# Electronic Medical Records – A Review of Cost-Effectiveness, Efficiency, Quality of Care, and Usability

#### Balaji Gopidasan, Shabbir Amanullah, Akin Adebowale

Department of Psychiatry, Woodstock General Hospital, Woodstock, Canada

## Abstract

Electronic medical records (EMRs), as they are more popularly known, are rapidly being accepted globally to ensure timely access to notes and a safer and quicker way to transfer information. It is an efficient way of delivering patient care. However, existing literature needs to be interpreted objectively, keeping in mind its many drawbacks. Different countries have different needs and health-care delivery models. Due to this, EMR systems vary worldwide. With giant strides being made every day in the use of software for various fields, the medical field has had to adapt to changes rapidly. The COVID-19 pandemic has pushed this to even greater levels of adaption. This article extensively reviews the existing literature on its usability and key areas that one needs to pay attention to. Key areas considered in this review include cost-effectiveness, efficiency, quality improvement, and usability. The cost-effectiveness, efficiency, and usability may depend on the design and implementation of the EMR. EMR can improve the quality of documentation. The workflow becomes inefficient when both EMR and paper documentation are simultaneously used. Usability scores improve if end users are involved in the early stages of designing and implementing EMR.

Keywords: Cost-effectiveness, documentation, electronic health records, patient care, quality improvement

### BACKGROUND

The use of information technology (IT) in health care is a rapidly evolving field. Electronic medical records (EMRs) or electronic health records (EHRs) are part of this evolution. EMRs have several benefits for patients and health-care providers. An increase in efficiency and effectiveness with EMR use has been proposed.<sup>[11]</sup>

EMR use increased significantly during the pandemic and is now integral to the health-care delivery system. A majority of hospitals in the US in 2017 were using EMR.<sup>[2]</sup> In private practice, the numbers were 80%–86% for rolling out and adapting the system.<sup>[3]</sup> In keeping with this increased use, there has been an increase in the number of vendors of EMR. Vendors provide the platform for EMR. The vendors vary in what they have to offer. For an individual practitioner or organization to consider the use of EMR, they need to consider several factors such as cost-effectiveness, efficiency, potential improvements in quality of care, and ease of use. These are not meant to be an all-inclusive or an exhaustive list, but rather the authors' selection of some key areas.

As with most new technologies, the cost is a barrier. Over the past few decades, there has been a rapid increase in the cost

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|                            | <b>DOI:</b> 10.4103/jopsys.jopsys_17_22   |

of health-care delivery. Before the COVID-19 pandemic, health spending was around 4% per year in Canada.<sup>[4]</sup> By 2020, the cost of health care in the US was \$4.1 trillion (4.1 lakh crore) from \$1.4 (1.4 lakh crore) in 2000.<sup>[5]</sup> The short-term and long-term costs of running an EMR are essential to keep in mind. Although the initial amounts may be low, the long-term costs can add up when one keeps in mind protection against malware, upgrades, concerns about ransomware, etc.<sup>[6-9]</sup> Details on the cost of establishing these IT systems are not easily available.<sup>[10]</sup> Comparative cost-effectiveness studies can guide agencies and institutions in choosing the best option for their organization's desired clinical outcomes. Managing costs is key to ensuring the sustainability of health-care systems and potentially addressing the effective rollout of their medical programs.<sup>[11]</sup>

Address for correspondence: Dr. Balaji Gopidasan, Woodstock Hospital, Woodstock, Ontario N4V0A4, Canada. E-mail: bgopidasan@gmail.com

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 How to cite this article: Gopidasan B, Amanullah S, Adebowale A.

 Electronic medical records – A review of cost-effectiveness, efficiency,

 quality of care, and usability. J Psychiatry Spectr 2022;1:76-9.

 Submitted: 21-Jan-2022;
 Revised: 24-Jun-2022;

 Accepted: 24-Jun-2022;
 Published: 19-Aug-2022.

