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Enhancing Healthcare Quality in Hospitals through Electronic Health Records: A Systematic Review

Peter Gatiti^{1*}, Eunice Ndirangu², Joseph Mwangi¹, Arnold Mwanzu¹ & Terry Ramadhani³

¹Faculty of Health Sciences Library, Aga Khan University, Kenya.

²School of Nursing and Midwifery, Aga Khan University, Kenya.

³Human Resources Department, Aga Khan University, Kenya.

Abstract

Background: The evolution of information technology has continued to put pressure on healthcare systems to switch from manual to electronic systems. The electronic health record is a leading information technology system that has drawn considerable interest from governments and private health facilities. However, EHR implementation has proved to be a problematic endeavor, especially in developing countries.

Objective: This review sought to determine the influence of EHR implementation on healthcare quality in hospitals and identifying applicable lessons for EHR implementers in hospital settings.

Methods: Relevant literature was searched in the identified databases, including Scopus, PubMed, CINAHL, PsycInfo, and Cochrane Library. Websites such as the World Health Organization and the National Institute for Health and Care Excellence were searched for policies and guidelines. The study used several terms and their variations to create a search strategy, including electronic health records, hospitals and, healthcare quality. The literature search was constrained to the English language and studies published between 2010 and 2020. The study carried out a narrative synthesis of results from the included studies.

Results: Overall, the findings of the systematic review demonstrated that EHR has a significant positive influence on healthcare quality by enhancing patient safety and ensuring effective, efficient, timely, equitable, and patient-centered care. Some of the EHR functionalities that facilitate quality healthcare include, practice management, communication, documentation or data entry, and medication management, decision support functionality, computerized drug prescription, electronic nursing documentation, and electronic management records. EHR implementation is faced with several challenges, which can be grouped into institutional side factors, human resource factors, technological factors, and ethical issues.

Conclusion: We established a significant effect of EHR implementation on several healthcare quality indicators, namely patient safety, effective care, efficient care, timely care, equitable and patient-centered care. EHR implementation is faced with challenges emanating from the healthcare institutions, healthcare professionals, technology, and ethical issues. There is a need to devise an effective mechanism that would minimize the challenges

that prevent successful EHR implementation in hospitals.

Keywords: Electronic health record; computerized medical record; electronic medical record; hospital and quality of health care.

1. Introduction

The evolution of information technology has continued to put pressure on healthcare systems to switch from manual to electronic systems. Electronic health record (EHR) is a leading information technology system that has drawn considerable interest from governments and private health facilities. However, EHR implementation has proved to be a problematic endeavor, especially in developing countries [1]. According to WHO (1) despite the high interest, the implementation of EHR seems to be overwhelming and almost out of reach to most of the healthcare facilities. The Global Health Observatory (GHO) data on EHR indicates that there has been a steady growth in the adoption of EHR over the past 15 years. However, the majority of the EHR systems have been adopted by upper-middle and high-income countries, and the adoption rates are much lower in the lower-middle and low-income countries [2]. Most of these health facilities in developing countries continue missing out on the benefits of a functional EHR in hospitals such as quality healthcare. This calls for more research that can help inform hospitals to successful EHR implementation and attain quality healthcare.

The concept of EHR emerged in 1991 as computer-based patient records with the functions of practice management, clinical management, system management, and drug management [3]. EHR foundation was laid by the emergence of the new computer technology in the 1960s and 1970s [4]. With the insufficiencies of the manual health records increasingly becoming clear to healthcare stakeholders, EHR has increasingly been developed and envisioned with a lot of gains to healthcare provision [4]. EHR provides opportunities to improve healthcare, entrench performance measures in healthcare, and enhance patient identification and healthcare professions in healthcare research [5].

EHR is implemented in hospitals with a view of improving the quality of healthcare services. They provide a significant chance to enhance health surveillance and appraise service delivery, which can result in the development in the promotion and management of public health and better clinical decision [6]. The application of EHR in hospitals has gained more prominence because it promises to, improve integration and accessibility of patient data and efficiency and cost-effectiveness of healthcare services. In addition, it has the potential of enhancing the physician-patient relationship to one that healthcare is shared by a team of healthcare givers. The fast-changing environment also necessitates the adoption of EHR [7].

Electronic health records are considered critical in enhancing healthcare services concerning the

dimension of healthcare quality defined by the Institute of Medicine (IOM), including, effectiveness, efficiency, safety, timeliness, patient-centeredness, and equity [8]. IOM recognizes EHR as a critical tool for improving patient safety and healthcare quality as well as an important tool in reducing the costs of outpatient care [9]. Further, Ajami and Bagheri-Tadi (9) noted that the adoption of information technology in healthcare has reduced healthcare services costs and increased efficiencies.

EHR influences healthcare quality through documentation, medical management, practice management, and communication [10]. EHRs lead to efficiency in healthcare services by reducing unnecessary test orders as well as reducing healthcare worker time and work done in documentation or other non-patient health-related work [11]. According to Mayer, da Costa (12), EHR holds crucial and sensitive personal information for diagnosis and treatment which are a rich source of intelligence for healthcare. The dissemination of these data is significant in creating a smarter healthcare system and improving the healthcare service quality.

Electronic health records face a lot of challenges in post-implementation, some of these challenges, common in computer systems include interoperability, usability, and data security [13]. There is uncertainty on whether the implementation of EHR impacts the quality of health services in hospitals. There have been some attempts to understand the functionalities within EHR that influence the quality of healthcare. For instance, a previous lancet study established that computerized medical records systems are important as they aid hospitals in delivering safer, more patient-centered, and efficient care, in addition to supporting appraisal, quality enhancement initiatives, public health, health-service planning, and research [14].

While the earlier studies highlight the effect of EHR on healthcare quality, they have not necessarily considered the pre-implementation, implementation, and post-implementation of EHR. Hence this review was guided by the research questions: “Does the implementation of electronic health records in hospitals enhance the quality of health care?; What aspects of electronic health records contribute to health care quality?; and what challenges do hospitals encounter in the implementation of electronic health records?” As this review sought to determine the influence of EHR on healthcare quality, literature was restricted within publications done between 2010 and 2020.

