identified that the health workers filled out the OPD and IPD registers carelessly and the higher-level clinicians did not care at all about filling out these books; so, may be themselves do not trust these data. As the key players, we came to know this and did integration of the two systems as the interventions to address this.

4.2   Reporting Procedures

The finding shows that, each of the health facility visited has its own type of ERM system used as shown in Table 2. Existing HMIS data Reporting processing at the hospitals using EMR systems varies one another depending on EMR type. Each facility has a unique way of aggregating data from different sources before entry to DHIS2. Some are semi manual like Amana with eHMS system and Mnazi mmoja with CTC2 database. Considering health facilities under this study, no hospital fully utilizes EMR data to produce HMIS report. There are some hospital management systems which implemented HMIS module, however they do not rely full on these systems when preparing monthly reports. Most of the time manual registers are used especially for the IPD and OPD data.

Table 2. Types of EMR systems used by health facilities

S/N	Institution/organization	EMR type
1.	Muhimbili Hospital	Jeeva
2.	Amana Hospital	eHMS and CTC
3.	Mnazi mmoja HC	CTC
4.	Tumbi Referral Hospital	GoT-HoMIS and CTC
5.	Morogoro Reg. Hospital	AfyaPro and GoT-HOMIS
6.	Mbeya Ref. Hospital	Care2x
7.	HISP Tanzania	DHIS2

In most cases, the patient data are recorded into registers and every month aggregate data are recorded manually into summary forms and submitted to DHIS2 office. At the DHIS2 office the reported summary forms are compiled into general HMIS book (OPD Book) before data entry into the DHIS2 system as shown in Fig. 2. Other, Hospitals are doing semi-manual reporting, for example, reports depend on the monthly provisional and diagnosis report printed from the EMR system called electronic Hospital Management System (eHMS). As illustrated on Fig. 3, each reporting
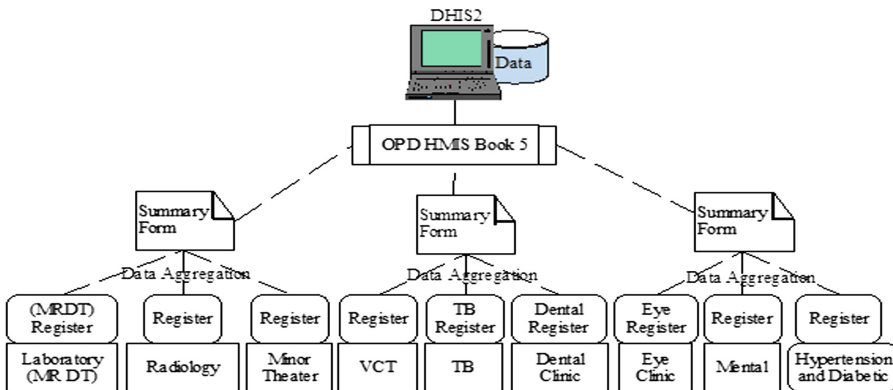

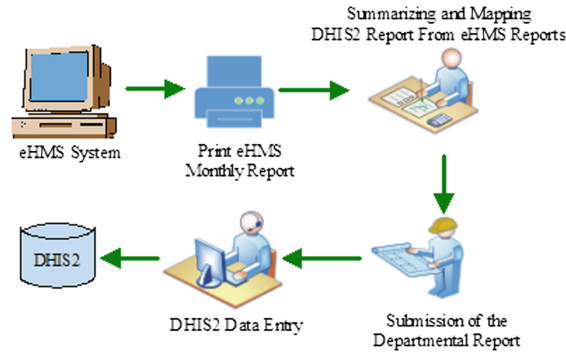**Fig. 2.** The current HMIS data reporting at the facility level

Fig. 3. Diagrammatical EMR to DHIS2 reporting procedure at the health facility

department print and summarize the provisional and diagnosis report from EMR into corresponding paper – based MTUHA book. Which later, is sent to DHIS office for data entry into DHIS2.

5   EMR – DHIS2 Integration Design

The prototype of EMR – DHIS2 integration was developed in a local machine using DHIS2 version 20 hosted in a local testing server to be connected with the local eHMS systems. The integration phases were *Data mapping*, *Report forms design* and *API Configuration*.

During ***data mapping phase***: The data elements in eHMS was mapped against DHIS2 data model which is organized into three parameters: Dataset, Period and Organizational unit. The Dataset is a collection of data elements to be reported for example OPD, IPD, and Dental. The Period specify the routine/frequency of reporting, example monthly, quarterly or annual. Also, period shows when the data is reported example January report, February report etc. The organization unit show the source of data, in hierarch identify what facility is reporting example Amana Hospital from Ilala district, in Dar es Salaam region.

Designing report form phase: involved coding the OPD and IPD reporting module into the eHMS by summarizing and mapping 500 eHMS of the provisional data elements to resemble the DHIS2 forms (OPD and IPD data sets). PHP and SQL were used to programme a query, which fetch data from MySQL database into a json report.

API configuration: After data mapping and report forms design, then next was to think on how data is going to be shared from eHMS to DHIS2. Therefore, Rest Web API using basic authentication was chosen for sending data. DHIS2 API makes external systems to access and manipulate data stored in DHIS2 instance. The API provide a programmatic interface to exposed data and service. Methods for applications like third party software clients to access. Based on Rest API, an OPD json data file for sharing was designed.

