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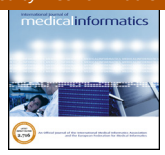

Barriers and facilitators to Electronic Medical Record (EMR) use in an urban slum

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ABSTRACT

Objective: Rapid urbanization has led to the growth of urban slums and increased healthcare burdens for vulnerable populations. Electronic Medical Records (EMRs) have the potential to improve continuity of care for slum residents, but their implementation is complicated by technical and non-technical limitations. This study sought practical insights about facilitators and barriers to EMR implementation in urban slum environments.

Method: Descriptive qualitative method was used to explore staff perceptions about a recent open-source EMR deployment in two primary care clinics in Kibera, Nairobi. Participants were interviewed using open-ended, semi-structured questions. Content analysis was used when exploring transcribed data.

Results: Three major themes – systems, software, and social considerations – emerged from content analysis, with sustainability concerns prevailing. Although participants reported many systems (e.g., power, network, Internet, hardware, interoperability) and software (e.g., data integrity, confidentiality, function) challenges, social factors (e.g., identity management, training, use incentives) appeared the most important impediments to sustainability.

Discussion: These findings are consistent with what others have reported, especially the importance of practical barriers to EMR deployments in resource-constrained settings. Other findings contribute unique insights about social determinants of EMR impact in slum settings, including the challenge of multiple-identity management and development of meaningful incentives to staff compliance.

Conclusions: This study exposes front-line experiences with opportunities and shortcomings of EMR implementations in urban slum primary care clinics. Although the promise is great, there are a number of unique system, software and social challenges that EMR advocates should address before expecting sustainable EMR use in resource-constrained settings.

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1. Introduction

Rapid urbanization is associated with growth in the number and size of urban slums, mostly as marginalized populations bearing a large burden of health problems [1–6]. Within these environments, increased health care needs coincide with a decreased capacity for health care delivery due to financial barriers, poor communication systems, fragmented services, and minimal continuity of care [6–11].

E-health, the application of information and communication technologies to health care, is a rapidly expanding domain in both developed and developing countries. Given the promise of information technologies to improve communication, sharing and tracking of health care, policy-makers have begun to promote the adoption of Health Information Systems (HIS) to facilitate the coordination of medical care. A HIS is defined as a system that captures, analyzes, processes and uses health information to inform decisions and improve quality of care [12]. A particular form of HIS are Electronic Medical Records (EMR). These are patient centric health systems [13], which have been extolled for their ability to address the storage, transport, exchange and upkeep problems associated with paper records [14–16].

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The World Health Organization (WHO) encourages developing countries to invest in HIS, citing evidence that they improve patient management, clinic efficiency and health outcomes in Sub-Saharan Africa. [17] According to UN-Habitat, slums form when rapidly increasing migration is associated with urban poverty, income inequality and unrecognized resident status [18]. Access to insurance is rare and continuity of care almost non-existent. At a community level, poor documentation of risks, diseases and deaths impedes effective health surveillance and planning [19–21]. With the number and size of urban slums growing, it is no surprise that EMR systems are offered up as a possible remedy for complex health information problems [4,22]. EMR use in slums has the potential to improve patient identification, information capture, disease tracking and drug distribution among a largely undocumented and transient population.

In Nairobi, Kenya's capital, 60% of the population resides in slums [23]. Kibera is the largest of these, with a vulnerable population subject to all expected impediments to health care access. Innovative Canadians for Change has been working to facilitate EMR implementations in Kibera clinics since 2011, deploying a primary care EMR derived from OpenMRS software [22,24,25]. This study explores the perceptions of clinic staff exposed to this EMR, focusing on benefits and harms to the community, and how EMRs should be deployed in slum settings to maximize impact.

2. Methods

2.1. Design

Descriptive qualitative method was used to explore the perceptions of primary care staff about both the challenges and benefits of an EMR introduced into two different clinics in Kibera, Nairobi. The intent was to expose the essence of participant's opinions, experiences and perceptions by understanding the how, what, where and why of the participants' EMR experience [26,27]. In-depth one-on-one interviews were conducted.

