Post Graduate Diploma in Management (Hospital & Health Management)
PGDM – 2021-23 Batch
Term – IV Part A: Term End Examination

Course & Code	:	**HIT 708 – Clinical Information System**	**Reg. No.**	:	
Term & Batch	:	**TERM III Part A, 2021-2023**	**Date**	:	
Duration	:	**3 Hours**	**Max. Marks**	:	**70**

Instructions:

- Budget your time as per the marks given for each question and write your answer accordingly.
- Don't write anything on the Question Paper except writing your Registration No.
- Calculator is allowed for computations but no mobile phone.
- **Attempt all questions.**

Part A- Short answer type questions: carrying 2 marks each **Total of 20 Marks**

Q1. Which attributes of data quality are to be checked and improved upon by an HMIS Manager

a. Completeness of reporting
b. Timelines of reporting
c. Accuracy of reporting
d. Relevance of data element collected
e. All of the above

Q2. Health management information system (HMIS) implementation often carries with it great expectations, but it's not unusual to find that many end-users who have little or no direct involvement or experience with system development become disappointed with the results. This happens because the _____.

a. final product does not match their expectations
b. return on investment (ROI) is higher than expected
c. health maintenance organizations (HMOs) are participating
d. demand for print materials is high

Q3. Mention any two reasons why HMIS systems fail in Developing Countries

Q4. The components of DSS –

a. Data management subsystems
b. Model management sub-system
c. Dialog management sub-system
d. All of the above

Q5. Mention any two challenges in the development and implementation of the HMIS system

Q6. Mention the three factors for the need for HMIS systems

Q7. Mention the difference between Electronic Health Records and Electronic Medical Records

Q8. The _____ provides a manager with the information needed to make decisions regarding, the hospital's operation activities

a. Electronic Health Records
b. Electronic Information systems

c. Management Information Systems
d. Decision Support Systems

Q9. Mention the key advantages of the Clinical Decision Support System in Primary Care

Q10. EDI in HMIS stands for _____
a. Electronic Data Interchange
b. Electrical Data Interchange
c. Workflow Automation Software
d. Enhanced Data Interchange

Please summarize key findings of the Case Study: Site readiness assessment preceding the implementation of a HIV care and treatment electronic medical record system in Kenya

Part B- Answer any 4 Short answer questions carrying 5 marks each **Total of 20 Marks**

Q11. State the objective of the study
Q12. Discuss the modules of HMIS
Q13. What are your insights based on the readings from the paper?
Q14. What are some of the conclusions of the paper?
Q15 Simplify and explain the implementation strategy for the EMR system

Part C- Case study – Answer any two (carrying 15 marks each) **Total 30 Marks**

Q16. What are the critical findings of the study? Summarize them with some examples from the paper. Also, create a summary table of the findings.
Q17. Please go through the learnings from the study under the discussion section, and explain what all strategies of implementation can be implemented for a tertiary care hospital in India. Justify your answer.
Q18. Outline some of the key challenges and opportunities that you see with the implementation of EHRs.

************************END**************************

Research Paper

Site readiness assessment preceding the implementation of a HIV care and treatment electronic medical record system in Kenya

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1. Introduction

Electronic medical records (EMRs) have the potential to increase the quality and accessibility of patient data [1–3], improve clinical processes and patient safety through clinical decision support [4–9], and create efficiencies in health care delivery [5,9–11]. EMR implementation requires significant up-front investments in software design and development, implementation and training, clinic-level operating costs, and information technology support [12]. Failures–where providers or patients reject a system–can be extremely costly [13,14]. A critical step to maximize the potential for successful implementation is to assure site readiness prior to EMR deployment [15].

