ORIGINAL RESEARCH

Factors affecting the utilisation of electronic medical records system in Malawian central hospitals

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Abstract

Background

In Malawi, paper-based medical record-keeping has been observed to exacerbate challenges related to accessing patient records and patient tracking. Despite the introduction of electronic medical record (EMR) systems in 2001, paper-based records continue to be in use. Some health workers prefer paper-based records to EMRs. This study assessed factors that affect the use of EMRs in Malawi, particularly at Queen Elizabeth and Kamuzu Central Hospitals. It further investigated the reasons why paper-based records are still in use despite the numerous associated disadvantages. The extent to which EMRs contribute to patient care was also analysed.

Methods

In this cross-sectional study, 111 randomly selected health workers were interviewed, using a semistructured questionnaire, at the 2 largest central hospitals in Malawi, where EMRs were first introduced in the country. Focus group discussions were conducted to gather further information on factors identified during the individual interviews.

Results and conclusions

Differences in age, gender, and previous computer experience were not associated with differences in EMR usage. However, education and employment levels has a positive association with EMR usage. Hardware and connectivity problems, as well as lack of training and managerial support negatively affected the use of EMRs. EMRs were found to improve data quality and efficiency in patient management.

Introduction

The use of information technology (IT) in health has revolutionised and improved the delivery of healthcare services globally. IT has been applied in hospitals for the administration and management of patients, human resources, procurement, emergency fleet management, and much more. Previously, all such tasks were managed using paper-based record-keeping systems, which proved to be inefficient in terms of information retrieval, security, and data quality and also did not allow concurrent data access.

Paper-based records are still used by health workers largely because many healthcare workers are more familiar with paper-based records after long-term use.[1] Paper-based record-keeping does not require the relatively high level of technical knowledge and skills needed for electronic record-keeping. Paper-based record systems can be used by people with less education or, indeed, with no training at all.[1] However, paper-based records have a number of limitations. Illegible handwriting makes it difficult for others to read, which can result in errors and consequently compromise the quality of data captured. Poor data quality has serious implications on patient care, such as mixing of laboratory samples and provision of incorrect drug prescriptions. Paper-based record systems lack confidentiality because they are shared among many users and patient privacy can be easily compromised.[2] Unauthorised users can easily access information as it gets transferred from one point to another. Patient follow-up is also difficult in paper-based record systems, which in turn disrupts continuity of care.[3] Electronic medical records provide a solution to the limitations of paper-based systems. The past decade has seen a rapid increase in the use of IT in both developed and developing countries.[4–5] In Malawi,

patient records were for a long time managed using a paper-based system until 2001,[6] when a computerised patient management information system was introduced. Since then, electronic medical records (EMRs) systems have transformed the delivery of healthcare services.[7–8]

An EMR is an individual's health-related information record, which is recorded using computer software. It is generated, collected, managed, and used by authorised healthcare workers within a healthcare institution.[9] Electronic records provide substantial benefits to healthcare workers and organisations in patient management and are quickly replacing paper-based records, which have been used for centuries in health systems.[10] EMR systems solve many of the limitations of paper-based systems. EMR systems have proved to be efficient and cost-effective in improving the quality of health services. EMR systems improve accessibility to health records, as well as the quality and accuracy of patient information.[5,11] In view of these benefits of EMRs, healthcare providers have widely adopted EMR use in healthcare globally.[12,13]

EMRs have been found to improve the quality of patient care, as they enable storage of large amounts of data and also facilitate quick data retrieval, which reduces time pressure on health workers.[11] EMRs require less data storage space and minimise the loss of patient records.[5–11] However, EMR systems still have their challenges, including lack of computer skills among health workers, frequent computer breakdowns, power failures, negative attitudes of health workers towards EMR systems, and the costs of staff training on such systems.[3]

EMRs were first introduced into the Malawian public health system at Kamuzu Central Hospital (KCH) in Lilongwe in

2001 by the Baobab Health Project (BHP) in conjunction with the Ministry of Health (MOH).[10–15] KCH is situated in the capital city, Lilongwe, in Malawi's Central Region, and it is the second largest public referral hospital in the country, after Queen Elizabeth Central Hospital (QECH) in the Southern Region. KCH mainly provides specialised services and it serves as a referral for the entire central region.