2.2. Setting

Kibera's population is estimated at close to one million persons [28–31]. Life-long residents describe it as a safe place, whereas outsiders regard it as unhygienic, disease-ridden and high-risk [28]. Officially, its residents are "illegal settlers" without entitlement to publicly funded health care or human services [32,33]. Kibera operates through countless private enterprises, with an entrepreneurial spirit extending to over 100 isolated clinics [34,35]. To the extent that it has been documented, Kibera's health care infrastructure is fragmented and inefficient, resulting in poor health outcomes and lack of continuity of care [36].

Some Kibera health clinics have adopted EMRs to improve health information management. The two clinics (Clinic 1 and Clinic 2) selected for this study adapted and adopted the same open-source EMR. Both clinics see over 25 patients per day, offer primary care services and exclusively attend to marginalized populations living in slum environments.

2.3. Sample

Study participants were consenting adults working at study clinics fulltime for at least a year prior to the commencement of the study. Purposeful sampling focused on nurses, physicians and support staff, and included "knowledge rich" persons identified by management [26,27]. All reported using a computer on a daily basis and most (8/10) rated their computer skills as "intermediate" with keyboarding skills using three or more fingers. Participants were informed about the study, were reassured that non-participation would have no consequences, and provided written consent to be interviewed. Observation saturation was reached with 10 participants (Table 1).

2.4. Data collection

An interview guide was developed using open-ended and semi-structured questions. The interview guide was pre-tested at an inner-city low-income family medicine clinic in Edmonton, Canada, and revised prior to use in the field study to reflect cultural nuances in Nairobi.

Data collection occurred in two stages. First, an introductory encounter was arranged with clinic managers to explain the study and establish rapport with potential participants. Second, interviews were arranged at a location of the participant's choosing.

Participants were asked to share any observations that might come to mind about the use of the EMR as part of their daily work at the clinic. Probing questions were used to express genuine curiosity about the participants' experiences and explore observations.

2.5. Data analysis

Audio-recorded interview were transcribed verbatim, then replayed at least once to verify accuracy and authenticity [37]. All participant identifiers were stripped from the data. Finalized, anonymized and validated transcripts constituted data for analysis.

Content analysis methods were used to explore observations while staying close to the data without undue interpretation [26,27,37]. Codes were generated to help categorize observations. Through an inductive process, common themes linking codes to categories emerged. Illustrative quotations were abstracted to ground categories, subcategories and themes while being attentive to credibility, transferability, dependability and confirmability [38].

3. Results

3.1. Themes

Eight categories and four themes emerged during iterative content analysis. Themes included: 1) System, 2) Software and 3) Social influences. A fourth overarching theme, Sustainability, traversed all categories (Fig. 1).

3.2. Systems

The systems category includes considerations of infrastructure and infostructure; all things and utilities needed for an EMR to be present and working in Kibera clinics. Important system subcategories include reliability, power, networks, Internet, workstations and component interoperability (Table 2).

3.2.1. Reliability

System reliability challenges were emphasized, with many examples of common and impactful deficiencies in slum settings. Unreliable infrastructure appeared to trump all other problems: when needed system supports went down, the EMR either could not function or would not function as intended. Network and Internet glitches often resulted in operational slow-downs, with major impacts on user confidence, EMR adoption and the need to revert to paper-based workflows.

3.2.2. Power and internet

Lack of reliable electrical power proved a major barrier to successful EMR transitions. Kibera's power could go down at any time and could be out for as long as 12 h. Independently, Internet services

Table 1
Participant Characteristics.

	Physician	Clinical Officer	Nurse	Technician	Pharmacist	Administration	Total
Clinic 1	1				1	2	4
Clinic 2	1	1	1	1	1	1	6
Total	2	1	1	1	2	3	10

