



# Navigating the Interoperability Landscape of Electronic Medical Record Systems in Developing Countries: A Narrative Literature Review

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## Abstract

Electronic medical records (EMRs) have transformed healthcare by digitizing patient data, improving access to information, and reducing medical errors. However, the lack of interoperability between different EMR systems remains a significant challenge. This paper employs a narrative review approach to examine Electronic Medical Record systems in Developing countries with a focus on their interoperability capabilities as well as the opportunities and challenges they encounter. The findings indicate that developing countries have shown varying levels of success in implementing Electronic Medical Records (EMRs) and ensuring interoperability. While some nations have made significant strides through national frameworks and standardized systems, others face challenges due to fragmented systems, inadequate policies, and limited infrastructure. To achieve full interoperability and improve healthcare outcomes, these countries need to develop and implement robust policies, adopt standards, invest in technology, and foster national coordination.

## Introduction

An Electronic Medical Record (EMR) is an electronic version of a patient's medical history that a healthcare provider has maintained for a while. (Boonstra & Broekhuis, 2010). EMR systems provide connectivity to all service delivery points within healthcare facilities. This is normally achieved through a complete infrastructure, including the hardware and software components. The system requires another critical parameter, the infostructure. The infostructure constitutes the human user. A complete EMR system, therefore, includes the infostructure and infrastructure. With EMR, patients can move from registration to exit through different pathways depending on their ailments. Essuman et al. (2020) state that this aids in the capture of crucial administrative and clinical data that is related to the care provided to a person by a specific provider, including demographics, progress reports, issues, medications, significant signs, medical history, immunisation reports, laboratory results, and radiology reports. If health organisations embrace Electronic Medical Records (EMRs), they will offer several advantages to physicians, patients, and healthcare services (Keshta & Odeh, 2021). Providing patients with higher-quality care, reducing prescription costs, increasing radiological tests, greater charge capture, and fewer billing errors offer distinct advantages (Menachemi & Collum, 2011). EMR adoption and integration in healthcare systems worldwide have expanded owing to numerous benefits (Woldemariam & Jimma, 2023). These advantages include decreased medical errors, enhancements to doctor productivity, and improved standard of treatment provided. Adopting and



integrating Electronic Medical Records (EMRs) has witnessed remarkable progress in Developing countries (Akwaowo et al., 2022). According to (Zanifa Omary, n.d.), Governments, healthcare organisations, and politicians are becoming increasingly aware of the revolutionary potential of EMRs in enhancing population health outcomes, lowering costs, and improving healthcare delivery.

Electronic Medical Records might have solved many issues in patient care, including the need to make hospitals paperless, but they still face major interoperability issues. This implies that when they go to different facilities, they lose their records because of the EMRs being silos or vertical systems. This is supported by Kruse et al. (2016), who are of the view that when patients seek healthcare services from various service providers practising in either their affiliated or unaffiliated institutions, there is no systematic connection between different healthcare providers, medical information about patients becomes fragmented, incomplete, and outdated.

Interoperability refers to the capacity of more than two applications or information systems to communicate. In the health sector, interoperability would entail sharing health records within and with other health facilities. Courbier et al. (2019) argue that interoperability increases health data sharing, helping to understand patients' needs and wants. This is supported by other researchers who equally note the contribution of the interoperability of EHRs in making care effective through the exchange of relevant information. Clarke et al. (2018) view the exchange of information as enabling understanding of adverse outcomes among patients and fragmentation of care, especially for patients with intricate care needs and co-morbidities.

With the advancements in technology in the health sector, the need to share information has increased, but past challenges have marred the capacity to do so (Bhartiya et al., 2016). The amount of data in the healthcare sector is growing by the day, and projections show that in the next decade or so, the growth will be exponential, leaving the players in the health sector with a daunting task of how to manage, share, and utilise the data (Dash et al., 2019). Interoperability will have to consider availing necessary information without compromising the quality of the content shared across platforms.