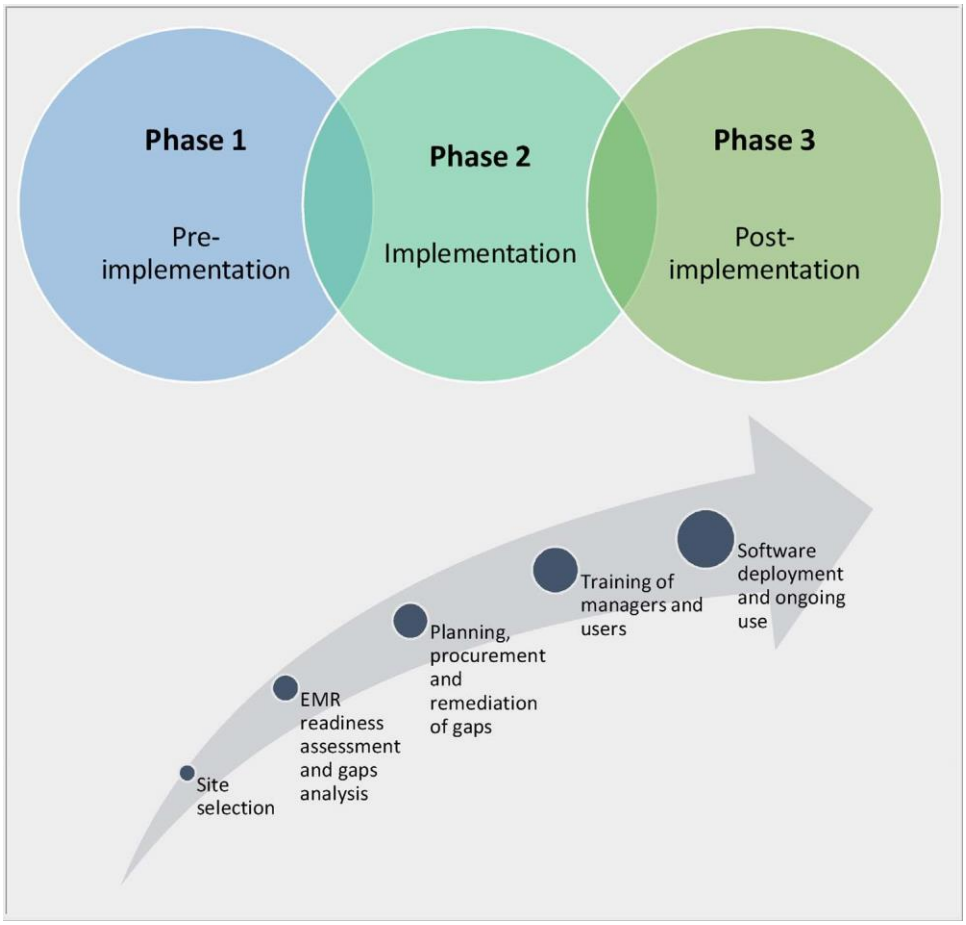
Readiness has been defined as "the extent to which individuals are cognitively and emotionally inclined to accept, embrace, and adopt a particular plan to purposefully alter the status quo" [16]. Researchers and practitioners have defined multiple domains of EMR readiness including: sound technical architecture and infrastructure [15,17–19], alignment of the technology platform with needs and professional interests [16,20], support from leaders and champions [15–18], sense of ownership [20], financial support [15,17,18,21], organizational values and culture [15,17], organizational flexibility to accommodate change [16], preparatory workflow redesign and staffing realignment [17], adoption of EMR-specific policies and procedures [17,21], as well as self-efficacy, favourable attitudes, and skills of system users [15,16,20–22]. Most of the determinants of EMR readiness are also determinants of successful on-going system use [23].

This manuscript evaluates the feasibility and utility of using ERAs to assess site readiness for implementation of KenyaEMR, an EMR system for HIV care and treatment. EMR readiness assessments (ERAs) were developed as the primary tool for evaluation of site readiness for KenyaEMR implementation. We describe outcomes of administering ERAs on a large scale in Kenya, identify lessons learned in transitioning leadership of the ERA process to the Ministry of Health (MOH), and provide recommendations on efficient use of ERAs for large-scale EMR implementation in low-resource settings.