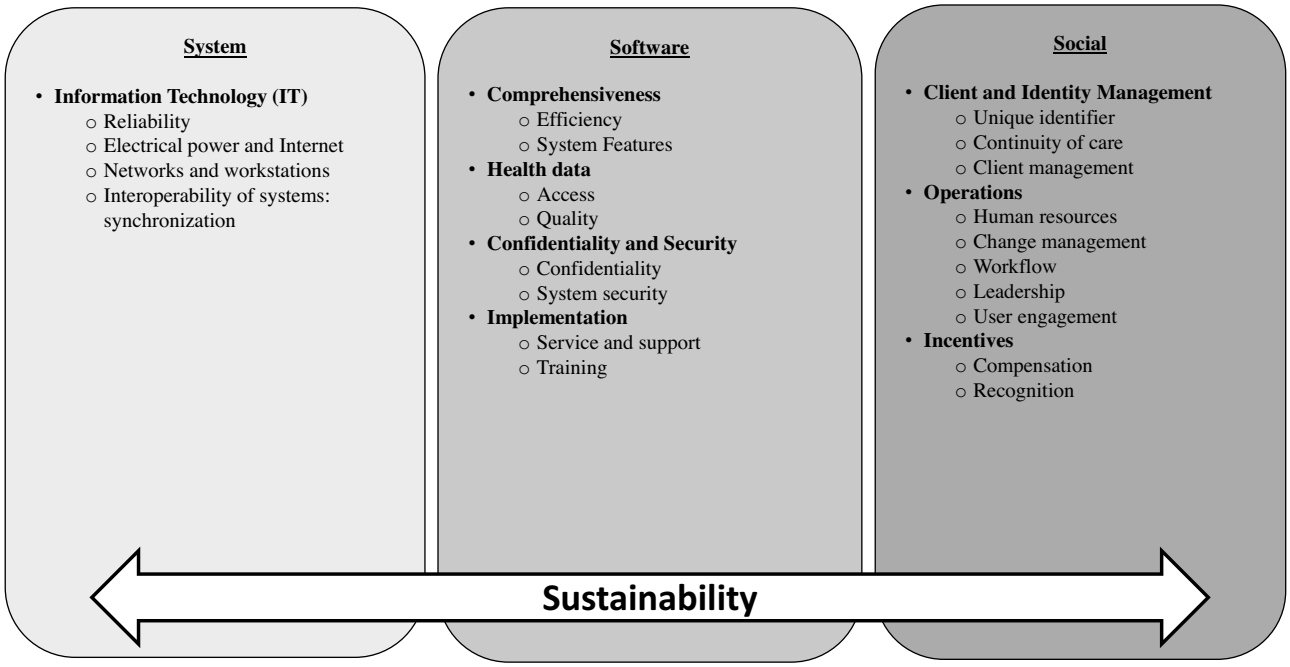

Fig. 1. Content analysis—themes, categories and subcategories.

could go down unpredictably for varying lengths of time. Even if the Internet remained operational, data transfer speeds were unpredictable and could slow the EMR so much that screens could take one to three minutes to load. One participant suggested modifying the EMR so that it could work offline, updating a central data repository only when Internet speeds were adequate. System-related slow-downs forced maintenance of parallel paper-based systems and both clinics developed workflows for data re-entry from paper backups after power or Internet down-times.

3.2.3. Network and workstations

The installation of sufficient computer hardware and networking proved problematic. Clinic 2, with its more complex floor plan, did not manage to equip all areas equally or adequately. One participant mentioned that it was difficult to access health information because her colleague's room did not have computer access. Although network reach was inadequate for some, when working well, it was cited as a major advantage over the prior disconnected workstations. Additionally, the wireless network was inadequate to EMR needs due to weak signal strength and insufficient providers in urban slum settings.

3.2.4. Interoperability

Lack of interoperability between the system components was cited as another impediment to successful EMR adoption. Participants expected HIS to connect clinics and services, or at least ease the exchange of information with use of one central system. Many felt that this promise went unfulfilled. Even though Clinics 1 and 2 implemented the same EMR, their informational infrastructure differed in ways that impeded interoperability. Failed integration related to administrative, financial and disease-specific surveillance systems. For example, Clinic 1 used an electronic database required to track medications subsidized for persons infected with Human Immunodeficiency Virus (HIV). They also had to interface with a different system for tracking HIV health maintenance. The EMR did not integrate these functions enough to allow retirement of the HIV HIS software. Clinic 2 relied heavily on enterprise resource planning (ERP) tools for ordering prescription drugs, but could not interface this with order-entry features of the EMR. Despite strong requests for better integration, both clinics suffered multiple incompatible systems mandated by funding opportunities, government requirements or NGO research projects. Many examples were given of inefficiencies caused by switching between multiple systems during episodes of care.