Implementing EMR could affect various aspects of the workflow, clinician's workload, and productivity. The workflow was often slowed down by the difficulty in reading a physician's writing or accessing the paper notes from another hospital. This is not an issue if hospitals are connected digitally. The choice of the EMR system is essential as some studies have shown that there can be delays requiring more time for documentation, limiting the clinical time with patients.<sup>[12-15]</sup> An efficient EMR could increase productivity and workflow processes.

Data are only as good as what is entered into the EMR system. Information quality and system quality need to be considered in implementing an EMR. Information quality includes ensuring the accuracy and the completeness of the data entered,<sup>[16]</sup> easy information access, continued availability of data, and confidentiality of the health data the end user needs to be satisfied with the EMR. This ensures buy-in and engagement in using the EMR on an ongoing basis. The usability evaluation of the EMR evaluates the EMR on various aspects of its usability. The usability evaluation methods vary widely as there is a lack of standardized methods. Gaining knowledge on the usability evaluation of the EMR helps in selecting, designing, and implementing EMR.

This review carried out a literature review of key factors that may potentially impact the adaptation and continued use of EMR. The key areas considered here are cost-effectiveness, efficiency, quality of care, and usability. The methodology and results are discussed under each domain.

## **COST-EFFECTIVENESS**

A literature search was conducted using PubMed with keywords "EMR" OR "electronic medical records" OR "EHR" OR "electronic health records" AND "cost-effectiveness" The search was restricted to 10 years from 2012 to 2022. Ten years is an arbitrary period to include only recent studies. There were 827 potential articles. The following inclusion criteria were applied: clinical trials, meta-analysis, or review, and systematic reviews were selected. This identified 278 results. After review, articles which did not focus on EMR or EHR and cost-effectiveness were excluded from the review. Only nine articles which focused on EMR or EHR and cost-effectiveness were selected for the review.

Reis *et al.*<sup>[1]</sup> did an overview of systematic reviews on EMR. This study was not able to draw any conclusion about cost-effectiveness. This is due to the mixed and inconclusive results of the primary studies. Most of the systematic reviews included in this review did not evaluate cost-effectiveness.

A study of cost–benefit analysis by Li *et al.*<sup>[17]</sup> indicates positive financial returns from using an EMR system.

The main benefits were the reduction in the time spent on creating a new medical record, decreased full-time employment of workers in the records section and other departments, and enhanced billing revenues. However, there were individual reports and studies regarding the cost-effectiveness of EMR.

Wiggins and Fridl<sup>[6]</sup> reported that EMR could produce financial benefits in certain ophthalmology practices over 5 years. Wang *et al.*<sup>[18]</sup> concluded that implementing EMR systems in primary care can financially benefit health-care organizations.

The EMR at the tertiary hospital was cost-effective, as reported by Choi *et al.*<sup>[7]</sup> Bar- Dayan *et al.*<sup>[8]</sup> reported financial benefits by including a list of preferred specialists list to the existing EMR system. A financial analysis by Schmitt *et al.*<sup>[9]</sup> points out that the anticipated benefits are much more than the implementation and maintenance cost of EMR. The cost benefits of the EMR could be due to various factors, including reallocation of the workforce, streamlining of the work process, effective documentation, access to information, and effective billing claims.

Adler-Milstein *et al.*<sup>[19]</sup> showed that 27% of practices had a positive return on investment, especially when the target was to increase revenue. Moore *et al.*<sup>[11]</sup> pointed out that the survey may not have considered the likely changes in the payment methods (e.g., value-based system payments).

Systemic review<sup>[1]</sup> was inconclusive about the cost-effectiveness of EMR. Authors feel that some studies <sup>[6-8,17,18]</sup> have endorsed the cost-effectiveness of EMR.

### **E**FFICIENCY

A literature search was conducted using PubMed with keywords "EMR" OR "electronic medical records" OR "EHR" OR "electronic health records" AND "Efficiency." Only 499 out of 4091 potential studies met the inclusion criteria as set above. On further review, only three articles which focused on EMR/EHR and efficiency were included in the review.