In 2005, the EMR system was extended to QECH in Blantyre.[10–14] QECH is the largest government referral hospital in country; it provides primary, secondary, and tertiary healthcare services for the Southern Region and other specialised services for the whole country. It also serves as a teaching and research hospital for the College of Medicine, a constituent college of the University of Malawi, and its research affiliates.[16] Despite the introduction of EMRs in Malawi, a considerable proportion of healthcare workers are still using paper-based records.[6] It is not clear why hospital management teams have not enforced a complete transition from paper-based records to EMRs.

Several studies have investigated the use of EMRs both locally and internationally. A survey conducted at the QECH Antiretroviral Therapy (ART) Clinic found that 70% of respondents preferred using the EMR system over paper-based records.[10] However, users identified several problems with the use of the EMR system; these included inadequate computer skills and unreliable computer network connectivity. SanJoaquin et al.,[3] identified several EMR-related challenges, including frequent power failure. However, the problem of prolonged power outages was addressed by the adoption of a long-lasting backup power system in conjunction with energy-efficient computers. Although there have been several studies conducted at QECH and KCH focusing on EMRs, these studies concentrated on specific departments rather than the entire hospital. As such, these studies were not representative enough to draw conclusions on the general performance of EMR systems in central hospitals. This study therefore attempted to comprehensively study factors that affect the utilisation of EMRs in Malawi. The study investigated existing factors uncovered in prior studies, but also attempted to uncover new factors specific to Malawi, particularly at KCH and QECH, which might have emerged after using EMRs for some time. The objectives of the study were to (1) assess knowledge and attitudes of health workers towards the use of EMRs; (2) identify technical, infrastructural, and managerial factors that affect the utilisation of EMR systems; and (3) investigate how EMR usage affects the delivery of health services.

Methods

The study was conducted at Queen Elizabeth and Kamuzu Central Hospitals. These hospitals are the 2 largest referral hospitals in Malawi in terms of bed capacity and specialised services offered. They also have been running EMRs for a longer period of time than any other hospital in the country, which allowed for sufficient information and experiences for investigation in this study. Data collected from the 2 hospitals provided a true reflection on the status of EMR usage in Malawi.

This was a cross-sectional study which applied both quantitative and qualitative techniques. The study population included health workers, from various departments, who were using EMRs, as well as those who had stopped using electronic records. Health workers investigated in this study included data clerks, nurses, clinicians, laboratory technicians, and HIV counsellors.

Table 1: Respondent characteristics

| Characteristic	QECH	KCH	Total
Gender			
Male	40 (74.1%)	14 (25.9%)	54
Female	46 (80.7%)	11 (19.3%)	57
Job title			
Data clerk	26 (68.4%)	12 (31.6%)	38
Nurse	30 (69.8%)	13 (30.2%)	43
Clinician	27 (100%)	0	27
Laboratory technician	2 (100%)	0	2
HIV counsellor	1 (100%)	0	1
Level of education			
Secondary	15 (62.5%)	9 (37.5%)	24
Tertiary	71 (81.6%)	16 (18.4%)	87

QECH = Queen Elizabeth Central Hospital (Blantyre); KCH = Kamuzu Central Hospital (KCH)

At QECH there were 5 departments that used EMRs, with a total of 139 health workers. The 5 departments were the Department of Medicine, ART Clinic, the Department of Paediatrics, the Adult Emergency and Trauma Centre (AETC), and the Laboratory Department. Only the medical, outpatient, and maternity (Ethel Mutharika Maternity Wing) departments were using EMRs at KCH, with a total of 40 health workers. The 111 participants included in this study were randomly sampled from the 179 workers in the study population. A semistructured questionnaire was used to collect data. The questionnaire comprised sections such as demographics; positive and negative factors affecting EMR usage; previous computer knowledge and training; general attitude towards EMR; and technological, managerial and infrastructural factors affecting EMR use. This method was guided by the Performance of Routine Information System Management (PRISM) framework, which identifies technical, behavioural, and organisational factors that affect routine collection of health information such as using EMR.[21](21)