2. Subjects and Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist and subheadings were used to conduct this review [15]. The standards of the Cochrane handbook for systematic reviews of interventions were also observed in conducting this review [16].

2.1 Eligibility Criteria

Randomized Controlled Trials, Cohort Studies, Case-control Studies, and Cross-sectional studies were included. Studies on EHR pre-implementation, implementation, and post-implementation were included. Only studies done in a hospital setting were included. Systematic reviews, meta-analyses, conference abstracts, and books were not considered.

2.2 Information Sources and Search

Scopus, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycInfo, and Cochrane Library were searched for studies relevant to EHR published between 2010 and 2020 (see Table 1 for search terms). Core database, WHO and the National Institute for Health and Care Excellence (NICE) were hands searched for more studies.

Table (1): Database search strategy

Date	Database	Search query	Limits	Results
September 10, 2020	PubMed	((((((((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh]) AND (randomized controlled trial[Filter])) AND (randomizedcontrolledtrial[Filter])) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh]) AND (systematicreview[Filter])) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh]) AND (meta-analysis[Filter])) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh]) AND (cohort studies[mesh:noexp] OR longitudinal studies[mesh:noexp] OR follow-up studies[mesh:noexp] OR prospective studies[mesh:noexp] OR retrospective studies[mesh:noexp] OR cohort[TIAB] OR longitudinal[TIAB] OR prospective[TIAB] OR retrospective[TIAB] AND (y_10[Filter]) AND (meta-analysis[Filter] OR randomizedcontrolledtrial[Filter] OR systematicreview[Filter])))) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh])) AND ("Case-Control Studies"[Mesh:noexp] OR "retrospective studies"[mesh:noexp] OR "Control Groups"[Mesh:noexp] OR (case[TIAB] AND control[TIAB]) OR (cases[TIAB] AND controls[TIAB]) OR (cases[TIAB] AND controlled[TIAB]) OR (case[TIAB] AND comparison*[TIAB]) OR (cases[TIAB] AND comparison*[TIAB]) OR "control group"[TIAB] OR "control groups"[TIAB])))) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND	in the last 10 years, English	222

		("Quality of Health Care"[Mesh])) AND (Cross-Sectional Studies[Mesh:noexp] OR cross-sectional[TIAB] OR Prevalence[mesh:noexp] OR prevalence[tiab] OR transversal study[tiab])) OR (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh])) AND ("interviews as topic"[Mesh:noexp] OR "focus groups"[Mesh:noexp] OR narration[Mesh:noexp] OR qualitative research[Mesh:noexp] OR ((("semi-structured"[TIAB] OR semistructured[TIAB] OR unstructured[TIAB] OR structured[TIAB] OR informal[TIAB] OR "in-depth"[TIAB] OR indepth[TIAB] OR "face-to-face"[TIAB] OR guide[TIAB] OR guides[TIAB]) AND (interview*[TIAB] OR discussion*[TIAB] OR questionnaire*[TIAB])) OR ("focus group"[TIAB] OR "focus groups"[TIAB] OR qualitative[TIAB] OR ethnograph*[TIAB] OR fieldwork[TIAB] OR "field work"[TIAB] OR "key informant"[TIAB])))) AND (((("Electronic Health Records"[Mesh]) AND ("Hospitals"[Mesh])) AND ("Quality of Health Care"[Mesh])) AND ("evaluation studies"[17] OR "evaluation studies as topic"[mesh:noexp] OR "program evaluation"[mesh:noexp] OR "validation studies as topic"[mesh:noexp] OR (pre-[tiab] AND post-[tiab]) OR (pretest[tiab] AND posttest[tiab]) OR (program*[tiab] OR (evaluat*[tiab] OR effectiveness[tiab])) OR intervention[tiab])) Filters: in the last 10 years, English		
September 22, 2020	Cochrane	"Electronic Health Records" AND Hospitals AND "Quality of Health Care"	in Title Abstract Keyword - with Cochrane Library publication date Between Jan 2010 and Jan 2020 (Word variations have been searched)	4
September 22, 2020	CINAHL	"Electronic Health Records" AND Hospitals AND "Quality of Health Care"	Applied filters: Peer Reviewed: Published Date: 20100101-20201231 Language :English	237
September 22, 2020	PsycInfo	"Electronic Health Records" AND Hospitals AND "Quality of Health Care"	Applied filters 2010-01-01 - 2020-12-31; English; Peer reviewed	28
September 22, 2020	Scopus	(TITLE-ABS-KEY ("Electronic Health Records") AND TITLE-ABS-KEY (hospitals) AND TITLE-ABS-KEY ("Quality of Health Care"))	LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (	326

			PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010)) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))	
September 22, 2020	CORE	Electronic+Health+Records+ AND+hospitals+ AND+Quality+of+Health+Care+	Year: 2001 - 2020 Journals	135

2.3 Data Collection Process and Data Items

One of the researchers (J.M) carried out thematic synthesis, which entailed findings appropriate data and extracting it through a template approach to collect common results under main headings. Data was only obtained from text indicated as ‘results’ or ‘findings’. Subheadings were included as data was obtained and themes emerged. Another researcher (P.G.) assessed the data and further identified themes and subheadings in an iterative process.

2.4 Risk of Bias

The trustworthiness of included studies was graded using the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) framework. Each study received an overall grade depending on the number of criteria fulfilled, and the likelihood of unfulfilled criteria altering the study’s conclusions. Qualifying studies were judged for bias by considering, risk of bias, imprecision, inconsistency, indirectness, and publication bias [18].

3. Results

3.1.Study selection

As shown in Figure 1 we retrieved 1,012 articles following the search strategy defined in our protocol. We removed 83 articles that were duplicates. Further, 578 articles were discarded after reviewing titles and/or abstracts. Two hundred and forty-eight (248) articles, that seemed to attain the inclusion criteria were excluded after assessing their full text. Therefore, 103 articles were assessed for eligibility and only 25 articles attained the criteria and were included in the study.