2. Methods

2.1. KenyaEMR

Since 2009, the Kenya MOH has embraced large-scale deployment of EMRs in public sector hospitals and clinics to support improved patient health outcomes. In September 2012, the International Training and Education Centre for Health (I-TECH) received United States President's Emergency Plan for AIDS Relief (PEPFAR) funding through the US Health Resources and Services Administration and the US Centers for Disease Control and Prevention (CDC) to develop and deploy an EMR for integrated care and treatment of HIV. This led to the development of KenyaEMR, which was developed using the OpenMRS platform (http://openmrs.org/). I-TECH was tasked to implement KenyaEMR at 300facilities within four geographic regions of Kenya (Nyanza, Western, Central and North Rift).



2.2. KenyaEMR deployment strategy

The process for KenyaEMR deployment included three phases: preimplementation, implementation, and post-implementation (Fig. 1). The pre-implementation phase included the process of engagement with MOH leadership and relevant stakeholders, site selection and evaluation of site readiness for KenyaEMR implementation. These activities required MOH leadership and engagement with HIV/AIDS service delivery implementing partners. The implementation phase involved "upgrading of sites" ranked as ready or almost ready to proceed with EMR adoption. The activities conducted during this phase included security reinforcements, hardware procurement, setting up of the local area network, installation of KenyaEMR, training of system users on KenyaEMR navigation and use, legacy data migration, and data quality assessments. The post-implementation phase involved support and maintenance of the system. Through all three phases, ITECH prioritized system sustainability by transitioning KenyaEMR implementation leadership to the MOH to ensure that the MOH has the capacity to sustain EMR deployments in the future. Additionally, ITECH established partnerships with local organizations including academic institutions to orient graduates with the knowledge and skills needed to use and support the system as they join the job market.

2.3. Site selection

County Health Records Information Officers (CHRIOs) and other MOH personnel, in collaboration with partners supporting HIV/AIDS care and treatment programs within health facilities (hereafter referred to as service delivery implementation partners [SDIPs]), spearheaded the site selection process and identified sites suitable for KenyaEMR implementation. The selection of sites was guided by criteria

Fig. 1. KenyaEMR implementation phases.

recommended by the MOH staff in consultation with the partners as well as CDC. The criteria specified prioritization of sites that were public health facilities, offered HIV care and treatment services (Comprehensive Care Clinics), had large patient volumes (greater than 500 patients actively receiving HIV care in the facility), and lacked an existing nationally recommended HIV/AIDS care and treatment EMR system (Comprehensive Patient Application Database, or CPAD, IQCare (https://fgiqcare.codeplex.com), or OpenMRS) [25]. After all sites that met the above criteria for prioritization were evaluated, the criteria were relaxed and some smaller sites were included.

Across all four regions, the MOH selected sites for EMR implementation on an on-going basis and in batches of 15–20 sites per region. The selection of each batch of sites was guided by targets agreed upon by the EMR implementation teams at the onset of the program. Within the two year PEPFAR-supported implementation timeline from October 2012–September 2014, the team aimed to complete 50–60 implementations every quarter, toward the target of 300 total KenyaEMR implementations. Prior to conducting ERAs, the implementation team cross-examined the proposed site list to authenticate the selection criteria standards and ensure that assessments were suitably targeted.

EMR Readiness Assessment Domains

- **Security**: Facilities were tasked to ensure adequate physical security (grills on the doors and the windows) for both the server and workstations prior to EMR deployment. Where security was deemed inadequate, the implementation team did not proceed with EMR implementation until all the necessary security reinforcements were done.
- **Power supply**: The IT equipment need to be adequately powered since unreliable power supply poses major challenges to EMR use. Availability of power at least 75% of the time (6 out of 8 hours in a day) was a prerequisite for EMR implementation.
- **MOH approved EMRs**: Facilities found to have an existing EMR system meeting MOH standards were not eligible for implementation of a new EMR system.
- **Patient workload:** Sites with at least 500 patients actively receiving HIV care were prioritized for EMR implementation.
- **Legacy patient data:** Individual HIV patient care cards (MOH 257 Card) should be up-to-date and contain all historic patient data before data is transferred into the EMR system. Sites that did not have their data in this standard format were required to complete a data reconstruction exercise prior to EMR implementation.
- **Server location**: The server location was identified during the ERA. The server needed to be physically secured and protected from unauthorized access. The proposed server room needed to meet basic server room environmental requirements including proper air-ventilation and fire suppression, adequate space, and accessibility to support personnel.
- **Site operations**: Information on site operations/activities was assessed including non-EMR changes planned in the next three months, the number of encounter points in the facility, managerial support, and personnel.
- **Facility leadership and management buy-in towards EMR implementation**: Leaders expressed their commitment to support EMR system by pledging and demonstrating to support some crucial requirements such as providing staff time off during EMR trainings, identification of server EMR room, and reinforcement of security in the EMR server room and other workstations.