Data were analysed using Stata version 12 (StataCorp, College Station, TX, USA). Sociodemographic variables (gender, educational level, job title) were summarised using frequencies and proportions. The use of EMR system functions, computing experience, usage frequency, and attitude towards EMRs were analysed using mean sum scores. Mean sum scores were also calculated for technical, managerial, and infrastructural factors. Chi-square analysis was used to assess associations among variables such as age, gender, educational level, job title and previous computing experience. In order to determine how EMR usage affected the delivery of health services, proportions were calculated on completeness, accuracy, and security of the information. Time taken to attend to patients and ease of use were also analysed.

Ethical considerations

Participation in the study was voluntary. Participants were free to discontinue responding to the questionnaire or interview at any time. Verbal explanations about the study were made privately before obtaining written consent from each participant. Information collected in the study was kept strictly confidential, concealed, and it was used strictly for the purposes of this study. There were no known risks for participating in the study. There were no incentives provided
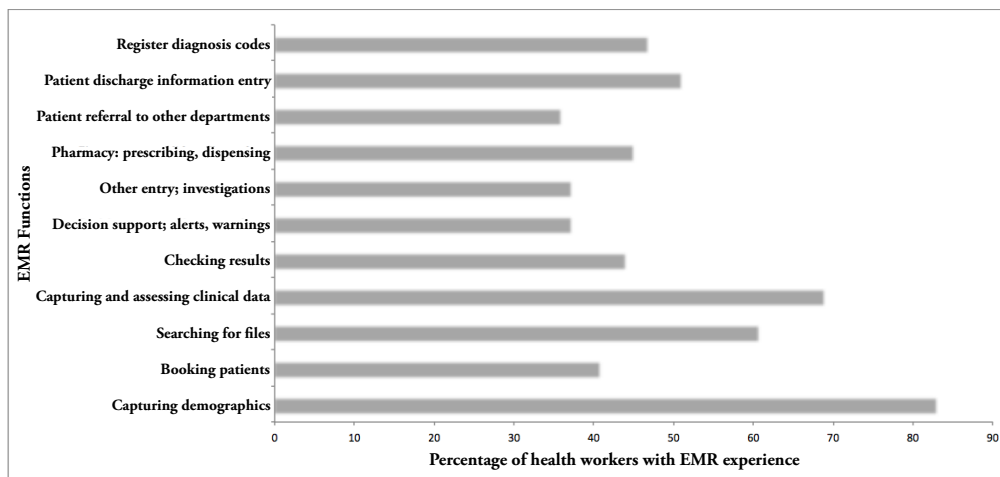
Figure 1: Use of electronic medical record functions at Queen Elizabeth Central Hospital (Blantyre) and Kamuzu Central Hospital (Lilongwe)

for participating in the study. However, the intended positive contribution of the study to the health system in Malawi was explained to participants. The study was reviewed and approved by the College of Medicine Research and Ethics Committee (COMREC).

Results and discussion

EMR use among study participants varied with demographic characteristics; EMR knowledge; previous computer experience; frequency in usage of EMR; attitudes towards EMRs; and technological, managerial, and infrastructural factors.

Study participants

There were a total of 111 participants interviewed in this study who were collectively sampled from QECH and KCH. Since QECH had more departments than KCH that used EMRs, it had more participants sampled (n = 86/111; 77.5%). In terms of profession, nurses (n = 43/111; 38.7%) made up the largest proportion of study participants, followed by data clerks (n = 38; 34.2%) and clinicians (n = 27; 24.3%). The total number of participants varied from question to question since some participants did not respond to all the questions. Table 1 shows the frequency distributions of gender, job title, and education levels among study participants.

Utilisation of EMR functions

Frequently used EMR functions were investigated to determine usage behaviour and possible technological correlates in the system design. Both human and technical determinants, as guided by the PRISM framework, were analysed.