Nguyen *et al.*<sup>[20]</sup> published a systemic review on the implementation of EMR. In this review, administrative efficiency was covered. It cited Darbyshire,<sup>[12]</sup> who reported reduced administrative and repetitive tasks as one of the major benefits of EMR.

There were contrasting findings on time taken for documentation, with some studies showing that it takes more administrative time and others showing that it improves efficiency.<sup>[12-15,21,22]</sup> The impact on workflow was mixed, with some studies reporting positive and others of negative impacts. Perceptions about changes in workload and productivity were mixed. The impact on the amount of time spent with patients was not conclusive. Some studies report no difference, whereas others reported negative and positive influences on the time spent by clinicians with their patients.

In their systematic review, Baumann *et al.*<sup>[23]</sup> noted that EMR increased the time for doctors to enter data within a year following EMR implementation.

This study also noted that the workflow was inefficient in EMR implementation, using both paper and electronic documentation.

Fuller implementation of EMR for documentation appeared to be associated with decreasing time spent documenting. In a meta-analysis, Campanella *et al.*<sup>[24]</sup> found an association between EMR used by health-care professionals and a reduction in documentation time.

EMR can improve regulatory compliance and communication and bring process improvements. EMR implementation can also pave the way to potentially effective resource use reduction and better reallocation.<sup>[25]</sup>

EMR can improve the quality of documentation. However, patients may feel that clinician is not spending enough time with them, whereas the clinician is also engaged in reviewing and documenting data in the EMR.

## QUALITY OF CARE

A literature search was conducted using PubMed with keywords "EMR" OR "electronic medical records" OR "EHR" OR "electronic health records" AND "quality of care" and identified 50,891 potential articles. Only 4435 met the inclusion criteria. On review, 11 articles focusing on EMR/EHR and quality of care were included for the review.

In a meta-analysis by Campanella *et al.*,<sup>[24]</sup> EMR was associated with higher guideline adherence and fewer medication errors. In another study, a systematic review by Nguyen *et al.*<sup>[20]</sup> reported that clinicians perceived improved information quality.

Entry of data was found to be more complete in EMR. EMR systems also improved the legibility of physicians' writing and improved accessibility to patients' charts. This was a problem with paper charts. However, one needs to keep in mind downtimes or potential technical failures, viruses, and ransomware attacks. These can affect access and, more importantly, confidentiality and raise liability. Medication errors and dangerous drug interactions are avoided when there are decision support capabilities along with the EMR. It is hard, however, to draw a firm conclusion from existing data as robust studies are lacking.<sup>[26,27]</sup>

A randomized controlled study by Jamieson *et al.*<sup>[16]</sup> demonstrated better quality of documentation when compared to handwritten notes. Through many different avenues, including medication interactions check, and adherence to guidelines, EMR brings about improved care quality.

# USABILITY

A literature search was conducted using PubMed with keywords "EMR" OR "electronic medical records" OR "EHR" OR "electronic health records" AND "usability" and identified 1091 potential articles. Only 551 met the inclusion criteria. On review, only three articles focusing on EMR/EHR and usability were included for the review.

Health-care Information and Management System Society defines usability as the effectiveness, efficiency, and satisfaction experienced by EMR users in their work to achieve specific tasks in different environments. There is a lack of standardization of EMR worldwide, and hence there is no ideal method to evaluate the usability of an EMR. The EMR vendors define their usability criteria and methods. Effective usability evaluations of EMR systems can help prevent the implementation of suboptimal EMR systems and improve EMR interfaces for health-care provider use. Compromised EMR system usability can significantly negatively affect clinical settings and EMR adoption.

Ellsworth *et al.*<sup>[10]</sup> conducted a systematic review of EHR usability evaluations. The study showed a dearth of valid usability evaluations in the development of systems at various stages. Most of the studies in this review have used survey or think-aloud methods for usability evaluations.

Ratwani *et al.*<sup>[28]</sup> concluded that there are misalignments between literature and stakeholders' perspectives regarding usability, safety challenges, and practices during EMR implementation. It also pointed out the lack of availability of tools for frontline workers that appear in the literature. The cost of implementing the EMR is not considered in the literature when offering best practices. Improving the partnerships between developers, stakeholders, and health organizations is critically important when it comes to safety and usability. Five key areas were identified in a review on usability, and they include.