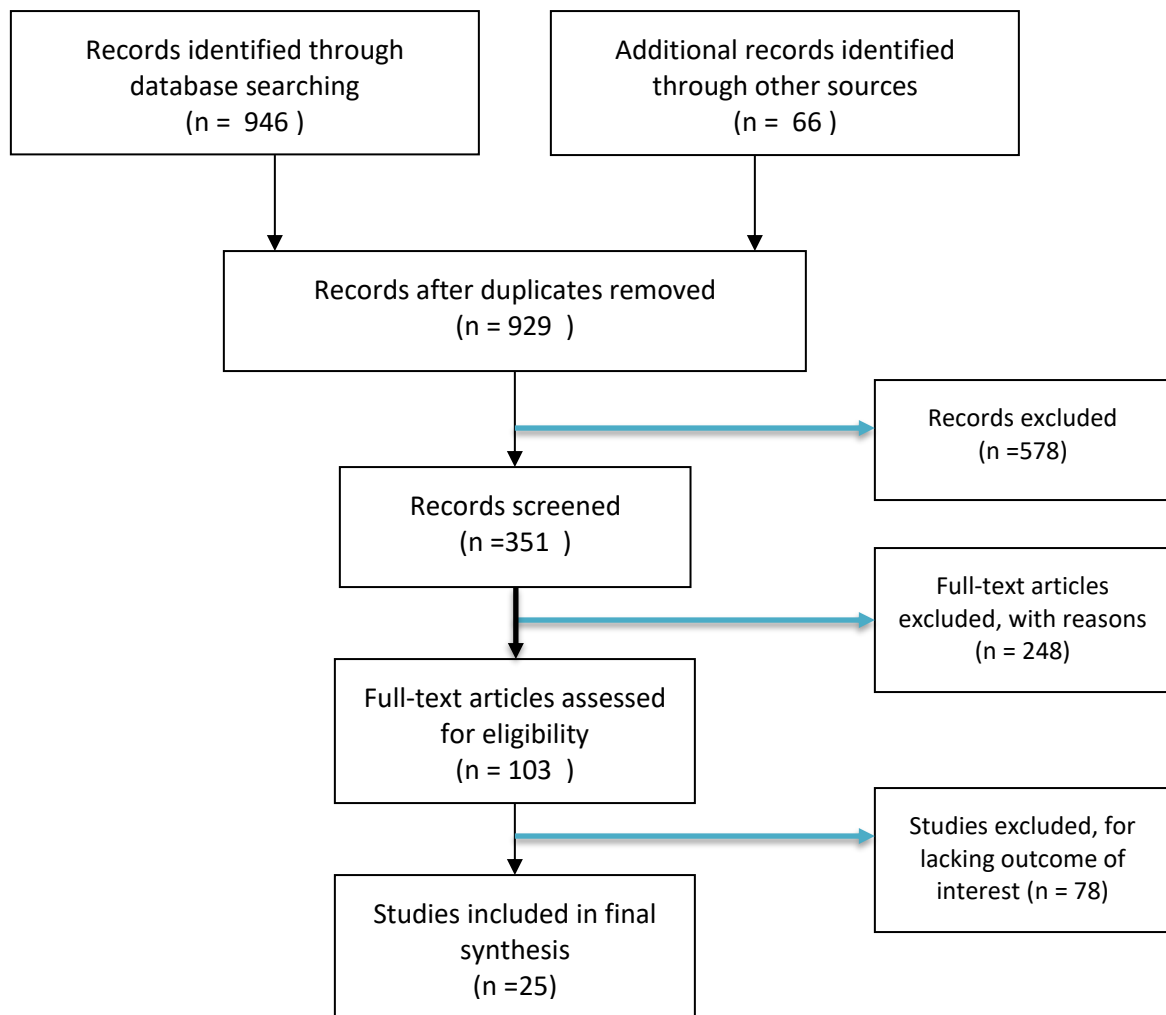


Figure (1) Study Selection

3.2.Study Characteristics

In consistency with the study inclusion criteria, the studies reviewed, as shown in Table 2, included, RCT (=1), Cohort Studies (n=2), Case-control Studies (n=1) and Cross-sectional (n=11) and Retrospective studies (n=10). More than half of the included studies (22) used quantitative methodology such as questionnaires, observational, and chart reviews. Five (2) studies used mixed methods such as surveys that included both questionnaires and interviews. Only (1) study used qualitative methodology, content analysis. Most studies in quantitative techniques conducted a t-test and ANOVA and chi-square test (14) while a good number (8) used regression analysis. A higher number of the research were done in the United States (15). Other studies were conducted in, Jordan (2), and Australia, Singapore, Kenya, France, Korea, Ghana, Ethiopia, and Saudi Arabia each with only one study.

Table (2): Study Characteristics

	Study	Country	Research Approach	Data Collection Method	Data Analysis Technique
1	Choo et al. (2014)	Singapore	Quantitative Studies		t-test; chi-square analysis
2	(Migdal et al., 2014)	US	Mixed Methods	Inter Views & questionnaires	chi-square analysis
3	(Parks Taylor et al., 2014)	US	Quantitative Studies	Inter Views	t-test; chi-square analysis
4	(Ayaad et al., 2019)	Jordan	Quantitative Studies	questionnaires	t-test
5	(Bae et al., 2018)	US	Quantitative Studies	Observational	regression analysis
6	Hu et al. (2020)	US	Quantitative Studies	Observational	t-tests
7	(Neishi et al., 2013)	US	Quantitative Studies	Observational	t-tests
8	(Park et al., 2020)	Korea	Quantitative Studies	Questionnaires	t-test; chi-square analysis
9	(Waithera et al., 2017)	Kenya	Qualitative Studies	Interviews	content analysis
10	(Spaulding & Raghu, 2013)	US	Quantitative Studies	Observational	regression
11	(Sharikh et al., 2020)	Jordan	Quantitative Studies	Questionnaires	
12	(John et al., 2010)	US	Quantitative Studies	Observational	t-test; chi-square analysis
13	(Jarvis et al., 2013)	US	Quantitative Studies	Observational	t-tests & ANOVA
14	(McCamley et al., 2019)	Australia	Quantitative Studies	Observational	chi-square analysis
15	(Plantier et al., 2017)	France,	Quantitative Studies	Observational	t-tests & ANOVA
16	(J. Adler-Milstein et al., 2015)	US	Quantitative Studies	Observational	ordinary least squares model, F-test
17	(Cienki et al., 2013)	US	Quantitative Studies	Observational	Multivariable logistic regression
18	(Stacy et al., 2014)	US	Quantitative Studies	Observational	one-way ANOVA
19	(Pyron & Carter-Templeton, 2019)	US	Mixed Methods	Direct observation, chart review, and end-user survey	The logic model
20	(Adler-Milstein et al., 2014)	US	Quantitative Studies	phone interviews	Ordinary least squares regressions
21	(Walker-Czyz, 2016)	US	Quantitative Studies	observation	Interrupted time series modeling
22	Abdulai and Adam (2020)	Ghana	Quantitative Studies	Questionnaire	Pearson correlation,