Utilisation of EMR functions varied among departments as well as among users. Health workers used half of the system functions shown in Figure 1 for different reasons. The most commonly used functions were capturing demographics (n = 92/111; 82.9%), followed by capturing and assessing clinical data (n = 75/109; 68.8%). These functions were frequently used because they applied to almost all patients who visited the hospital. More efforts need to be applied to these functions, as they have a substantial influence on perceptions of the entire EMR system. These results are similar to those reported by Nour El Din[17] in Saudi Arabia, wherein 48% of the core EMR functions were not utilised by physicians because they were unaware of their availability in the system. The authors also found that the freedom that system users

had to choose between EMRs and paper-based records led to low usage of some of the EMR functions.

EMR training

EMR training instils confidence in the usage of the EMRs among users.[18–19] There were 76 respondents (72.4% of 105 for whom data were available for analysis) who had received basic training on EMR use. Few respondents (n = 8/105; 7.6%) received advanced training. Many respondents (n = 21/105; 20.0%) claimed not to have received any training at all. Clerks showed better understanding and knowledge of the EMRs compared to all other workers. This was probably because clerks used the system more frequently than the other staff workers. At the KCH medical department, data were captured only during day shifts but not at night. This was because most night shift healthcare staff worked part-time and were not trained to use the EMR system. Training plays a major role in promoting effective utilisation of EMRs.[20]

Attitudes towards EMR usage

Most respondents (n = 79/107; 73.8 %) indicated that EMR use did not interfere with serving patients during consultations. Additionally, 72 (65.5%) of 110 participants responded that computers were equally beneficial for both administrative and clinical functions. A large proportion of respondents (n = 77/110; 70.0 %) strongly felt that EMRs were more useful than paper-based systems. Overall, health workers had positive attitudes towards the use of EMRs, as compared to paper-based records.

Technological factors affecting EMR utilisation

Of the technological factors that were analysed (*system information, terminologies used, screen design and layout, system capabilities*, and *availability of technical support*), *system features* had the lowest mean score (2.5). *Screen design and layout* had the highest mean score (3.0). Even if a system is useful and has all the necessary functions, poor design could deter users from using the system. Human–computer interaction factors, such as system features, colour, attractiveness, and usability of the system heavily affect system usage. The PRISM framework identifies technical determinants as one of the major factors that affect performance of routine collection of health information.[21]