3.3. Software

The software theme encompassed considerations of EMR comprehensiveness, data quality, confidentiality and security and implementation support (Table 3).

3.3.1. Comprehensiveness

Participants acknowledged potential benefits of EMR use, emphasizing how the EMR could improve efficiency in a busy clinic. Once implemented, the EMR sometimes reduced time taken to find, retrieve and file client records. The alternative involved managing piles of papers in multiple locations. EMR use decreased the time taken to arrange referrals between Clinics 1 and 2. One participant credited more efficient referrals with improving chronic disease management. Repeat visits were more efficient because the client's past history could be retrieved and updated without renewed doc-

Table 2
System Considerations—Illustrative Participant Responses.

Concept	Quotations
Reliability	*"And when you want to save the bill there is a problem, it is not saving it is not saving." (P4 C1)*
– Erratic, often slow, system performance.	*"It's slow at some points, it's slow. I think when it's used for some time it can be very very slow. [. . .]. It is quite discouraging." (P1 C1)*
Power and Internet	*"Power fluctuations so we don't have you know reliable power, electricity." (P5 C2)*
– Internet connectivity and power interruptions affecting EMR access.	*"The challenge of the internet because you find that the system needs internet connectivity [. . .] You try to post something and its slow, you're held up, you know delaying and clearing a patient is being reviewed, you end up making the queues much longer and you end up making the clinicians feel like maybe the manual system is the best." (P7 C2)*
	"We do not have constant and reliable internet band-width so this makes it a challenge because the EMR is cloud-based system and so the fluctuation of the internet makes entry sometimes very slow or impossible." (P3 C1)
Networks and Hardware	*"The major challenges of [EMR system] like where I work you find that we have only one computer that has the [EMR system] that we can use, I know it [EMR system] can be accessed [by] any computer as long as there is internet. [. . .]. Of course [EMR system] require patients to be registered and then also for both doctors to have computers and internet but now it is only [in] one room which has this [. . .]. So that is the challenge." (P9 C2)*
– Insufficient density of devices and connections.	
Interoperability	*"I am not sure [if] [EMR system] would be able to be synchronize with the HIV data, the [HIV Database] but if it were possible to, it would be okay to have one system that can help us since we have an integrated site, we have one system to see all the patient... it would be good." (P10 C2)*
– Fragmentation and duplication of data in multiple systems that do not coordinate or exchange information.	*"The main challenge was first of all we had so many other systems that we were using. [. . .]. Looking at the nature of the work in Kibera [. . .] we usually see approximately 150 to 200 patients a day so the workload is quite high. [. . .] We had indicated that we needed it [EMR system] [. . .] to be [. . .] synergized. If they could have been synergized or made it to one system that would be much easier for us [. . .] in terms of reporting, [...] and [...] inventory management." (P8 C2)*

umentation. Clinic productivity reports, mandated by government, took less time to prepare and submit.

3.3.2. Health data

Other participants expressed frustration over missing EMR functionality. Examples included lack of sufficiently detailed reporting (e.g., to satisfy research or government accountabilities) and incomplete laboratory interfaces, test result tracking, and medical supply management. Unmet information needs discouraged users from fully embracing the EMR and prevented the clinic from retiring its paper record system. Maintaining a 'hybrid' paper-electronic system proved time consuming.

The most frequently cited EMR-attributable benefits related to information consistency and persistence. For example, before the EMR, key maternal-child information would be lost if the booklet given to clients was lost. Post-EMR, it was easier to track and share prenatal data. In general, the EMR made it easier to quickly determine who was seen and when.

Participants reported greater trust in EMR-stored information. A minimum set of structured data could be accessed from multiple locations, staff worked with the same core data for the same client, and more consistent reports could be generated more easily. EMR users were visibly accountable for data they entered, and this was perceived to enhance the quality of that data. A growing clinical data repository also made it easier to track health trends in Kibera.

3.3.3. Confidentiality and security

A frequently cited positive effect of EMR use was improved confidentiality of health data. Previously, the clinics were overwhelmed with paper management, making it difficult to keep charts from general view. Most patients carried papers from place to place. The EMR made it obvious to clients that their data was secured behind usernames and passwords, with different access granted to different staff. Clinicians cited the importance of encrypted data backed up off-site. A reciprocal worry was that the EMR data repository may not be adequately protected. One participant recalled how server crash caused data loss and a major disruption to clinic operations.