2.4. EMR readiness assessments

The ERAs were conducted using an assessment tool which was accompanied by a standard operating procedure (SOP) (available on request). The tool was derived from a generic ERA tool provided within the MOH Standards and Guidelines for EMR systems in Kenya, 2010 [26]. ERAs assessed eight domains of site readiness for EMR implementation: facility leadership and management buy-in towards EMR implementation, security, power supply based on frequency and duration of outages, presence of other EMRs, patient load, charts format, server location, and site operations/activities. Assessment teams rated facilities on a consensus basis based upon the ERA responses in three categories, as follows:

i) "Highly-prepared" facilities: a) reported to have power at least 75% of the time and had a stand-by power back-up in place; b) demonstrated adequate security (lockable doors and grilled window) in all or majority of the rooms used for the EMR; and c) had site leadership which expressed full support and buy-in for the EMR system.
ii) "Moderately-prepared" facilities: a) reported to have power at least 75% of the time; b) demonstrated to have security at least in the server room; and c) had site leadership which expressed full support and buy-in for the EMR system.
iii) "Not prepared" facilities: a) reported to lack power for at least 75% of the time; b) lacked a secure server room; or c) had site leadership that seemed hesitant or unwilling to adopt EMR system.

"Highly prepared" facilities adopted KenyaEMR at point of care (POC), where multiple EMR terminals were installed in clinic consultation rooms, while "moderately prepared" facilities adopted KenyaEMR for retrospective data entry (RDE), where a single terminal was installed for data entry. The details of each domain are provided in Fig. 2.

The assessment tool was initially piloted at 15 sites between July and November 2012. This was to derive best practices and lessons to apply during the roll-out phase. Following these initial assessments, ITECH modified the tool based on the field experience and feedback from the MOH and implementing partners. Sections deemed complex were reviewed and simplified, and sections deemed non-essential were removed.

To improve the efficiency of ERA data collection and results sharing between stakeholders, the paper tool was converted to an electronic format using Formhub (http://formhub.org/), which allowed for data collection via Android devices. Although it was hoped that the MOH and implementing partners would primarily use the electronic version of the tool, it became apparent that some individuals could not access the electronic version due to lack of Android mobile devices while others preferred to use the paper form. As a result, teams reverted to primarily using the paper-based tool.

After these initial ERAs, the MOH and SDIPs began leading the assessments starting in January 2013, with I-TECH continuing to provide technical support. This shift in leadership was driven by the need to ensure greater involvement of the MOH and implementing partners in EMR activities, and to forge local ownership of the EMR implementation process to support sustainability. I-TECH's implementation team continued to provide advanced technical support, including reviewing the assessment tool and processes, supporting logistics planning and composition of the ERA teams, and validating the data collected by ERA teams for any errors of omission or commission. Each ERA team comprised of 3–5 people, who were mentored and oriented by I-TECH on the assessment process ahead of the activity. The MOH mobilized facility staff to participate while the SDIPs worked with facilities to address gaps identified during the ERAs; both staffed the assessment teams.

Initially ERAs were done in a two-stage process, each involving a site visit by the ERA team: i) assessment and dissemination of the findings; and ii) development of preliminary implementation plans. However, it was recognized that these two stages delayed execution of initial preparation activities. Therefore, the two stages were combined in a single visit, giving the facility management team the opportunity to immediately start planning for the necessary upgrades such as security reinforcements in the EMR rooms and securing the server location as recommended by the team of assessors. ERAs typically took 3–4 h to complete, including debriefing of results and development of preliminary plans with facility leadership.

