

The Role of EHRs Interoperability towards Facilitating Informed Decision Making in Healthcare Facilities in Tanzania: Conceptual Framework

Augustino Mwogosi(PhD Candidate)
School of Nursing and Public Health
University of Dodoma
Dodoma, Tanzania

Dr. Stephen Kibusi
School of Nursing and Public Health
University of Dodoma
Dodoma, Tanzania

Dr. Deo Shao
College of Informatics and Virtual Education
University of Dodoma
Dodoma, Tanzania

Dr. Ntuli A. Kapologwe
President's Office-Regional Administration and Local
Government
Dodoma, Tanzania

Abstract:- EHRs facilitate sharing of healthcare from clinicians involved in patient care within and across health facilities. Interoperable EHRs can facilitate this exchange of information and as a result be able to facilitate decision making. Despite increasing adoption of EHRs in Tanzania, the realization of benefits that EHRs could offer through interoperability still lags behind. Currently most EHRs are not interoperable thus making it difficult to facilitate exchange of information between systems. The aim of the study therefore was to contribute to final conceptual frameworks that relate Interoperability and Decision making in the healthcare.

Integrated Literature review was conducted to understand concepts related to Interoperability and decision making.

Six propositions emerged from relevant studies that contribute in understanding the role of EHRs interoperability in facilitating decision making.

Interoperability allows for collaboration which is an important aspect in decision making. Several studies have identified the benefits of having interoperable EHRs, but few have explored on how such benefits can contribute on decision-making

Keywords:- EHRs Interoperability; Decision Making; Electronic Health Records Systems; Decision Support.

I. INTRODUCTION

Electronic Health Records (EHR) are digital records of health information that can be shared across healthcare settings [1]–[3]. The Electronic Health Records Systems (EHRs) facilitate the sharing of health information from all clinicians involved in patient care in a certain healthcare facility with other healthcare providers across facilities such as emergency department, medical imaging department, pharmacies and laboratories [4]. The successful health information sharing offers EHRs users with benefits by providing better ways for cooperating with other healthcare practitioners. These benefits

are in line with the 2012-2018 e-Health strategic goals that state “enable the health sector to operate more effectively as a connected system, overcoming fragmentation and duplication of service delivery” another goal state that “make patient care safe and effective by ensuring that the correct information is available in a timely manner, where it is needed and to whom it is needed” [5].

Because of the fact that decision making requires the use of tools that are capable of providing right information, to the right person through right channels in the right intervention format and at the right points for action[6], then The EHRs capability of transferring medical data from one provider to another and the access of such data by the providers from any facility and at any time is an essential condition for meaningful use of EHRs in supporting decision making [7]. Healthcare practitioners and facilities leaders need a sufficient amount of data to make accurate decision when taking care of patients as well as managing the healthcare systems [8]. For instance, clinicians need data to make clinical judgments [9], [10], public health workers need data to make decisions on prevention and detection of diseases [11], [12] and policy makers need data as evidence for policy making[10], [13], [14]. Patient data such as demographics, vital signs, medical history, laboratory and radiology departments' results, nursing care plans and documentation as well as medication lists can be stored, tracked and generated using EHRs. Thus, successful implementation of EHRs might result into better medical care for patients[15] through informed decision making. This is emphasized in the 2019-2024 digital health strategic goals stated in a report by the Tanzania Ministry of Health, Community, Development, Gender, Elderly and Children (MoHCDGEC) in 2019 “empowered healthcare providers and managers to take evidence based actions”.

Despite the increasing EHRs adoption and wider spread of EHRs in health facilities in Tanzania, several challenges exist in the healthcare systems that are due to lack of interoperability of the EHRs systems. Such challenges include, inaccurate and fragmented data, lack of common structured and accessible standards for health terminology, inability to exchange data, lack of standardization as well as limited data

use [16]. Henceforth, the criteria of sharing and exchange of data between institutions or between providers is not met in most of the EHRs adopted in Tanzania due to inconsistency in the implementation of EHRs by the healthcare facilities in Tanzania. For instance currently in Tanzania patients seeking to transfer their medical history from one health facility to another for different reasons such as seeking for a second opinion by multiple other healthcare professionals is so difficult. This raises a question as whether it is possible to use EHRs to facilitate decision making in the healthcare facilities in Tanzania.