3.3.4. Implementation

Post-implementation support shortfalls compounded user frustration. Requests for fixes were not responded to in a consistent or timely manner and changing needs were not matched by EMR customizations. User training was not sufficiently sustained post-implementation. Participants cited lack of standardization, failure to match training approaches to different learning styles and general conflict with client care pressures. For example, daytime Clinic 2 training did not meet the needs of night staff, part time staff, and community health workers. Participants also noted that the training missed an opportunity to make the case for EMR adoption. Suggestions for improving training effectiveness included organizing off-site sessions spread over at least a two-day period, role-specific training, on-the-job retraining about common functions, better involvement of clinic leadership and giving experienced staff more ownership through peer-to-peer support.

3.4. Social

Client and identity management, change management and adoption incentives were cited as key social determinants of EMR impact (Table 4).

Table 3
Software Considerations—Illustrative Participant Responses.

Concept	Quotations
Comprehensiveness – Software features were missing which were necessary for clinic staff to use the EMR in their daily practice.	*"The other challenges of course, I am unable to use it to prescribe or to order [...] tests so I feel that it does not really help me. If I use [EMR system] I will still have to go back to paper." (P9 C2)* *"Please work on the reporting modules that would be very important for acceptance. It will reduce the friction that we have met with." (P3 C1)*
Data Quality – EMR better for accessing and searching health information. – EMR better for generating reports, reducing clinical error and maintaining accurate minimum data set.	*"What I like about the system, it is easier. [. . .] These cards, sometime you can misplace them, but when you come to this system you can find the patient very easily. [. . .] I am very grateful, it had made our work to be very easy." (P4 C1)* *"In terms of it [EMR system] really links up from the triage area, registration of the patient down to the clinician whether the patient will see the doctor [. . .]. So once you click and open the file in the system you are able to see [. . .], all what the patient has gone through and the doctor that has prescribed. In itself, it's a good system." (P8 C2)* *"[Paper] can have so many clinical errors [. . .], [. . .] you find [. . .] it is tedious and time consuming. [. . .] But with an electronic medical record system it makes work very easy, it's more efficient because the data is entered at the point of use. [. . .] You are likely to have a more accurate report within the shortest time possible. [. . .] I believe the EMR will be the best system, we have challenges but I think it's a good system."(P7 C2)* *"I know we have [EMR system] at Clinic 1 and its internet based, so if they are to go to Clinic 1 or any other facility in Kibera one would be able to access their history. There would be that consistency and it would improve their health. We would be able to see their progress and even the treatment they've had before, how they were being managed." (P9 C2)* *"There is a data we run each and every month. [. . .] They have to take all those different books, tabulate them manually and we don't know if there are still some errors while compiling the data. So it takes them even three days to take the different diseases, [. . .] occurrences per day, monthly. So its takes a lot of their time." (P6 C2)*
Confidentiality and Security – Access to identifiable patient information restricted by role. – EMR securely protects patient information from disasters (e.g., fires).	*"The manual records that we have <laughter> they are not confidential at all. [. . .] I think when we are talking about electronic medical records there is a way that controls can be put, [. . .] so that not everyone can access certain files or you can only access a file up [to] a certain level which is really important and good for confidentiality." (P8 C2)* *"It would be more secure in the [EMR system] rather than paper. [. . .] In fact, in an event of a fire here, all the manual records would be lost. [. . .]. It's more secure in the system."(P10 C2)*
Implementation Support – Post-implementation challenges not addressed with timely support. – Clinic changes not accommodated post-implementation.	*"It was rolled out well, but then after that nothing was done about it." (P8 C2)* *"Use was very consistent and then it went down again mainly due to the crash of the server [. . .] also hit by internet shortage crisis. The motivation that may have been achieved by that time sort of died. [. . .]First give it time, [. . .] show [clinic staff] that eventually at the end of the month these are the benefits you get for using the system versus [. . .] not using the system." (P3 C1)* *"We have walked the journey putting in [. . .] relevant applications that address the needs of the health centre. [. . .] Of course the challenge has been its taken a bit long, which is understandable because there are a lot of things we are trying to put 11 modules among other things. [. . .] So far so good." (P7 C2)* *"This current system has not really been installed completely. [. . .]. I appreciate the system but I have not used it so much."(P10 C2)*