For seamless interoperability in the healthcare industry to be achieved, continuity of care must be enabled, care coordination and collaboration must be facilitated, patient safety and clinical decision-making must be improved, operational efficiency must be increased, and patients must be given the freedom to participate in their healthcare actively. The significance of interoperability will only increase as healthcare systems develop and become more networked (Torab-Miandoab et al., 2023). This will highlight the necessity of strong information governance frameworks, standardised data exchange protocols, and cooperative efforts among all stakeholders in the healthcare ecosystem. The context of EMR interoperability examines the current and general interoperability of implemented EMRs.

### **Literature Review**

Several researchers have examined EMR interoperability. Sharing patient data between independent institutions, each having implemented Electronic Health Records or Health Information Systems, involves significant concerns. Data sharing requires an interoperable and integrated environment that users commonly understand. The sheer number of standards, systems, developers and procedures seriously hinders interoperability. Several authors document strengths, weaknesses, and limitations regarding standards in EMR interoperability efforts.

Ehrenstein (2019) conducted a study, "Obtaining Data from Electronic Health Records." Regarding interoperability, the research details how EHRs are or can be linked to research registries and other registries. The authors detail the factors that will lead to better interoperability, including increasing lightweight standards, finding new ways to measure interoperability, introducing embedded EHR



tools, incentivising workers, and offering additional clarification regarding the application of HIPPA. There is insufficient information on guidelines for integrating registries, an essential factor for interoperability.

Ayaz et al. (2021) note that the Fast Healthcare Interoperability Resources (FHIR), which combines its various versions HL7 v2, HL7 v3, and CDA (Clinical Document Architecture), has also revolutionised the interoperability landscape. FHIR has served for several years with numerous advantages attributed to its standard. It enables the sharing of patient data to be more easily implementable and expressive than previous standards such as HL7 v2 and HL7 v3 and Clinical Document Architecture. Owing to the advantages, several major are adopting the standard, such as Cerner, Allscripts, and Epic.

Reisman (2017) discussed the Challenge of Making Electronic Data Usable and Interoperable. The authors detail three crucial stages in the meaningful use of EHRs: Data capturing and sharing, advanced clinical processes, and improved outcomes. The research also answers why interoperability is so complex and details the following that need consideration. In assessing EHRs' meaningful use, costs are still high, there is a need for a lot of collaboration, and the path to interoperability is unclear.

In the article, Issues in Achieving Complete Interoperability while Sharing Electronic Health Records, Bhartiya et al. (2016) highlighted the challenges to interoperability, such as semantic and syntactic differences, security concerns and the need for standardised guidelines. They also discussed security issues and approaches to interoperability. The author recommends combining technical solutions and user intervention to achieve interoperability.

Interoperability increases health data sharing, helping to understand what patients need and want. Concerning rare diseases and research on diseases, interoperability of health management systems or EMRs ensures that the needs and wants of the patients are embedded in the research and design process (Coubier et al., 2019). Further, researchers are quickly noting the contribution of interoperability of EHRs in making care effective through the exchange of relevant information. The exchange of information enables understanding of adverse outcomes among patients and fragmentation of care, especially for patients with intricate care needs and co-morbidities (Clarke et al., 2018).

Interoperability can increase productivity among healthcare teams while reducing medical facility costs. Researchers note medical staff productivity can be significantly stalled when no system interoperability exists. While implementing EHRs is essential in improving the quality of care and performance among healthcare teams, actual performance is realised only when these systems are interoperable.

Authors note that performance can best be documented when there is cross-provider interoperability and full integration of EHRs (Weiner et al., 2012). Jones (2022), in his study, showed that clinical waste of over 45 minutes every day is caused by using outdated information and related technologies, leading to many losses annually. In addition to enhancing the availability of new information, interoperability of EHRs means piles of paper documents can be digitised or replaced by digital information, which is a profoundly easier way to access, log, and store information.

The interoperability of EMRs also reduces errors in the healthcare sector. The integration and sharing of information among digital applications and programs facilitates a better flow of information, leading to enhanced efficiency and faster patient outcomes. Ndlovu et al. (2021) note that interoperability minimises the need for inputting patient data manually, note that interoperability minimises the need for inputting patient data manually, reducing the time needed for data entry,



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reducing errors, and alleviating issues surrounding text's readability emanating from poor handwriting. Thus, if data is correctly entered when the patient is registered and going through the first encounter, health facilities have higher chances of holding accurate patient health information throughout the life cycle.