The ERA process enabled the facility, the MOH, SDIPs, EMR implementing partners, and other stakeholders to commence EMR implementation preparations such as the setting up of the local-area network (LAN), and enabled the assessors to flag key issues that needed to be resolved preceding implementation. Assessments that revealed major gaps warranted delaying or disqualifying a facility from EMR implementation until the gaps were resolved. As assessment results were being analyzed, stakeholders identified areas to provide support and their roles in EMR implementation were clarified. I-TECH was responsible for LAN installation and for providing initial required IT

equipment such as the servers and the work stations. Any other infrastructural upgrades were tasked to other stakeholders including the facility adopting the EMR system. EMR committees were formed at sites to provide local management of the process, with I-TECH providing support and technical assistance to each committee.

3. Results

3.1. ERA results

From September 2012 to September 2014, a total of 381 ERAs were completed in I-TECH implementation regions. Out of 381 sites that had ERAs completed, 328facilities were rated as highly or moderately prepared to adopt an EMR system at their initial assessment (Table 1). An additional 15facilities found not to be prepared for EMR adoption at their initial evaluation were found to be highly or moderately prepared to adopt an EMR at a repeat evaluation. Thus, in total 343facilities were found to be ready for EMR deployment).

3.2. Pathways to KenyaEMR adoption

All 343facilities that the ERAs found to be highly or moderately prepared for EMR implementation proceeded to deployment. However, the pace of deployment was slower than anticipated due to unanticipated challenges and

Fig. 2. Domains of EMR Readiness Assessment.

circumstances on the ground, such as delays in equipment delivery, which forced the implementation team to reduce the rate of assessments. The program experienced significant procurement delays in the period from Oct 2013 to March 2014, which caused a slowdown of both ERAs and EMR implementations conducted and increased the time from ERA to EMR deployment. To minimize the time lag from assessment to deployment, ERAs were carried out in tandem with deployments. All facilities moved sequentially through the three phases of implementation, but in batches of 15–20 sites. Through implementation of the ERAs, I-TECH identified four different routes that sites followed on the path to KenyaEMR adoption: Pathway 1) ERA leading to point of care implementation, Pathway 2) ERA leading to retrospective data entry implementation, Pathway 3) Multiple ERAs leading to eventual EMR implementation, and Pathway 4) ERA leading to decision not to implement (Table 2). In the sections below, we describe each of the four pathways, report the number of sites that followed each pathway, and briefly describe a case study from one site that followed each pathway.

3.2.1. Pathway 1: ERA leading to point of care implementation

POC was considered to be the preferred model of EMR implementation for sites. Two hundred and eight facilities (61%) were found to have consistent power supply, physical security, and managerial buy-in and were recommended to adopt KenyaEMR at POC. All 208 sites went on to successfully deploy POC EMRs, with a median time from ERA to deployment of 79 days.

A case study comes from a district hospital in the Western region of Kenya, with approximately 4000 patients enrolled in the HIV care and treatment program. ERA results showed that the primary source of power in the facility was the national electricity grid, typically accessible at least 75% of the day. Moreover, a generator was available and was normally used as a back-up power source in the event of blackouts. The facility further indicated that no power blackouts had occurred during the month preceding the assessment.

Prior to the ERA, the site leadership had already identified a secure room to house the computer and other IT equipment, with security measures including grills on the windows, lockable doors, security

Table 1
Results of initial EMR readiness assessments.

Activity Period	Number of ERAs conducted	Initial ERA Result		
		Highly prepared	Moderately prepared	Not prepared
Sept 2012 – March 2013	53	10	3	7
April 2013 – Sept 2013	143	54	36	20
Oct 2013 – March 2014	47	12	43	4
April 2014 – Sept 2014	138	137	48	7
Total	381	213	130	38

*15 of these facilities received a second ERA between April and Sept 2014 and were found to be highly or moderately prepared, leading to EMR deployment.