A high proportion of the participants favoured the technological characteristics of the EMR system, with 82 (75.9%) of 108 respondents agreeing that EMRs are beneficial because they are easier and faster to use than paper-based systems. Seventy-seven (70.6%) of 109 respondents also agreed that the EMR system terminologies were related to the performed task. EMR systems currently function well for data entry and reporting and a large number of users are involved in these tasks. It is therefore not surprising 70.6% of respondents found EMR terminology applicable to their tasks. The system provided information that users needed for their tasks, and they found that the screen features were
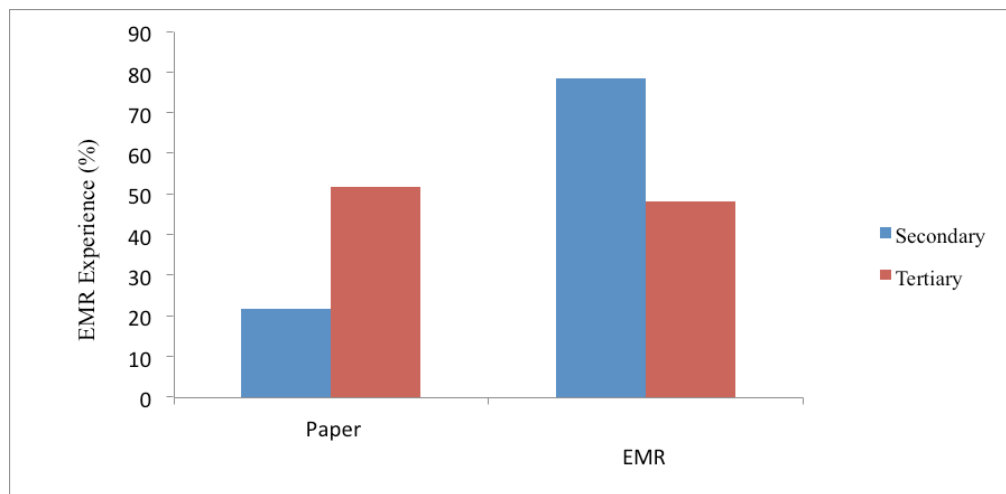
Figure 2: Education level and electronic medical record utilisation among health workers
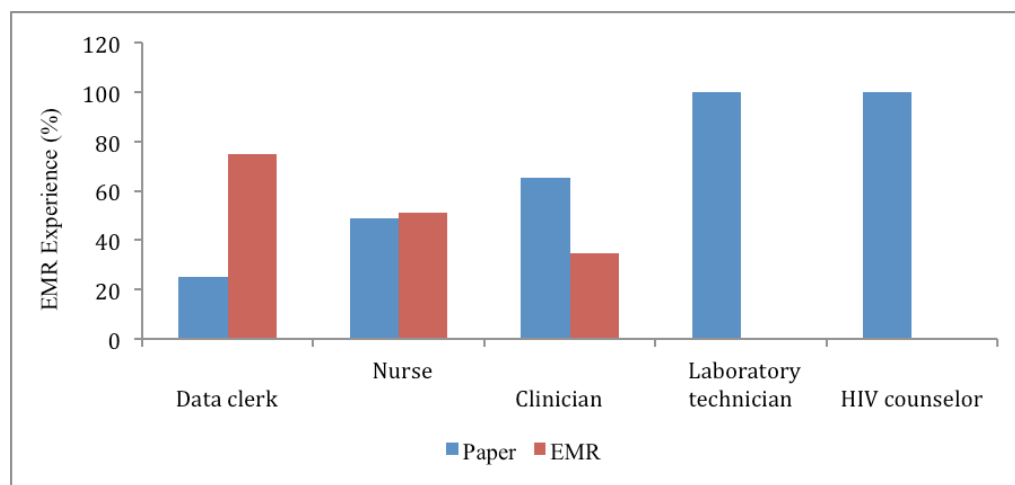

Figure 3: Electronic medical record usage versus paper-based records usage by job title

resources for EMR use, with a category mean score of 2.7 (standard deviation [SD] = 0.94; (95% confidence interval [CI] = 2.56 to 2.92). The remaining half indicated that management did not provide support and resources for EMR use. Managers lacked adequate knowledge on the benefits of EMR use by supervisors, as evidenced by the lack of enforcement on EMR use and absence of explicit EMR policies at both hospitals.

Availability of space for EMR machinery and convenience of location were among the infrastructural factors investigated. Most respondents (n = 93/107; 86.9%) found that the spaces where EMR computers were mounted were convenient to use. The category mean score was 3.1 (95% CI = 2.93 to 3.25). It was only in the medical department at QECH where respondents complained that computers were placed inconveniently—too close to patients' beds, which made access to the EMR computers difficult and compromised the privacy and security of patients' data. In such circumstances, paper-based records were preferred over EMRs. At the KCH medical department and the QECH paediatrics department, there were not enough computers, which made EMR usage difficult. Ayotallahi[24] and Lium[25] also found that computer availability was one of the major factors that affected EMR use; having inadequate or too few computers and mounting them in inconvenient locations due to lack of space negatively affected the utilisation of EMR systems, particularly, among physicians.

logically organised. This indicated that the system promoted quality health service delivery, which eventually improves healthcare services. Participants suggested that the system could be more effective if it was enforced and implemented in all departments. Participants suggested that the system could be more effective if it was enforced and implemented in all departments. It was unfortunate that some departments had stopped using EMRs because they claimed that the system failed to capture adequate patient information that clinicians needed for patient management. This finding is similar to what Msukwa[22] reported—that 22% of clinicians were not satisfied with EMRs because the information collected in the EMR system was judged to be inaccurate and incomplete. Similarly, Alharthi[23] found that physicians were not happy with the accuracy and completeness of records captured in EMR systems.