Although interoperability is essential to the Health Information Systems (HIS) implementation, research on this dimension in Tanzania context is relatively scarce and evolving. Hence, this study aims to broaden this emerging research line by introducing interoperability as a contributing factor for decision making improvement through the implementation of EHRS. To do so Researchers, propose a conceptual framework based on literature review of EHRS interoperability and decision making. This study will broaden understanding of researchers in the Low and Middle Income Countries (LMICs) including Tanzania on the significance of having interoperable EHRs as a facilitator of decision making in healthcare facilities in the country.

II. MATERIALS AND METHODS

Since the aim of the study was to contribute a final conceptual framework that associated Interoperability and Decision Making in the healthcare, therefore appropriate method was to conduct an integrative literature review whose purpose is to make revision on a topic, criticize and synthesize in an integrated way in such a way that new perspectives and frameworks can be generated[17], [18].

In order to understand the EHRS interoperability concepts and its role in facilitating decision making an integrative literature review was conducted. In order to identify literatures the following databases were consulted EBSCOhost, Taylor & Francis, Emerald Insight, JSTOR, Research for life via Hinari database.

III. RESULTS

Tanzania like many other LMICs have made great transformations in their health systems through the wide use of digital solutions[19], [20]. For instance currently in Tanzania at the government and private healthcare facilities EHRs and many other HISs have been implemented. Besides, there exist several strategies and reforms aiming at improving the healthcare delivery through digital solutions. As a result of these initiatives concepts such as HIS/EHRs interoperability and Decision making in healthcare start to emerge [21], [22].

This section examines the studies related to EHRS interoperability and decision making and the relationship between EHRS interoperability and decision making in healthcare facilities. Besides, a conceptual framework is proposed from the literatures to show how interoperability can contribute to the improvement of decision making in Tanzania.

A. EHRs Interoperability

For EHRs to have a potential use, systems must be able to exchange data with one another used to their fullest potential, systems must be able to exchange data with one another[23]. Often referred to as interoperability, allowing healthcare professionals and their patients to have real time access to information that they need to make informed decisions HIMSS, [24]. While healthcare systems have a variety ways to communicate like paper mail, phone calls, fax or email [25], [26], the EHRs is usually seen as the easiest and secure way[27]. Interoperable EHRs allows sharing of health data electronically between different EHRS and healthcare practitioners within and across healthcare facilities where it becomes easy for healthcare practitioners to provide care to their patients and thus patients can be able to move in and out of different healthcare facilities [28]. Interoperability is essential in healthcare service delivery because healthcare facilities need to interact with one another so as to share and exchange health data, and EHRs are the essential tools to facilitate. EHRs interoperability therefore, refers to effective communication of health information electronically. Basically, data need to be transferred properly without any missing information. The goal for EHRs interoperability is to optimize the health of individuals and populations in general. In the LMICs, it is unfortunate that Interoperability is considered to be an afterthought when a healthcare facility decides to select EHRs, even though in real sense it should be in the forefront when check listing the requirements for EHRS. To have a meaningful use of EHRs in the LMICs, EHRs interoperability should be an essential part.

According to the Office of the National Coordinator for Health Information Technology (ONC) in USA, for EHRs to be considered completely interoperable, four key areas of technology need to be successfully integrated [29]. These areas are application interaction with users, system communication, and information processing and management as well as consumer integration. This means EHRs must be able to facilitate communication for clinicians, pharmacists, laboratory and patients in the comfort of their own homes. Besides, there are standards of EHRs interoperability so that communication among EHRs and different other healthcare systems is improved, thus three key levels of EHRs to allow systems to have ability to access data, exchange information, integrate data and coordinate care even across healthcare facilities HIMSS [24]. Foundational interoperability level, allows for EHRs to give data to another system while also receiving data without requiring interpreting the received data. The second level of interoperability is called structural interoperability, in which data should be able to pass through the system correctly without being altered. The semantic interoperability level, allows for data to be restructured and codified correctly so that each system can receive correct any new data and be able to understand it HIMSS [24]. Other researchers further explain interoperability to include other factors such as security and privacy, business issues, legal and ethical issues, environment issues, stakeholders and Human computer interface[30], [31].