3.4.1. Client and identity management

An unanticipated social effect of EMR implementation related to client identity management. While unique personal identifiers are an absolute requirement for EMR use, there was no national health care number. Moreover, Kibera residents placed high value on lack of consistent personal identifiers. It is common to use different identities for different purposes, possibly related to specific stigma associated with some health conditions or general mistrust of systems that might track identities. One EMR user noted that clients typically have at least five distinct identities. One clinic attempted home-visits to geographically anchor patient identities and to improve continuity of care across multiple disease states, but this was met with resistance from clients. The EMR did not anticipate this challenge; offering no ability to link multiple records to one person or to retrospectively merge health data.

3.4.2. Operations

Operational difficulties were closely tied to human resource challenges. Kibera clinics can experience high staff turnover, incentivizing EMR use can be difficult and leader intentions may not be fully aligned with staff priorities. New leaders did not necessarily inherit the EMR commitment of their predecessors and there was a

Table 4
Social Considerations—Illustrative Participant Responses.

Concept	Quotations
Identity Management – Identifier needed to facilitate continuing and cross-clinic EMR use. – Clients use different names to protect multiple health identities.	*"If [patients] are given a good reason and the information is sorting in the right way, they are open to providing information. [. . .] A unique identifier is a very fundamental component of the EMR because that way it can minimize the chances multiple registrations. [. . .] If we had a way to create a unique identifier across all platforms then that way we would make sure that . follow-up is easier and retrieval from the past medical history is also easier." (P3 C1)* *"I would say is the continuity [. . .] health seeking behaviour is quite different from the economically advantaged people. [. . .] It becomes really difficult to get their [patient] previous history. [. . .] It helps to identify this patient that has come in previously with certain conditions. You can know how they take their medication. It basically allows us to better take care of these patients." (P8 C2)*
Change Management – Transition process from paper to EMR. – Effective communication strategy needed to gain buy-in from clinic staff.	*"We need another meeting with the [EMR system] team and us [. . .] where people are again given the process, what is happening, what is expected of us, what we expect to see. An opportunity also for the [...] staff to be able to voice their feelings [. . .] I think that is missing, how we transition from the paper to the paperless. It would be good for us to [. . .] have some timelines [. . .] the [EMR system] team to tell us we hope to have installed this by this time." (P10 C2)* *"And generally change is expected to make some friction, eventually they [staff] will accept, but it is inevitable." (P3 C1)* *"Management should communicate [. . .] the current direction is such that people need to move towards EMR. [. . .] Some staff are excited about the system. [. . .]. We have had those who [. . .] are resisting this change because they feel they are so used to the [paper] system. [. . .]. It's explaining why we should move in this particular direction and the advantages we likely to get at the end of the day." (P7 C2)*
Incentives – Monetary rewards. – Being part of a progressive and modern health facility. – Improving quality of work.	*"I've been paid by whoever who is paying. So when I know very well when I am not being paid and there I am being paid, I weigh these options." (P1 C1)* *"I think that would also motivate us and that we are part of the health, a modern health facility. [. . .] For me it's not a temporary thing, if we begin it that way with incentives is it sustainable? [. . .] I don't think it's sustainable. People will only use [the EMR system] when the incentives are there. If they are not there people will not use it." (P10 C2)* *"If we are here to serve the patients and to serve them well, then the best motivation should be getting a good result out of it and understanding what we are doing. [. . .] I think it's good to speak to [the] staff generally to find motivation and the quality of work that we do rather than how much we take home." (P3 C1)*

perceived lack of operational continuity, especially relating to EMR responsibilities and accountabilities.

Participants acknowledged than any system change can stress staff relations, and some staff will always resist a shift from paper-based processes, but felt that change management could be improved with a stronger sense of purpose and commitment. The importance of unequivocal and consistent leadership support was a common observation. Deployment delays and glitches were less upsetting when staff were forewarned. To the extent that implementation may have been smoother at one of the clinics, participants explained that change management efforts focused on commitment to standardized processes which the EMR could support.