Managerial and infrastructural factors

Availability of resources and managerial support were analysed to determine their effects on EMR use. Even in the context of high-quality EMR systems, a lack of managerial support can lead to divergent priorities in resource allocation and hinder the success of EMR implementation. Seventy-eight (73.6%) out of 106 participants agreed that the EMR system was important to hospital managers. There was disagreement among respondents about whether or not management supported the use of the EMR system. Half of respondents (n = 52/104) agreed that management provided support and

Association of age, gender, job title, educational levels, and previous computing experience with EMR utilisation

Thirty-four (58.6%) of 58 respondents within the 21- to 30-year age group used EMRs more than paper-based records. This study only included 2 participants aged 61 to 70 years and both used paper more than electronic records. Despite this variation, the differences in EMR versus paper-based record usage were not statistically significant among age groups (P = 0.93). These findings are consistent with those reported in a study by Nour El Din[17] who found that health worker age was not associated with EMR versus paper record use preferences. However, these findings contradicted results from several prior studies that found that younger health workers used EMRs more than older health workers.[19,24,26]
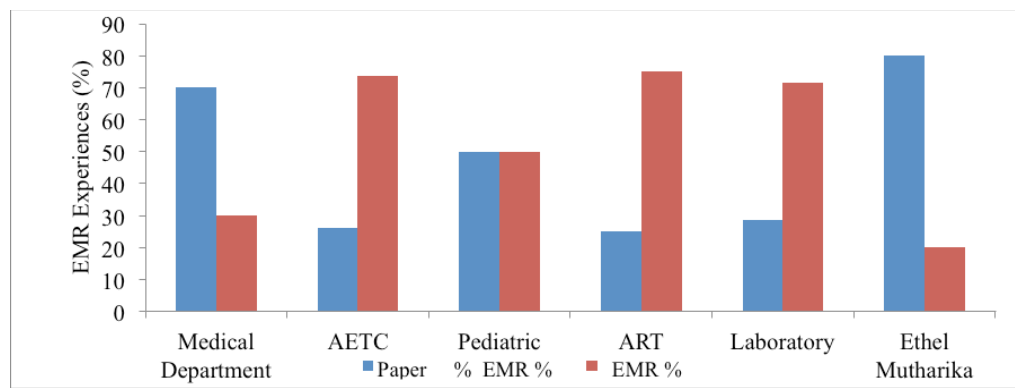
Figure 4: Electronic medical record usage versus paper-based records usage by department

Table 2: Previous computer experience and use of electronic medical records (EMRs) among health workers

Variable	Paper-based	EMR	Total	Chi-square	df	P-value
Previous computer usage	37(46. 3%)	43 (53.8%)	80			
				0.02	1	0.89
No previous computer usage	12(44.4%)	15 (55.6%)	27			
Total	**49 (45.8%)**	**58 (54.2%)**	**107**			

Mutharika Maternity Wing at KCH used paper-based records more often than EMRs. The paediatric departments used paper-based records at the same frequency as EMRs. Overall (in all departments put together), EMRs were used more frequently than paper-based records, and this difference was statistically significant (P = 0.01). Higher EMR usage in AETC might have arisen because this is the first point of initial contact for most patients in the hospital, and where their details are first captured in the system. Lack of supervision in the medical departments and the inconvenient locations of the EMR computers may have contributed to low EMR uptake in the medical wards. Additionally, much of the record keeping in the medical wards is carried out by clinicians, and as shown earlier (Figure 3), clinicians were more inclined to use paper records.

There was no significant difference between males and females in terms of EMR versus paper-based record preference (P = 0.35). This was probably because males and females have equal exposure to technology in modern contexts. These findings are consistent with a study that was conducted in Kenya on the usage of electronic medical records among healthcare workers in selected health facilities, where gender did not affect EMR use.[27]

EMR usage varied significantly by educational level among the study participants (P = 0.01). Health workers with tertiary-level education used EMRs and paper-based records in nearly equal proportions. However those with secondary-level education used EMRs more than paper-based records (Figure 2).