					Multiple linear regression
23	(Julia Adler-Milstein et al., 2015)	US	Quantitative Studies	Questionnaire	Regression model
24	Biruk et al. (2014)	Ethiopia	Quantitative Studies	Questionnaire	Logistic regression analyses
25	El Mahalli (2015)	Saudi Arabia	Quantitative Studies	Questionnaire	Chi-square and Monte Carlo tests

3.3. Electronic Health Record and Healthcare Quality

Results are presented on the influence of EHR on healthcare quality concerning the six dimensions of healthcare quality including, safe care, effectiveness, patient-centered care, timely care, and efficiency. One of the healthcare quality indicators, equitable care did not yield any results from our search.

3.4. Safe Care

The study retrieved three studies that considered EHR and safe care as an indicator of quality healthcare. Table 3 contains a summary of key findings on the influence of EHR on safe care. A pre and post-intervention study by Choo, Johnston (19) demonstrated that there was an insignificant difference in medication errors among hospitals at pre-implementation and post-implementation of Electronic Medical Record (EMR). This demonstrated a lack of change in the incidence of error in the medication after the implementation of EMR. According to Neishi, Gan (24) in hospitals with basic and full EHR, pressure ulcer patients, were less expected to experience pressure ulcers compared to pressure ulcer patients who attend hospitals with no EHR. In addition, postoperative hemorrhage or hematoma (PHH) patients who attend hospitals with full EHR were at a high chance of experiencing PHH, while PHH patients admitted in hospitals that had basic EHR had similar results.

Further, Walker-Czyz (37) observed that implementing an integrated EHR has a positive effect on healthcare quality. Walker-Czyz (37) also attributed a 15 percent decrease in hospital falls to the intervention of EHR. It was also observed that following EHR intervention the rates of catheter-associated urinary tract infection and Central Line-Associated Bloodstream Infection (CLABSI) rates increased substantially with time. Notably, hospital-acquired pressure ulcer and Ventilator-Associated Pneumonia (VAP) rates went up throughout the adoption period of EHR shadowed by a significantly higher rate of decrease after the implementation, leading to almost the eradication of infection. However, the cost. EHR implementation also did not show any significant effect on the cost of care as evaluated in Hallucinogen Persisting Perception Disorder (HPPD).

Table (3) Safe Care (n=3)

Study	Country	Study Design	Main Findings
Choo et al. (2014)	Singapore	Retrospective design with a control group	The mean incidence difference of 0.06 medication errors per a thousand patient days among hospitals at pre- and post-implementation was insignificant.
Neishi et al. (2013)	USA	Cross-sectional Study	It was found that patients who attended hospitals with EHR were less likely to get pressure ulcers, as compared to those who attend hospitals without ERH (0.66 [0.56, 0.78] and 0.74 [0.68, 0.79]). It was found that patients who attended hospitals that have adopted EHR tend to conduct PHH, as compared to those who attend hospitals without ERH (0.66 [0.56, 0.78] and 0.74 [0.68, 0.79]).
Walker-Czyz (2016)	USA	Retrospective Study	A 15 percent decrease in hospital fall rates was linked to EHR implementation.

3.5.Effective Care

The study retrieved four studies that considered EHR and effective care as an indicator of quality healthcare. Table 4 contains a summary of key findings on the influence of EHR on effective care. John, Johnson (29) established that patients being treated by physicians who used decision support in EHR were at a high chance of having an Attention-Deficit Hyperactivity Disorder (ADHD) visit, as compared to the ones being treated with physicians who do not use decision support in EHR. A greater proportion of patients in the intervention group had an ADHD visit as compared with the patient in the control group. ADHD visit reminder was linked with approximately 20 percent growth in the number of patients that had a visit during the study, in which ADHD management was highlighted. Again, the adoption of EHR based ADHD documentation template throughout ambulatory visits enhanced the documentation quality of the healthcare offered in those visits.

Sharikh, Shannak (28) disclosed that EMR accounts for 29.5% of the variation in healthcare quality. However, Stacy, Washington (34) could not establish any significant mean difference between pre-implementation of EHR and implementation of EHR. The variant standard deviation range stayed the same between the pre-implementation phase and the implementation phase. Further, there was an insignificant difference in CMI, between the pre-implementation and implementation phases. This revealed that EHR implementation and clinical documentation do not showcase a statically significant effect on CMI. In a qualitative study in Kenya, healthcare providers pointed out that EMR had increased the overall performance of healthcare service delivery. It influenced improved clinical decision-making

and improved teamwork among healthcare professionals. It was also revealed that EMR enhanced the quality of care at the hospital. Consequently, these effects resulted in satisfaction for both patients and healthcare providers. EMR was also found to have improved management of time and patients. Other areas the EMR improved include, information retrieval, confidentiality, communication, data comprehension, and accountability of finance and supplies [26].