Interoperability is related to privacy of Patient Health Information (PHI). When healthcare organisations do not know precisely where the data they hold for patients is at any given time, there is a high chance that it will result in data breaches (Seh et al., 2020). There are no guarantees that printed PHI will not lead to a breach of privacy. On the other hand, when data is communicated through secure, interoperable networks, there is confidence that the patient's data is secured.

Ultimately, the interoperability of EHRs improves patient experiences. The overall patient experience improves as the amount of attention and care patients receive from the care teams increases. Physicians will be taking less time to process data and more time to analyse and understand the needs of their patients. What interoperability EHRs seek to achieve is improved patient engagement and patient care (Li et al., 2021). While technology firms such as Apple are obsessed with the experience of customers, healthcare should also take advantage of the savviness that comes with interoperability to improve patient experience.

Developers must adhere to interoperability standards when designing and developing EHR systems (Rebecca A Meehan 1, 2016). Developing standardised interfaces will enable the seamless transfer and communication of required patient data across EHRs. As EHRs develop and the need for interoperability increases, developers and vendors must consider carefully when incorporating customised security controls, as they usually result in challenges in securely sharing data (Cresswell et al., 2013).

Beyond interoperability standards, scholars also note that interoperability, even when properly implemented, does not meet end users' expectations and requirements. Bowman (2013) has noted issues with improper implementation and specifications of EHRs. Most of the implementations have design flaws partly due to the rising intricacy of systems, so they do not fully attain the promise of enhancing patient safety, care quality, and process efficiency (Keshta & Odeh, 2021). In this case, they miss the required adaptability and flexibility but rely on the organisation and context for which they have been developed. This is a huge challenge that interoperability must overcome to succeed. Interoperability has also been greatly affected by inconsistencies between free text and structured data and a lack of transparency of ICT actions and processes. In this context, when improperly deployed, automated processes such as automated data capture can cause issues (Ehrenstein, 2019). This way, inaccurate or out-of-date information could be captured, particularly when employing templates.

Another significant challenge in interoperability is the proper development and implementation of EHR decision support systems, which usually leads to bias in automation. These issues could be surpassed by certifying the development of EHRs in the context of meaningful use (Reisman, 2017). However, a comprehensive study assessing the experiences of meaningful use demonstrated weaknesses in meeting the overarching need for patient safety, care quality, and process efficiency. Ultimately, these issues affect the data shared across systems in interoperability frameworks.

Most studies on the interoperability of electronic medical records have emphasised the technical aspects; however, according to Seyedesedigheh (2019), a multidisciplinary approach is essential when evaluating emerging technologies like interoperability.



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## Methodology

This paper used a narrative approach to review secondary data on various EMR systems' state of interoperability. Research papers from 2012 to 2024 concerning the interoperability of Electronic Medical Records in developing countries were used. The keywords Interoperability, EMR (Electronic Medical Records), Electronic Health Records, Health information exchange, and developing countries were used. Electronic databases were searched, including EBSCO, Google Scholar, and pertinent healthcare informatics articles. Studies were included in the analysis if they reported on challenges, opportunities and interoperability of Electronic Medical Records or Electronic Health Records in developing countries. Studies that were not published in English before 2012 and those that were out of context and irrelevant to the topic were excluded.

## Results/ Findings

Some developments have been made as far as interoperability of Electronic Medical Records is concerned in developing countries. According to the National Health Act: National Health Normative Standards Framework for Interoperability in eHealth (2014), South Africa's National Department of Health (NDoH) has endeavoured to ensure the interoperability of systems in the country's healthcare system. Efforts can be traced back to March 2014 when the National Health Normative Standards Framework was launched to provide standards and guidelines for the country's Electronic Health Records.

Significant developments have been made in the field of interoperability as far as standards are concerned. Mkayula et al. (2022) note that some hospitals in Tanzania utilise similar standards that enable the interoperability of EMRs. HL7 standard and a single standard DICOM are used for imaging systems promoting the interoperability of EMRs. Despite this achievement, the findings highlight the complexity of achieving EMR interoperability in the healthcare system and the need for coordinated efforts at both the hospital and national levels. Establishing hospital ICT policies that align with national health strategies, investing in interoperability technologies (such as REST APIs and HL7 FHIR), ensuring reliable internet access, and allocating sufficient budgets for interoperability efforts are recommended.