The participant's sense of EMR involvement and ownership varied. Some felt engaged but most did not. Lack of buy-in from the targeted users decreased their motivation to invest in system optimization and there appeared to be a persisting lack of appreciation of the EMR end-goals.

3.4.3. Incentives

Participants raised but had mixed feelings about monetary and non-monetary incentives for EMR use. Some felt that extra time and effort should be compensated, either financially or through some kind of certification. Others recognized that material incentives could not be sustained. One participant suggested that successful implementation should generate its own reward through, for example, easier workflows and client satisfaction; and could even attract new staff to a progressive, efficient and effective clinic. Another participant suggested that recognition is paramount and advocated for "Employee of the Month" style celebration of implementation milestones.

3.5. Sustainability

Concerns about sustainability were raised by almost all participants. Participants were anxious about different funding strategies for different HIS applications. Moreover, different organizations, with different mandates and commitments, do not align resource planning for systems, software and social challenges. The EMR is seen by some as a "pilot" project lacking a long-term commitment, and this perception may have undermined the willingness of some staff to weather the challenges of implementation. Others emphasized that staff empowerment, user engagement and leadership alignment needed work before any EMR initiative could be sustained.

The importance of building organizational capacity was emphasized more than needs for power, networks, good Internet service. Some participants suggested that value-based incentives (e.g.,

doing the right thing, quality of work, etc.) needed to be supplemented with monetary (e.g., financial incentives) and social (e.g., employee certification and recognition) rewards. The most pragmatic, and Kibera-spirited, comments related to the business case for EMR adoption and how the clinics could be made more sustainable through use of digital health records.

Sustainability considerations grouped in three themes: matters of software, systems and supports. Open-source software is a sustainable intervention in urban slums that is customizable with relatively low total cost of ownership. Power and internet systems clearly affect EMR reliability, although mobile alternatives are emerging. Supports for systems and staff proved essential to sustainability. Finally, effective change management strategies are integral part of the deployment process as users need to be guided, coached, and provided clear communication on the process; transparency was often lacking during the EMR deployment.

4. Discussion

The results of this study reveal diverse challenges associated with EMR deployments in slum settings. Some impediments, such as reliable power, networking, Internet and computer hardware, are unlikely to change without significant investments. Until reliability can be assured, EMR initiatives should anticipate infrastructure problems and seek system features that allow rapid switching to alternate power sources or off-line modes that allow clinic operations to continue during outages. These major deficiencies are problems larger than System factors. The government, power and internet companies need to invest in fiber optic systems, develop mobile battery packs or create a stronger and reliable wireless connectivity in urban slums to effectively address the problems. Even when such fail-safes are available, this study highlights the importance of on-site technical support and iterative adaptation to change in settings where unforeseen circumstances are the norm.

Other barriers to EMR use may be within the means of individual clinics to influence, given sufficient preparation and support. Participants in this study highlighted the importance of support, training, leadership and change management before EMR implementation as well as long after go-live. Dedicated implementations teams and an internal EMR champion at the clinic is necessary to provide ongoing support to users long after the implementation process has been completed. These needs are not extraordinary, but they may be more acute in resource-poor settings. It is possible that a relatively greater investment is needed to achieve EMR readiness in urban slum environments. Although the clinics observed in this study were aware of the need to invest time and energy before seeing EMR-related rewards [39], insufficient training, resistance to change, lack of communication and inadequate change management led many participants to worry about the sustainability of their EMR initiative. Accordingly, EMR deployment plans could benefit from careful consideration of the range of issues raised by participants in this study once well along their EMR journey.

Our results suggest that well-intentioned EMR users were very aware of the need for an EMR and the potential benefits to be gained from better management of health data. There were oft-repeated perceptions that an EMR-enabled clinic would be safer, more productive, better able to protect privacy, more capable of drug and disease surveillance, and more attractive to a relatively scarce health care workforce. However, the participant experiences also make it clear that the promised advantages were yet to be fully realized and may not be achievable without a different approach to user support, human resource and change management.