Table 2

The number of EMR deployments and median time (days) from ERA to deployment.

Activity Period	EMR implementation pathway				Total EMR deployments
	Pathway 1 N (Median)	Pathway 2 N (Median)	Pathway 3 N (Median)	Pathway 4 N (Median)	
Sept 2012 – March 2013	11 (68 days)	2 (39 days)	0	0	13
April 2013 – Sept 2013	74 (93 days)	16 (83 days)	0	0	90
Oct 2013 – March 2014	28 (118 days)	27 (168 days)	0	0	55
April 2014 – Sept 2014	95 (52 days)	75 (55 days)	15 (428 days)*	0	185
Total	208 (79 days)	120 (87 days)	15 (428 days)	38	343

*These 15 sites were found not to be prepared for EMR deployment at their initial ERA, but found to be prepared for deployment at a subsequent ERA. Median time from first ERA to deployment is shown.

guards, and security lights. However, several enhancements to the physical security of the rooms were recommended during the ERA. The leadership team was very supportive of the EMR initiative and therefore swiftly addressed the identified gaps with the support from SDIPs within 4 weeks. The ERA team then endorsed the site for POC EMR implementation.

3.2.2. Pathway 2: ERA leading to retrospective data entry implementation

One hundred and thirty five facilities received recommendations to proceed with RDE implementation of KenyaEMR. One hundred and twenty facilities were found to be prepared at their initial ERA, and the sites went on to successfully deploy RDE EMRs, with a mean time from ERA to deployment of 87 days. For example, one district hospital in the North Rift region of Kenya was recommended for RDE implementation despite having a high patient volume active in HIV care (> 3500 patients) and a generator available for back-up power supply. This was based upon low physical security in several of the clinic consultation rooms and the vulnerability of clinic and records rooms to flooding. The facility management indicated that they could not reinforce the security of all the EMR rooms promptly because of lack of funds. However, the management was very keen to have the EMR and assured they would look for funds to address the issues of security reinforcements in the future.

3.2.3. Pathway 3: multiple ERAs leading to eventual EMR implementation

In approximately 15 sites, an initial ERA revealed the need for significant remediation to prepare for EMR implementation, and a second ERA was essential. At the second ERA, these sites were recommended to proceed with EMR implementation, and they successfully deployed EMRs with a mean time from first ERA to deployment of 428 days. A Health Centre in Nyandarua County, within Central Kenya exemplified the case of multiple ERAs leading to eventual EMR implementation. The MOH in Nyandarua County selected the facility to receive an ERA in September 2013. The facility had enrolled 375 patients in HIV care at that time.

Assessment results indicated that this facility had electrical power at least 75% of the day. The facility leadership indicated that they were ready and committed to support the EMR implementation. However, security concerns were flagged by the assessment team indicating that locations where IT equipment (including the server) would be placed lacked adequate security. The assessment team observed that the building was old and constructed using timber, which is easy to break into. However, the Health Center had a stone-built wing of the facility in construction, though it was not initially planned for housing the HIV/ AIDS Comprehensive Care Clinic.

The assessment team notified the facility that it could not adopt KenyaEMR due to the physical security concerns in the rooms housing EMR equipment. The facility leadership reviewed the concerns aggressively and discussed possible alternatives. Motivated to adopt an EMR system, the facility arranged to relocate its HIV/AIDS services to the more secure stone-built construction in early 2014. Furthermore, the facility reinforced the windows of this building to ensure adequate physical security for IT equipment.

Having taken these steps, the facility communicated those changes to the CHRIO and requested a re-assessment to ascertain site readiness. This facility was assessed for the second time five months after the initial ERA. Security was found to be adequate and the facility was endorsed for a POC EMR implementation. KenyaEMR was implemented in the facility one month after re-assessment.