6   Evaluation

6.1   Enhancement of Data Availability

According to PRISM framework, data availability is a factor toward data use. After eHMS – DHIS2 integration, the designed OPD and IPD reporting form into the eHMS was reduced to three steps as demonstrated in Fig. 4, now report can be generated direct from the EMR system, printed and forwarded to the DHIS2 system.
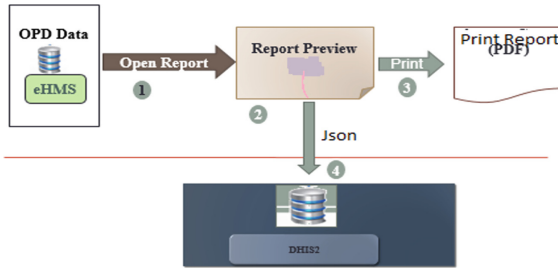

Fig. 4. Reporting process after eHMS – DHIS2 integration

6.2   Data Quality Improvement

The effectiveness of EMR – DHIS2 integration on terms of data quality was evaluated by comparing OPD and IPD dataset reports from EMR and DHIS2 of the same month. The results show miss-match of reports between the two systems especially before the use of EMR reporting module. The EMR reports was based on the implemented HMIS report form that are in DHIS2 formats. Before integrating eHMS and DHIS2 (that is before using eHMS as data source for OPD and IPD reporting) the values in DHIS2 were not matching with values in eHMS. As shown on the Fig. 5 a graph showing selected data elements from OPD report on December 2017 at Amana Hospital. There is miss-matching of data values in DHIS2 and eHMS, where by the system were under and over reporting of data in different data element.

After the integration somehow, data consistency was observed. Figure 6 indicates data values extracted from DHIS2 and eHMS on March 2018 after using eHMS as a HMIS data source. The reports show matching of data values in both systems. Though little data entry error was observed with slightly mismatching.
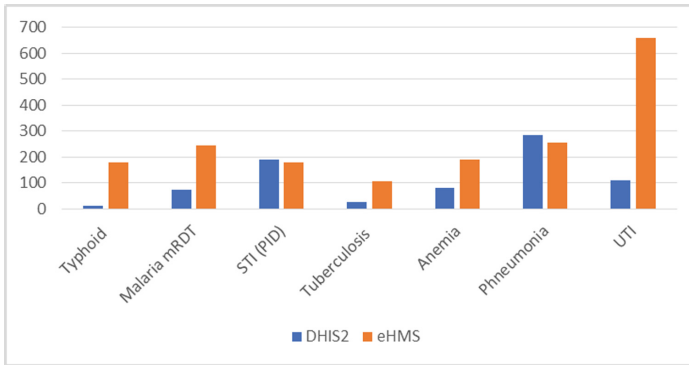
Fig. 5. Data values in DHIS2 and eHMS OPD reports on December 2017 before integration
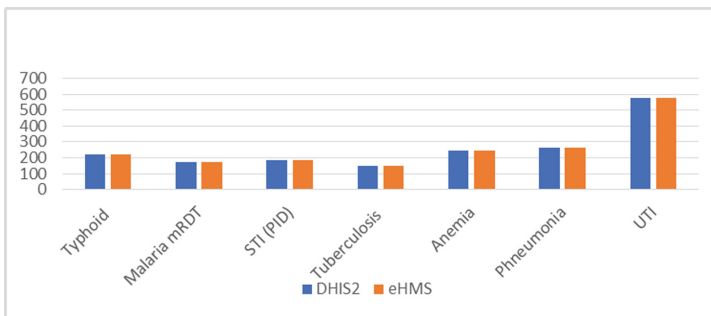

Fig. 6. Data values in DHIS2 and eHMS OPD reports on March 2018 after integration

7 Discussion

The study shows that, although hospitals are more paper less on clinical operations, but the truth is, they are operating manually on data reporting to DHIS2 that challenges the technical constraints to data use. Since EMRs carries actual value from service providers, there little use or not used at all when preparing monthly or quarterly HMIS data reports impose a question to where data reported into DHIS2 comes from? The qualitative review reviled that in most cases data from EMR are written first (which is not always the case) in the HMIS reporting books and then re-entered into the DHIS2. This process has cited out to be error prone due to missing values during aggregation or data entry error.

As per [10], poor data (in terms of quality) is not normally used, and because it is not used, it remains of poor quality. Although, data quality and information usage are closely linked, it is only through the use of data close to its source, that data quality may be improved. The integration of EMR – DHIS2 serves Health Workers with task to compute and compile report based on manual register, which is error prone. The approach to EMR-HMIS integration should not distort a well-established HMIS report

mechanism as review of the HMIS in Tanzania. With the DHIS database aimed at empowering health managers at district, region and national level to use information to improve health services, the integration should align together with procedures and processes, so will clearly contribute to a strengthens the existing hierarchy of reporting.

It's not only about EMR and DHIS2 data sharing, but the quality of data reported should be of a concern. Data entered into the EMR inaccurately renders even the most technologically sophisticated integration leading to failure or little use of integration. Data quality concerns may affect decisions about the integration process. For example, in this case data values from EMR are not matching with the values in the DHIS2. So, before integrating data must checked. Is data integrated upon entry or does it require approval and or cleaning first? The findings show that, DHIS2 can easily accept json, xml and csv files for importation Therefore technology is not a problem when it comes to HIS integration and so is EMR – HMIS integration should not primary be perceived as a technical problem, rather a complex operational issue. These operations will affect the perceived benefits of integration, so they need to be sorted out first before striving for integration.

Integrating EMR data to routine system of health data reporting is realistic and produce a valuable information needed for clinical practice and improve service evaluation and delivery outcomes. To improve facility HMIS data reporting and use, the EMR system should be enabled to capture, aggregate and share relevant information across all functional units within health facility by supplying aggregated data to DHIS2 [21]. Since EMRs produce first-hand information that is recorded on patient – doctor encounters, EMR – DHIS2 integration is critical to ensure that health facilities are reporting health-related data that are reliable, valid, complete, comparable, and timely, to DHIS2 so as to produce analysis of services, diseases and human resources data for health management.

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