Ease of learning, efficiency, effectiveness, and cognitive load, can have a bearing on the ratings for EMR usability.<sup>[29]</sup> Ease of learning, cognitive load, and effectiveness can impact usability ratings of EMR systems.<sup>[29]</sup> An essential component of EMR systems is the ease of learning. By incorporating the cognitive load into the EMR system design, EMR can become effective. The users are more likely to adapt to EMR in a shorter duration. Cognitive load is defined as how intuitive information and functionality are presented within the EMR system.<sup>[29]</sup>

Currently, standardized methods for assessing the usability of EMR systems are lacking. Standardized usability evaluations can make it easy to compare the different EMR systems. Collaborative work between stakeholders and developers can improve EMR usability and safety.

This study considers only the literature, which was in the English language. There may also be studies that may not have been reported, particularly negative ones. There is also a lack of systematic studies in certain areas as this is an evolving area. Systematic studies can help a better evaluation and understanding of EMR.

Looking to the future, health-care systems are attempting to integrate multiple data sources such as community practitioners' data with hospital-based EMR data. In addition, patients also have their health-care record systems' personal health record (PHR). Research is underway in integrating and interpreting the data in the PHR.

Nowadays, EMR data are stored on cloud-based systems, which have medical-legal implications. If the data are stored

in another country, a governmental agency in that country can access the data without valid consent through a judicial process. EMRs are also becoming a target of ransomware attacks.

## CONCLUSION

EMR has the potential to provide substantial benefits to physicians, clinical practices, and health-care organizations and systems. By improving the quality of care and safety through EMR, the financial effects will likely be significant. However, there is no data to show this at this point. The systematic study was inconclusive about the cost-effectiveness of EMR. The cost-effectiveness of EMR may vary depending on the type of practice. EMR can improve documentation quality with variance in the time taken to document. EMR can improve guideline adherence and reduce medication errors. In addition, collaborative work between stakeholders and EMR developers can enhance the usability and safety of EMR. Success in any system depends on the users' training and acceptance; this system is no different. Support services for EMR users are essential. Organizations and entities could undertake usability, cost-effectiveness, and quality control measure evaluations in considering adopting an EMR solution. Still, there is a lack of literature in some key areas. Future research can focus on this gap and help evolve successful EMR solutions.

# Financial support and sponsorship Nil.

#### **Conflicts of interest**

There are no conflicts of interest.

#### REFERENCES

- Reis ZS, Maia TA, Marcolino MS, Becerra-Posada F, Novillo-Ortiz D, Ribeiro AL. Is there evidence of cost benefits of electronic medical records, standards, or interoperability in hospital information systems? Overview of systematic reviews. JMIR Med Inform 2017;5:e26.
- Available from: https://www.healthit.gov/sites/default/files/page/2019-04/AHAEHRUseDataBrief.pdf. [Last accessed on 2022 May 06].
- Available from: https://www.healthit.gov/data/quickstats/office-basedphysician-electronic-health-record. [Last accessed on 2022 May 06].
- National Health Expenditure Trends, 2021-Snapshot. Available from: https://www.cihi.ca/en/national-health-expenditure-trends-2021snapshot. [Last accessed on 2022 May 06].
- How Has U.S. Spending on Healthcare Changed Over Time? Peterson-KFF Health System Tracker; 2022. Available from: https:// www.healthsystemtracker.org/chart-collection/u-s-spending-healthcare -changed-time/. [Last accessed on 2022 May 06].
- Wiggins RE Jr., Fridl DC. Analysis of the financial return of electronic health records. Ophthalmology 2016;123:214-6.e2.
- Choi JS, Lee WB, Rhee PL. Cost-benefit analysis of electronic medical record system at a tertiary care hospital. Healthc Inform Res 2013;19:205-14.
- Bar-Dayan Y, Saed H, Boaz M, Misch Y, Shahar T, Husiascky I, et al. Using electronic health records to save money. J Am Med Inform Assoc

2013;20:e17-20.