3.2.4. Pathway 4: ERA leading to decision not to implement

There were 38 ERAs which led to a decision not to proceed with EMR implementation. The most common factors preventing EMR implementation were lack of reliable power, security issues which could not be remedied, or existence of another nationally recommended EMR system. For example, an assessment in one Health Centre in Nyanza region found that the facility had already adopted one of the recommended EMR systems in Kenya (IQCare), so the assessment team immediately determined that the site was not suited for a new EMR implementation.

4. Discussion

We found that EMR readiness assessments preceding large scale deployment of an EMR system at HIV care and treatment facilities in Kenya were feasible and useful for identifying sites ready for EMR deployment. The assessments evaluated health facility internal environment in terms of available resources, IT infrastructure, and leadership buy-in (from MOH and stakeholders) for successful and sustained EMR adoption and use. The benefit of conducting the ERAs was that assessment results spurred the MOH and SDIPs to systematically address identified gaps.

At sites where ERAs identified too many shortcomings, it was necessary to either delay or halt plans for KenyaEMR implementation. As has been alluded by other studies, failed implementation can be extremely costly [13,14]. The fact that 90% (343/381) of sites that received an ERA eventually implemented KenyaEMR indicates that majority of assessments were targeted to sites with a realistic possibility of moving onward to EMR implementation. The pre-screening step, which entailed contacting site managers or implementing partners by telephone to verify patient volume and the presence of an existing EMR, was effective in reducing the number of sites dropped following ERAs, thus saving both time and costs.

Moreover, ERAs were instrumental in determining facilities' EMR adoption pathways. The ideal EMR implementation model was POC, which allows clinical staff to benefit from the decision support system

features that are not applicable to RDE implementation. Previous studies have found that clinical decision support features within EMRs offer the potential to improve clinical processes and patient safety [4]. ERAs led to recommendations for POC implementation at 61% of facilities which proceeded with KenyaEMR deployment. Sites which were recommended for RDE implementation in the near term were encouraged to undertake further remediation to enable future transition to POC implementation.

Through ERAs, several strategies were identified that worked well for the implementation team:

i) Setting of targets for both ERAs and EMR implementation on aquarterly basis and in batches of 15–20 sites per region enabled teams to focus on a manageable number of sites during a given period. Short-term targets were guided by overall implementation targets and enabled the team to routinely monitor progress and milestones reached against overall targets.
ii) Converting from the two-staged ERA process to a combined as-sessment and dissemination and preliminary planning process conducted on a single day. By providing immediate ERA results to facilities, the facility management was able to immediately commence implementation plans and maintain momentum towards KenyaEMR deployment.
iii) Transitioning ERA implementation to the MOH and SDIPs based onlessons learned from the initial 15 pilot assessments. The shift in responsibility relieved the I-TECH technical team from this activity and enabled them to spend more time focusing on highly technical activities while scaling up EMR across 300 sites, and ensured increased involvement of MOH and partners in EMR activities. The presence of a SOP for ERAs and the decision to revert to the use of a paper-based tool for ERAs were critical in ensuring that the MOH could confidently lead the ERA process.

In the end, more than 300 ERAs were led by the MOH and SDIPs.

Using a participatory process of engaging with multidisciplinary groups of health care professionals in EMR selection is recognized as a best practice which increases buy-in and readiness for EMR adoption [24]. Our ERA process, with its emphasis on collaboration and synergy of effort between MOH, SDIPs, and I-TECH, fostered buy-in for EMR implementation. We believe this process fostered local ownership from the onset of the implementation and deployment process, a critical condition for successful and sustained EMR adoption and use.

5. Conclusion

The ERAs assisted in resource mobilization, remediation of EMR implementation gaps, formulation of upgrade plans and buy-in from MOH leadership to support EMR implementation work. The process of carrying out readiness assessments stimulated engagement of facilitylevel personnel to assure a fertile environment for EMR adoption and fostered transition of ownership and leadership of EMR implementation steps to local health authorities. Such local engagement and leadership bodes well for successful and sustained EMR adoption and use.

MOH-led EMR readiness assessments proved to be feasible and useful in determining facilities' EMR adoption pathways. We recommend that the sites be followed up and evaluated to determine how successful they are in EMR implementation, adoption and use.