Table (4) Effective Care (n=4)

Study	Country	Study Design	Main Findings
John et al. (2010)	USA	Randomized control trial	It was established that patients who attend to physicians who use decision support in EHR were at a high chance of having an ADHD visit, odd ratio=1.9 at 95% confidence level (CI: 1.1–3.4) compared to the ones who fail to use decision support in EHR. A greater proportion of patients in the intervening group had an ADHD visit as compared with the patient in control group, 71 percent vs 54 percent, with an odds ratio of 2.2 at 95% confidence level (CI: .2– 4.0; P<.04).
Sharikh et al. (2020)	Jordan	Cross-sectional Study	EMR account for 29.5% of the variation in the healthcare quality (R2=.295).
Stacy et al. (2014)	USA	Retrospective Study	There was an insignificant difference in CMI, between the pre-implementation and implementation phase (F(1,3534)=.397, P>.529).
Waithera et al. (2017).	Kenya	Cross-sectional Study	EMR had increased overall performance on healthcare service delivery. It influenced improved clinical decision-making in patient management and improved collaboration. It was also revealed that EMR enhanced healthcare quality in the hospital

3.6.Patient-Centered Care

Five studies were retrieved that considered EHR and patient-centered care as an indicator of quality healthcare. Table 5 contains a summary of key findings on the effect of EHR on patient-centered care. Ayaad, Alloubani (10) observed that the quality of EMRs has a statistically significant relationship with healthcare services quality. Similarly, Hu, Qu (23) demonstrated that EHR implementation has a significant relationship with patient satisfaction indicators such as discharge information, care transition, the responsiveness of staff, recommend the hospital, and general hospital rating [23]. Jarvis, Johnson (17) noted that in hospitals that have advanced HER, users registered 4.21 point higher projected process of care score, as compared to non-advanced EHR users. In addition, hospitals system were linked with 5.17 points higher process of care scores, and for-profit hospitals were linked with 9.72 points higher process of care scores. Advanced EHR use could enable a better clinical process of care, without undesirable effects on patient experience.

Migdal, Namavar (20) ascertained that EHR can improve doctor-patient communication. They noted that residents got significant feedback in the 3 months, after the adoption of EHR, compared with 3 months before HER adoption. Communication was improved concerning addressing patients through their favorite name; proper introduction including, role introduction, informing the patient of medical procedures and the amount of time it will take and any effect; quick response to patient requests; listening to the concerns of patients; striving to make offer the patient the best healthcare; communicating appropriately with the patient; showing respect and being considerate; and being concerned to patient's needs. Taylor, Ledford (42) determined that there was a reduction in communication after the adoption of EMR, among physicians and nurses. However, the change was not statistically significant. In addition, communication among patients and physicians did not have any significant difference after EMR implementation.

Table (5) Patient-Centered Care

Study	Country	Study Design	Main Findings
Ayaad et al. (2019)	Jordan	A cross-sectional, descriptive, and comparative design	The study observed that the quality of EMRs has a statistically significant relationship with healthcare services quality ($r=.659$, $p>.001$).
(Hu et al., 2020)	USA	Cross-sectional study	Certified EHR implementation had a significant correlation with patient satisfaction indicators such as, discharge information ($\beta = 0.45$, $t = 2.09$, $p = 0.037$), care transition ($\beta = 0.44$, $t = 2.84$, $p = 0.005$), responsiveness of hospital staff ($\beta = 0.47$, $t = 2.13$, $p = 0.033$), recommend hospital ($\beta = 0.66$, $t = 2.68$, $p = 0.010$), and general hospital rating ($\beta = 0.39$, $t = 2.11$, $p = 0.035$).
Jarvis et al. (2013)	USA	Retrospective, cross-sectional analysis	The study determined that hospitals that have advanced EHR users registered 4.21 ($p<.001$) point higher projected process of care score, as compared to non-advanced EHR users. In addition, system hospitals were linked with 5.17 points higher process of care scores, and for-profit hospitals were linked with 9.72 points higher process of care scores.
Migdal et al. (2014)	USA	Retrospective cohort study	According to the results, residents got significant feedback in the 3 months, after the adoption of EHR, compared with the 3 months before the implementation of HER.
Taylor et al. (2014)	USA	Pre-post cohort design	Findings revealed that there was a reduction in communication after the implementation of EMR, among doctors and nurses, from 69.33% to 60.98%. However, there was no evidence to show a significant difference ($\chi^2=1.16$, $df=1$, $p=0.28$). Reported communication among patients and physicians failed to show any statistically significant difference after the implementation of EMR (73.3% vs 75.6%, $\chi^2=0.13$, $df=1$, $p=0.72$).

3.7. Timely Care

The study retrieved two studies that considered EHR and timely care as an indicator of quality healthcare. Table 6 contains a summary of key findings on the effect of EHR on timely care. Adler-Milstein, Scott (36) found no evidence of a relationship between basic EHR implementation and improved performance with regards to the length of stay in the hospital. However, EHR adoption was associated with a slightly lesser mean length of stay in the hospital as compared to the ones operating without EHR,

however, this was not significant. Further, Adler-Milstein, Scott (36) pointed out that there is a significant relationship between, management improvement and shorter length of stay in both hospitals that had implemented EHR as well as those with no EHR. However, the difference is much lower in the hospitals without EHR as compared to the one with EHR. Plantier, Havet (31) affirmed that EHR positively influences healthcare management quality concerning the quality of patient data and delays in sharing data at discharge.

Table (6) Timely Care

Study	Country	Study Design	Main Findings
Adler-Milstein et al. (2014)	USA	Survey	EHR implementation was linked with a slightly lesser average length of stay ($r = -0.011$; $P = .98$) as compared to those with no EHRs, although they were not significant.
Plantier et al. (2017)	France	Retrospective study	EHR has a positive influence on healthcare management quality with regards to the quality of patient data ($p < 0.001$) and delays in sharing data at hospital discharge ($p < 0.024$).

3.8.Efficiency Care

The study retrieved six studies that considered EHR and efficiency care as an indicator of quality healthcare. Table 7 contains a summary of key findings on the effect of EHR on timely care. Adler-Milstein, Everson (32) determined that higher levels of EHR implementation are related to enhanced performance on process adherence and patient satisfaction, however, this was not the case with efficiency. Cienki, Guerrera (33) opined that patients attending hospitals that had implemented EMR were not likely to obtain direct discharge instruction or any acknowledgment or elevated blood pressure, however, these patients are in a greater position of obtaining inclusive life change advice. The latter findings are attributed to the application of prepared educational materials, availed after the implementation of EMR. The factors related to a directed referral encompassed, elevated blood pressure state, treatment with an antihypertensive agent in the emergency department, and a prescription at discharge. The post-implementation phase of EMR had a negative correlation with direct follow-up.