This was possibly because most health workers with secondary education were clerks and their scope of EMR usage was mostly limited to the single EMR function of collecting patient demographic information. In addition, clerks were regularly supervised, and they were mandated to perform their tasks by their supervisors. In contrast, a study conducted in Kenya on the use of EMRs among healthcare workers in selected health facilities found no association between educational levels and EMR usage habits.[27]

Figure 3 depicts the association between job title and EMR usage. Most data clerks (n = 27/36; 75.0%) used EMRs more often than paper-based records. Nearly two-thirds of the clinician respondents (n = 17/26; 65.4%) preferred using paper-based records more than EMRs. According to job title, the variation in preference for either EMR or paper record usage among the participants was not statistically significant (P = 0.07).

Figure 4 shows usage comparisons between EMRs and paper-based records according to participating departments. AETC (which functioned as both an emergency and outpatient department at QECH at the time of data collection), the QECH ART Clinic, and the QECH laboratory used EMRs more frequently than they did paper records. The medical departments in the participating hospitals and the Ethel

Comparing usage between hospitals, health workers at QECH (61.9%) used EMRs more frequently than at KCH (25%). This difference was statistically significant (P = 0.03). The focus group discussions revealed that lack of managerial support resulting from frequent leadership changes, lack of EMR training, and low staff retention contributed to low EMR usage at KCH.

Most of the participants (75%) had some experience using computers. There was no statistically significant difference in EMR usage between individuals with and without previous computing experience (P = 0.89) (Table 2). In contrast to these findings, Laerum et al.[28] found that computer illiteracy contributed to limited EMR among health workers. Similarly, Meinert and Peterson[29] observed that limited computer literacy on the part of physicians contributed to resistance to EMR use. Most users in this study were not familiar with the touchscreen computers, which probably acted to somewhat cancel out their overall computing experience differences.

Effect of EMRs on the delivery of health services

The majority of respondents (n = 78/103; 676%) found EMRs to be faster and easier to use than paper-based records. Most respondents (84/108, 77.8%) felt that information was more accurate in the EMR system and that patients were attended to more quickly than with the paper-based records system. Eighty-three of 108 respondents (76.9%) indicated that the EMRs maintained privacy and security of patient information. Participants stated that EMRs enabled health workers to generate more accurate information, speed up access to patient information, and they expressed satisfaction with the reminders and warnings about important patient and prescription information. This reduced medical errors and improved decision-making for patient management. The use of EMRs also enabled clinicians to assess more patients

within a shorter period of time. Giaedi[30] found that the use of EMR systems reduced access time to patient records; EMRs also reduced costs related to paper consumption. EMR utilisation also reduced the pressure on the already limited number of health staff, as less time was spent retrieving records thereby freeing more time for patient management. Moreover, EMR usage increased patients' satisfaction because patients were given quick, thorough and adequate information.[30]

Conclusions

This study investigated factors that affect the utilisation of EMR systems by health workers in Malawi particularly, at central hospitals. There was higher usage of EMRs at QECH compared to KCH, even though EMRs were first introduced at KCH. Short supplies of computers and inconvenient locations of EMR machines heavily affected EMR usage in some departments. Health workers still found EMRs to be quicker, more secure, and more accurate in aiding patient management compared to paper-based records. Electronic record-keeping enabled clinicians to consult more patients within a short period of time compared to paper records. EMRs also reduced healthcare staff workload, as less time was spent retrieving paper records. Age, gender, and previous computer experience had no effect on EMR usage frequency. However, the lack of EMR training and managerial support were among factors that negatively affected EMR uptake by healthcare workers. Educational level was also found to significantly influence EMR utilisation.

The overall attitude of health workers towards EMR usage was positive. The findings from this study may guide hospital management, system designers, installers, users and non-users on measures for improving the use of the EMRs to improve health service delivery. Future research will be required to address patient attitudes towards EMRs in this context and to address patients' concerns related to the use of EMR systems in Malawi.

Acknowledgements

Competing interests

All authors declare that they have no competing interests related to this work.

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