Interoperability of EMRs is mainly absent in Rwanda. Mugabe Nzarama et al. (2024) note that even within the same facility, many healthcare facilities in Rwanda use distinct EHR systems that are not connected. There is a notable lack of data continuity among healthcare providers due to this fragmentation. Also noted in the study is the lack of policies promoting interoperability at the national level, lack of standardised frameworks, lack of a common data model, and technological barriers, all of which hinder interoperability.

According to Ndlovu et al. (2021), there is limited interoperability among and within health facilities or sectors, even though Electronic Record systems have been implemented in most of Botswana's facilities. Even when widely established standards are used, different databases and systems are still not interoperable. A small number of facilities, mostly private ones, have technical interoperability. Lack of regulation and control, a poor ICT infrastructure, tight maintenance funds, and inconsistent unique patient identifiers are some obstacles to interoperability.

Ngugi et al. (2021), in their study "A multivariate statistical evaluation of actual use of Electronic Health Record Systems implementation in Kenya", focused on the use of EHR in developing countries and detailed the successes and limitations of both EHR and their interoperability. The author established that only a few of the facilities 14.1% that were included were interoperable. Indications are that the use of EHRs and data interoperability needs improvement. The limitation of this study is that they didn't interrogate why the other facilities were not interoperable.



Systems that have leveraged similar standards have been documented as successful in interoperability. Ngugi et al. (2021) document KeEMR successes, an EMR that employs a communication layer referred to as the interoperability layer (IL) to allow the exchange of health data with other health information systems like the ADT pharmacy system. Ministry of Health (2024), in a document on the Kenya Health Information Systems interoperability, provides details of the interoperability layer comprising authentication and authorisation of services, interlinking and routing of services, transformation and translation, and alerting and auditing services. This enables the system to communicate with IFHIS, KNBS, and other external systems.

### **Discussion**

This study has examined the interoperability landscape of EMR systems in developing countries, highlighting the challenges and opportunities they present. The findings reveal that while EMRs offer significant benefits, the lack of interoperability between different EMR systems remains a major obstacle to seamless data exchange and improved healthcare delivery.

The analysis identified key factors influencing interoperability, including adopting standardised data formats, protocols, and communication infrastructure. Existing standards and protocols, such as HL7, have facilitated data exchange, but their widespread implementation remains crucial. Furthermore, the study identified various strategies for promoting interoperability in developing countries, including updating legal frameworks, implementing a national health information exchange system, and investing in the necessary technological infrastructure.

The discussion emphasises the critical role of interoperability in enhancing patient care by enabling healthcare professionals to access comprehensive medical records, improving care coordination, and promoting informed decision-making. Additionally, interoperability can contribute to reducing medical errors by eliminating the need for manual data entry and facilitating the transfer of accurate and complete patient information. Finally, it can significantly advance healthcare efficiency by streamlining workflows, reducing administrative burdens, and enabling data-driven research and improvement initiatives. To achieve interoperability of Electronic Medical Records, other interoperability aspects should be addressed in addition to technical aspects.

### **Limitations**

Due to time and resource constraints, only a few developing countries in Africa were explored, examining a broader range of developing countries may provide a clearer understanding. Additionally, the study relied on just a few databases, meaning that other databases and repositories could uncover additional studies and offer a more comprehensive reflection of EMR interoperability.

### **Conclusion**

Implementing Interoperable Electronic Medical Records (EMRs) in developing countries has demonstrated varying degrees of success, with several nations achieving progress by adopting national frameworks and standardised systems. However, significant challenges persist, particularly in fragmented infrastructure, insufficient policies, and limited technological investments. To address these challenges, developing countries must prioritise creating robust policies, adopting international standards, and sustaining investments in technology. Additionally, fostering national coordination will be essential in advancing interoperability, critical for improving healthcare outcomes and overall system efficiency. Addressing these issues holistically will enable these nations to fully capitalise on the transformative potential of EMRs.



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