McCamley, Vivanti (30) indicated that pre- EMR only 75.7 percent of clinicians accessed patient records while post-EMR 100 percent could access patient records. There was also an increase in chart access in a minute, from 68.5 percent to 99.2 percent. The legibility of patient records increased from 53.8% indicating a great pre-EMR to 99.2 percent post-implementation of EMR. There was a reduction from 82 percent to 34.5 percent of clinicians lack of awareness of medical alerts in pre-EMR to post-EMR. In the post-EMR, the number of nutrition diagnoses increased to 227 from 155 in six months, while

20 percent of diagnoses were resolved within the first quarter of EMR implementation. There was also a trend that was observed in the post-EMR where nutritional diagnosis resolutions increased 18 months after EMR implementation. However, in the last quarter, the average number of days to resolution steadied. Findings demonstrated that the adoption of EMR can be beneficial to the diabetic profession since it can enhance the capacity and efficiency of diabetic departments.

Park, Kim (25) ascertained that hospitals that fully implemented EMR had a lower rate of usage of antibiotic drugs than hospitals with incomplete EMR and paper-chart groups. Results supported the assumption that various EMR function minimizes the use of antibiotics. According to results hospitals that fully implemented EMR saw a decrease in antibiotic use. In addition, it was shown that hospitals with complete EMR systems had greater rates of prescription of polypharmacy compared to hospitals with incomplete EMR. Pyron and Carter-Templeton (35) found out that following the implementation of EHR there was an improvement in patient flow and provider efficiency. Evidence showed that EHR documentation has a significant effect on several care services indicators, such as efficiency, productivity, safety, quality control indicators, patient flow, and workflow.

Spaulding and Raghu (27) failed to show any statistically significant variation in costs between sequential computerized physician order entry (CPOE) use to no use up to 50%. Predicted salary costs decreased for some time before increasing again. This revealed that salary costs are related to the use of CPOE in a non-linear way. However, results showed that the assumption that CPOE utilization is related to greater levels of efficiency failed to hold for every use.

Table (7) Efficiency Care

Study	Country	Study Design	Main Findings
J. Adler-Milstein et al. (2015)	USA	Retrospective study	Results revealed that high levels of EHR implementation is linked to improved performance on process adherence (0.147; $p < .001$) and patient satisfaction (0.118; $p < .001$), but efficiency (0.01; $p > .78$).
Cienki et al. (2013)	USA	Retrospective study	In post-EMR patients were not likely to get directed discharge instruction or any acknowledgment or elevated blood pressure, however, they were at a higher chance of getting comprehensive lifestyle modification instruction.
McCamley et al. (2019)	Australia	Retrospective study	In the pre-implementation of EMR, 75.7% of clinicians could access patient data as unlike 100% of clinicians ($n = 119/119$) in the post-implementation of EMR ($P < 0.001$).
Park et al. (2020)	Korea	Cross-sectional study	Hospitals with fully implemented EMR registered a 16.1% lower rate ($\exp(-0.176) = 0.839$) of antibiotic use as compared to the one with

			partial EMR and paper-chart groups (16.1%; 95% CI, 0.7–29.1; $p = 0.041$).
Pyron and Carter-Templeton (2019)	USA	Retrospective study	EHR documentation has a significant effect on several aspects of healthcare including, productivity, efficiency, patient safety, quality control measures, patient flow, and workflow
Spaulding and Raghu (2013)	USA	Cross-sectional study	Results failed to show any significant difference in wage costs among successive CPOE use levels from zero usage to 50% usage. Projected wage costs were reduced from 51% to 90% use and later increased abruptly at the highest use level ($p < .001$).

3.9. Electronic Health Records Functionalities

The study retrieved five studies that considered EHR functionalities. Table 7 contains a summary of key findings on EHR functionalities. Sharikh, Shannak (28) opined that the EHR practice management function accounted for 20.3% of healthcare services. Communication function in EMR determined, 22.8% of healthcare services quality. Further, documentation function in EMR accounted for 22.5% of health service quality while medication management function in EMR determined 21.6% of healthcare services quality.

John, Johnson (29) established that embedding a decision support system in EHRs improves the quality of care in patients with ADHD. Plantier, Havet (31) revealed that several aspects of EHR improved healthcare quality. They noted that automation of drug prescriptions contributed to patient record quality. In addition, automation of information shared at discharge had the anticipated impact on the delay in discharge message being shared and as well the quality of the patient record. Walker-Czyz (37), opined that the application of evidence-based practice (EBP) standards of care, designed within the EHR and incorporated on the nurse's workflow at the bedside, supports decision making at the point of care. This can enhance healthcare quality without having any negative effect on direct cost.

Ayaad, Alloubani (10) determined that the EMR efficiency dimension has a strong positive relationship with healthcare services quality. In addition, the EMR availability dimension had a strong positive relationship with healthcare services quality. The level of order delivery and fulfillment by EMR increased the responsiveness to patient needs, save time for patient care and work organization, which led to a significant effect on enhancing healthcare services quality. The availability of an EMR to be used when needed, concerning the privacy and functionality of EMR to worm the needed tasks like management medicine, documentation, and communication among healthcare workers have a critical role in increasing healthcare services quality.