Similar potential benefits from EMR use, and barriers, have been observed with other EMR implementations in low resource settings [14,15,40–46]. Some deployment experiences also resonate with observations of EMR initiatives in seven developed countries [47]. The potential disabling effects of insufficient up-front investment, user-support, leadership commitment and adaptation to local needs appear to span all deployment contexts. Factors observed in Kibera but not in more advantaged settings principally related to infrastructure and social issues.

We observed social challenges that may be unique to urban slums, including a fascinating mismatch between EMR unique identifier requirements and a community imperative for multiple health care identities. Although the governments of developing nations work to implement unique personal identifiers, this may not benefit slum settings until residents attain the rights, legal status and trust that would motivate use of a national identity. Biometric identifiers may help but, even then, urban slum EMRs will need to tolerate multi-identity contexts until the technologies are widespread, affordable and accepted.

Responsibility for effective EMR use ultimately rests with users, not implementers. Our results suggest that post-implementation barriers and facilitators most affected the sustainability of EMR initiatives in resource-challenged settings. This is especially true for primary care EMRs that may not attract disease-specific niche funding, such as those promoted in Kibera for HIV and TB care management.

The choice of a descriptive qualitative method for the Kibera EMR study proved a good fit to the early stage EMR experiences in that resource-constrained setting because we were able to capture the true experiences of front line primary care clinic staff. Even if a quasi-experimental design could be resourced, it would be exceptionally difficult to control multiple covariates associated with a complex informational intervention in a chaotic social-clinical context. Use of qualitative inquiry allowed a special access to two newly EMR-equipped clinics, and opportunity for first-hand recording of user perceptions about their EMR experiences.

4.1. Limitations

Our particular qualitative study had important limitations. The timing of observation was such that both clinics were still adopting the EMR, therefore exposure was relatively recent. This is an especially difficult time when growing pains may have been overemphasized in the reports of participants. Further, our observations may have been distorted by the unique situation of the key observer, who had been involved in earlier work to promote use of open-source EMRs in the Kibera community. Familiarity with the researcher may have increased trust, particularly as there was no connection to slum officials. Prior exposure to the researcher could also have predisposed participants to politely spare her from harsh EMR criticisms. To the extent that participants seemed comfortable listing EMR-related grievances, this limitation does not appear to have been a major barrier to disclosure of negative experiences. Additionally, we acknowledge the importance of conducting a comparative analysis referencing EMR implementations in different countries and slum settings. More research is needed in this area.

5. Conclusion

The purported advantages of EMR implementation in urban slums are widely promoted. Increasingly capable health information systems could facilitate communication, help coordinate care, and improve the continuity of care in disadvantaged communities like Kibera. However, available systems may not have the ability to simplify care or improve efficiency where funding and human resources are scarce, infrastructure is unreliable and health data

Summary points

What was already known on the topic?

- Rapid urbanization is associated with growth in the number and size of urban slums and an associated rise in the burden of disease, further worsening an already fragmented and inefficient health care system.
- Rigorous qualitative research is needed before quantitative studies can be considered.
- Interoperability between various health information systems can influence EMR adoption.

What this study added to our knowledge?

- This rigorous descriptive qualitative study provides the opportunity for first-hand recording of user perceptions about their EMR experiences in an urban slum.
- Financial and non-financial incentives proved to be important factors for participants, encouraging uptake and EMR use.
- Social challenges such as multiple identities may be unique to urban slums, a critical mismatch between EMR unique identifier requirements and community needs for multiple health care identities are considerations that need to be addressed during the EMR implementation.
- Emphasis on the sustainability of software and system factors must be made; social factors must be addressed in order to ensure front line users continue to view the EMR as a long-term commitment rather than merely a "pilot" project.

demands are opportunistic, not strategic. This study described perceptions of local EMR stakeholders in two urban slum clinics. They shared many observations that may be important for other EMR initiatives to heed, and worried most about the sustainability of EMR initiatives in like communities. The future for EMR use in urban slums is promising. Innovative new technologies, such as mobile applications and point-of-care laboratory tests, could extend the reach of EMRs where infrastructure is wanting. New cloud-based EMR ecosystems, where data is collected and stored centrally could leverage cell phone networks to promote more health information sharing, coordination of care and ultimately better outcomes for vulnerable populations.

Competing interests

None.

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