- Schmitt KF, Wofford DA. Financial analysis projects clear returns from electronic medical records. Healthc Financ Manage 2002;56:52-7.
- Ellsworth MA, Dziadzko M, O'Horo JC, Farrell AM, Zhang J, Herasevich V. An appraisal of published usability evaluations of electronic health records via systematic review. J Am Med Inform Assoc 2017;24:218-26.
- Moore KD, Eyestone K, Coddington DC. Costs and benefits of EHRs: A broader view. Healthc Financ Manage 2013;67:126-8.
- Darbyshire P. 'Rage against the machine?': Nurses' and midwives' experiences of using Computerized Patient Information Systems for clinical information. J Clin Nurs 2004;13:17-25.
- Jensen TB, Aanestad M. Hospitality and hostility in hospitals: A case study of an EPR adoption among surgeons. Eur J Inf Syst 2007;16:672-80.
- Kossman SP. Perceptions of impact of electronic health records on nurses' work. Stud Health Technol Inform 2006;122:337-41.
- Laerum H, Ellingsen G, Faxvaag A. Doctors' use of electronic medical records systems in hospitals: Cross sectional survey. BMJ 2001;323:1344-8.
- Jamieson T, Ailon J, Chien V, Mourad O. An electronic documentation system improves the quality of admission notes: A randomized trial. J Am Med Inform Assoc 2017;24:123-9.
- Li K, Naganawa S, Wang K, Li P, Kato K, Li X, *et al.* Study of the cost-benefit analysis of electronic medical record systems in general hospital in China. J Med Syst 2012;36:3283-91.
- Wang SJ, Middleton B, Prosser LA, Bardon CG, Spurr CD, Carchidi PJ, et al. A cost-benefit analysis of electronic medical records in primary care. Am J Med 2003;114:397-403.
- Adler-Milstein J, Green CE, Bates DW. A survey analysis suggests that electronic health records will yield revenue gains for some practices and losses for many. Health Aff (Millwood) 2013;32:562-70.
- Nguyen L, Bellucci E, Nguyen LT. Electronic health records implementation: An evaluation of information system impact and contingency factors. Int J Med Inform 2014;83:779-96.
- Smith K, Smith V, Krugman M, Oman K. Evaluating the impact of computerized clinical documentation. Comput Inform Nurs 2005;23:132-8.
- Carayon P, Smith P, Hundt AS, Kuruchittham V, Li Q. Implementation of an electronic health records system in a small clinic: The viewpoint of clinic staff. Behav Inf Technol 2009;28:5-20.
- Baumann LA, Baker J, Elshaug AG. The impact of electronic health record systems on clinical documentation times: A systematic review. Health Policy 2018;122:827-36.
- Campanella P, Lovato E, Marone C, Fallacara L, Mancuso A, Ricciardi W, *et al.* The impact of electronic health records on healthcare quality: A systematic review and meta-analysis. Eur J Public Health 2016;26:60-4.
- Featherly K, Garets D, Davis M, Wise P, Becker P. Sharpening the case for returns on investment from clinical information systems. Healthc Q 2007;10:101-4.
- Atasoy H, Greenwood BN, McCullough JS. The digitization of patient care: A review of the effects of electronic health records on health care quality and utilization. Annu Rev Public Health 2019;40:487-500.
- Subbe CP, Tellier G, Barach P. Impact of electronic health records on predefined safety outcomes in patients admitted to hospital: A scoping review. BMJ Open 2021;11:e047446.
- Ratwani R, Fairbanks T, Savage E, Adams K, Wittie M, Boone E, *et al.* Mind the Gap. A systematic review to identify usability and safety challenges and practices during electronic health record implementation. Appl Clin Inform 2016;7:1069-87.
- Kavuma M. The usability of electronic medical record systems implemented in Sub-Saharan Africa: A literature review of the evidence. JMIR Hum Factors 2019;6:e9317.