Table (8) Electronic Health Records Functionalities

Study	Country	Study Design	Main Findings
Sharikh et al. (2020)	Jordan	Cross-sectional Study	EHR practice management function accounted for 20.3% of healthcare services ($F=147.885$, $P\leq 0.05$), communication function determined, 22.8% of healthcare services quality ($F=171.264$, $P\leq 0.05$), documentation function accounted for 22.5% quality healthcare ($F=168.173$, $P\leq 0.05$, and medication management function determined 21.6% of quality healthcare ($F=160.240$, $P\leq 0.05$).
John et al. (2010)	USA	Randomized control trial	The study established that embedding of electronic decision support in EHRs improves quality of care in ADHD patients.
Plantier et al. (2017)	France	Retrospective study	It was noted automation of drug prescriptions contributed to quality records. Automated information shared during discharge caused a delay in discharge message being shared and as well affected patient record quality.
Walker-Czyz (2016)	USA	Retrospective Study	The application of EBP care standards, designed within the EHR and incorporated in nurse's workflow at the bedside, enhances decision making at the point of care, which can enhance healthcare quality without having any negative effect on direct cost.
Ayaad et al. (2019)	Jordan	A cross-sectional, descriptive, and comparative design	EMR efficiency dimension has a strong positive relationship with healthcare services quality ($r = .731$; $p < .001$). EMR availability dimension had strong positive relationship with healthcare services quality ($r = .705$, $p < .001$).

3.10. EHR Implementation Challenges

The study retrieved five studies that considered challenges facing EHR implementation. Table 8 contains a summary of key findings on challenges facing EHR implementation. Abdulai and Adam (38), identified several factors that affected EHR implementation including, age, gender, experience, computer literacy, and EHR knowledge. These factors significantly predicted 27.4% of the variance of healthcare provider readiness. However, education level, professional group, and healthcare workers that had been working for over 6 months did not have a significant effect on healthcare workers' readiness for EHR implementation. According to Adler-Milstein, DesRoches (39), EHR is faced with several challenges in implementation which include financial capital, doctors' support, and complexity of attaining meaningful use in good time. Biruk, Yilma (40) determined that male healthcare workers are 1.87 times more prepared for EMR compared to female healthcare workers. Equally, healthcare workers with good knowledge of EMR are around 2.12 times more prepared for EMR unlike healthcare workers with little knowledge. Healthcare workers who are ready to use EMR are 2.63 times more likely prepared for EMR compared to

their counterparts. Respondents with past IT experience are 1.69 times readier to adopt EMR, unlike their counterparts.

El Mahalli (41) observed that EHR was underutilized in several hospitals. The leading factors that challenged the implementation of EHR included, the loss of access to records in the event of a power outage or computer failure, lack of constant training and/or support from the IT department, more time need for entering data into the system, system hang-up, complexity of technology and system not customized to users' needs. According to Waithera et al., (2017), some of the challenges facing EHR implementation in Kenya include little funding despite the high costs associated with its implementation and maintenance. In addition, some functions of EMR systems are not fully used as they are inaccessible. The lack of ICT employees to manage EMR is also a challenge. Other challenges facing EHR implementation are computer insecurity, incomplete data, and extensive password sharing.

Table 9: EHR Implementation Challenges

Study	Country	Study Design	Main Findings
Abdulai and Adam (2020)	Ghana	Cross-sectional Study	Younger healthcare workers, men, old employees unlike the ones who have worked for not more than half a year, computer literacy and EHR knowledge, significantly predicted 27.4% of the variance of healthcare provider readiness. However, education level, professional group, and healthcare workers that had been working for more than half a year were not significant predictors of provider preparedness for EHR implementation.
Julia Adler-Milstein et al. (2015)	USA	Retrospective study	Over 50% of the sampled hospitals stated challenges concerning financial capital including upfront costs and ongoing costs, getting doctors' support, and complexity of meeting meaningful-use criteria in good time as the overall challenges facing the implementation of EHR among US hospitals.
Biruk et al. (2014)	Ethiopia	Cross-sectional Study	It was determined that male healthcare workers are 1.87 times more ready for EMR than female healthcare workers (AOR = 1.87, 95% CI: [1.26, 2.78]). Healthcare workers with good knowledge of EMR were thought to be around 2.12 times more prepared for the EMR system as unlike healthcare workers with little knowledge (AOR = 1.87, 95% CI: [1.32, 3.52]).
El Mahalli (2015)	Saudi Arabia	Cross-sectional Study	Leading factors that challenge HER implementation as cited by respondents included, the loss of access to records in the event of a power outage or computer failure (88.6%), lack of constant training and/or support from the IT department (85.9%), more time need for entering data to the system (84.9%), system hang up (83.8%), the complexity of technology (81.6%) and system not customized to users' needs (81.1%).

Waithera et al., (2017)	Kenya	Cross-sectional Study	some of the challenges in EMR implementation include little funding despite the high costs associated with its implementation and maintenance. Some functions of EMR systems were not fully used as they were inaccessible. Lack of employees in the ICT department to manage EMR. Other challenges noted were, insecurity of computer machines, incomplete data, and extensive password sharing.
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4. Discussion

EHR is implemented in hospitals to improve healthcare quality. EHR helps to attain quality healthcare [10, 28, 37] by attaining, patient safety, effective care, patient-centered care, timely care, equitable care, and efficient care delivery. However, Choo, Johnston (19) had a different differed observation, noting that there is no change in medication error incidence after EHR implementation. Using a single vendor or self-developed EHRs significantly reduces the possibility of patient safety events. However, the same cannot be said of multi-vendor EHRs [22]. In the same light, pressure ulcer patients in hospitals with EHR, are less likely to experience pressure ulcers compared to pressure ulcer patients in hospitals with no EHR [24]. EHR while improving patient safety, leads to a reduction in hospital fall rates. In the long run EHR's lead to higher rates of reduction of Hospital-acquired pressure ulcers and VAP [37].

Regarding effective care, it was evident that patients with physicians who used decision support in EHR were at a higher chance of having an ADHD visit, compared to the ones who fail to use decision support in HER [29]. It was also established that EHR implementation and clinical documentation do not showcase statistically significant effects on CMI [34]. Results revealed that EMR increases the overall performance of healthcare service delivery. It influences improved clinical decision-making in patient management and improved teamwork among healthcare workers. EMR also enhances the quality of healthcare at the hospital. Accordingly, these effects result in satisfaction for both patients and healthcare providers. EMR improves the management of time and patients. In addition, EMR helps to improve, information retrieval, confidentiality, communication, data comprehension, and accountability of finance and supplies [26].

Regarding patient-centered care, it was conclusive that EHR implementation is significantly correlated with patient satisfaction measures namely, discharge information, care transition, the responsiveness of healthcare workers, recommendation of the hospital, and overall hospital rating [23]. Adler-Milstein, Everson (32) also observed that higher levels of EHR implementation are linked to improved patient satisfaction. Advanced EHR use can enable a better clinical process of care, short of

negative impacts on patient experience [17]. EHR improves doctor-patient communication in terms of providing significant feedback to patients, addressing patients by their favorite name, proper physician introduction, informing patients of what is to be done, time to be taken, and the effect it will have on the patient, listening and responding to patients concerns promptly, physicians doing their best to make sure patients get the best healthcare, being respectful and considerate to patients, and being sensitive to the needs of patients, both physical and emotional. However, the effect of EHR on doctor-patient communication is questioned by Taylor, Ledford (42) who failed to establish any statistically significant difference after the implementation in physician and patient communication prior to and after EHR implementation.

In relation to timely care, Adler-Milstein, Scott (36) perspective is that there is no evidence, which shows that basic EHR adoption is related to enhanced performance concerning average length of stay in hospital. Equally, Thompson, O'Horo (43) observed no evidence to show that EHR implementation has a significant influence on the length of stay in the hospital. However, EHR was shown to have some positive effects on management which in the end lessens the length of stay in hospital [36]. This can mean that EHR moderates the relationship between patient management and their length of stay in the hospital since EHR influence the quality of healthcare management with regards to the quality of patient record [31].

Regarding efficiency in healthcare discharge, EHR implementation did not show any significant positive effect on efficiency [32]. On the contrary, Pyron and Carter-Templeton (35) argued that after implementation of EHR there is an improvement in inefficiency. They noted that EHR documentation significantly affects healthcare efficiency, patient flow, and workflow. Further, patients in post EMR implementation are less likely to get directed discharge instruction or any acknowledgment or elevated blood pressure, however, they are at a higher chance of getting comprehensive lifestyle modification instruction [33]. Following EHR implementation in hospitals, healthcare efficiency can be a witness in patient medical record access, chart access, and medical record legibility. EHR also reduced the lack of awareness among clinicians of medical alerts such as food allergies alerts and the need for a language translator. EHR also shows a positive impact on the dietetic profession since it can improve the capacity and efficiency of dietetic departments [30]. Another area that EHR showed a positive influence is on drug use, where EMR is associated with a lower rate of antibiotic drug use compared to partial EMR use [25].

4.1. Electronic Health Records Functionalities

EHR entails several functionalities that each in a way influence quality healthcare. Sharikh, Shannak (28) identified four EHR functionalities namely, practice management, communication, documentation or data entry, and medication management, which had a significant effect on healthcare

services quality. EHR includes a decision support functionality for healthcare services, which improves the quality of care in patients with ADHD [29]. According to Plantier, Havet (31), computerization of drug prescription through EHR contributed to quality patient records. In addition, automatized data sent during discharge causes a delay in discharge message being shared and it as well affects patient record quality.

Furthermore, the application of evidence-based practice (EBP) standards of care, designed within the EHR and included in nurse's workflow at the bedside, supports decision making at the point of care that can enhance healthcare quality without having any negative effect on direct cost [37]. The level of order delivery and fulfillment through EMR increases the responsiveness to patient needs, saves time for patient care and work organization, which leads to a significant effect on enhancing healthcare services quality. The functionality of EMR to perform needed work including, medication management, documentation, and communication among healthcare workers have a critical role in increasing healthcare services quality [10].

4.2. EHR Implementation Challenges

EHR implementation faces a number of challenges that undermine the objective and goal of EHR in improving healthcare quality. The leading EHR implementation challenges include financial costs. The implementation of EHR requires substantial financial resources both for the initial setup as well as for sustaining its operation [39]. Waithera, Muhia (26) also pointed out that little funding despite the high costs associated with EHR implementation and maintenance presents a challenge to EHR implementation. Earning doctors' support and complexity of attaining meaningful use criteria in good time, also present a challenge to EHR implementation [39].

Implementation of EHR is also affected by the gender and age of healthcare professionals. Biruk, Yilma (40) observed that male healthcare workers are more prepared for EMR implementation as compared to female healthcare workers. Equally, healthcare professionals with a good knowledge of EMR are more prepared for EMR unlike the ones with little knowledge. Healthcare professionals with past IT experience are more prepared to adopt EMR as, unlike their counterparts. According to El Mahalli (41), EHR implementation faces several challenges including, power outage or computer failure, inadequate training and/or support, time-consuming, system hang-up, the complexity of technology, and system not customized to users' needs. The shortage of ICT skilled employees also presents a challenge to the implementation of EHR in hospitals. More challenges included, insecurity of computer machines, incomplete data, and extensive sharing of passwords among health professions [26].

4.3. Limitations

This review is founded on the assumption that EHR has a significant influence on healthcare quality. Another limitation in this review is on the included studies which had a different definition of EHR. This might produce an extent of over-generalization in the results, although the use of different terms to refer to EHR made it unviable to ignore studies that refer to EHR in other terms such as EMR. The studies included were done in a hospital setup, while this could be justified since EHR implementation requires a significant financial investment that only hospitals could afford, there is a chance of missing out on the experience in different health systems and cultures. The quality of the included studies in this review differed. Several studies engage small sample size and research tools of possibility limited reliability and validity. Additionally, only a small number of studies were founded on valid theories, and most studies were inclined on limited variables.

5. Conclusion

We established a significant effect of EHR implementation on healthcare quality, regarding patient safety, effective care, efficient care, timely care, equitable and patient-centered care. EHR includes several functionalities that help to enhance healthcare quality. These functionalities include practice management, communication, documentation or data entry, and medication management, decision support functionality, computerized drug prescription, Electronic Nursing Documentation (END), and electronic management records. EHR implementation is faced with challenges emanating from the healthcare institutions, healthcare professionals, technology, and ethical issues. There is a need to devise an effective mechanism that would minimize the challenges that prevent successful EHR implementation in hospitals. The EHR functionalities should also be enhanced to further improve healthcare quality.

6. Declarations

6.1 Conflict of Interest Statement

The authors have no conflict of interests to declare.

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