It is vital for EHRs to be able to exchange data with another system using standards that can make it easy to interpret vocabulary. This ensures accuracy of patient data and

improves accessibility of the data in a small amount of time, as compared with paperwork during patient's appointments. More importantly interoperability can address the growing expectations of health workers working in healthcare facilities and the current EHRs challenges such as limited data use and inaccurate and fragmented data both of which limit the meaningful use of EHRs. Fortunately, the trend that existed in the healthcare facilities in the LMICs where healthcare providers viewed patient data as their properties and become unwilling to share the data with other providers outside their facilities, is coming down. Currently, healthcare providers are willing to share their data with other health providers; therefore it is high time healthcare facilities realized the benefits that EHRs interoperability could offer the healthcare sector.

Despite the growing body of research on the benefits of EHRs, less emphasis is given on the role it plays in facilitating decision making in the LMICs, Tanzania in particular. Benefits to public health practitioners, patients and physician as well as cost reduction benefits have been highlighted. A recent study by Howard & Ermilio [32], explains electronic exchange of data can yield public health benefits, authors in this study give example on the responses to pandemics such as COVID-19 that require effective sharing of patient data. According to the study through sharing of data public health leaders can come up with effective measures through which they can allocate resources, such as masks. Another study by Iroju, Soriyan, Gambo, & Olaleke[33] explains the benefits of interoperability to healthcare providers and patients, the research study shows the importance of sharing the sharing of patient data across different healthcare facilities to enable efficient healthcare that helps in managing patient loads. The study further explains that with EHRs being interoperable providers have real time data, this allows them to treat patients with less errors caused by lack of access of data. Besides, the same study explains that EHRs interoperability provides benefits to patients by knowing that their health records are complete and accurate and they can have access to them wherever they go in different other facilities. Other research studies explain the cost benefits of EHRs interoperability, in their study researchers explain about the variety ways that healthcare facilities can save money when they decide on investing in interoperable EHRs [34], [35]. One such ways, is the ability of a provider to have more time to see higher numbers of patients since they are no longer spending time scrutinizing through paper records [36].

The studies have given partial view of what EHRs interoperability might offer to the healthcare sector, especially in the LMICs such as Tanzania. Further clarification needs to be done in terms of how EHRs interoperability contributes in facilitating decision making through the use of EHRs.

B. Decision Making in Healthcare

Effective decision making plays a great role in optimizing healthcare delivery. The concept of decision making in healthcare has not been explored enough to have a full coverage. The focus has been more on decision making in clinical practices, therefore terms such as clinical decision making, clinical decision support systems have been given much emphasis [9], [37], [38] and other practices being underrated. However, healthcare decision making covers a

broad range of practices by different workers including the health facilities leaders, public health and medical practitioners. However, in the recent years, there have been some attempts to include non-clinical decision making as a component in healthcare decision making studies. Three main important categories are identified in decision making in healthcare; clinical decision making, nonclinical decision making and both, where nonclinical decision making involve healthcare facilities leaders, researchers and public health practitioners and clinical decision making involve medical practitioners such as clinicians, nurses, laboratory technologists/technicians. In the healthcare context, it is appropriate therefore to use the third concept where both clinical and nonclinical decision making are explored.

For quality decision making factors such as data availability, timely access of data and organized information are very influential [39]. The EHRs has catalyzed change for healthcare workers by making available vast amount of patient data and other health information that can be used for decision making. The complete amount of patient data available electronically instead of volumes of paper and through sharing of such data to other healthcare providers can assist in decision making. If EHRs is used in a meaningful manner, it provides several benefits to the healthcare such as automated drug interaction and allergy alerts and dosing errors detection. Besides, clinical parameters found in EHRs data example, vital signs and test results can be used to create alerts that notify clinician or trigger order tests [40]. Therefore, to have a meaningful use of EHRs, data collected by EHRs should improve patient care by giving access to evidence based tools that can be used to assist with decision making [41].

The capability of EHRs to share data between healthcare facilities can result into several positive outcomes mainly decision making.

C. EHRs Interoperability and Decision Making

EHRs Interoperability maximizes effective decision making practices in healthcare [39]. The concepts of EHRs interoperability and decision making can be associated to some extent. The decision making concept to some extent depend on EHRs interoperability concept to reach to improvement of healthcare practices to individuals by the healthcare stakeholders that include clinicians, pharmacists, nurses, laboratory technicians, public health practitioners and healthcare facilities leaders.

The use of interoperable EHRs can support collaboration in healthcare settings [42], [43]. Collaboration involves multiple people that work together interactively to reach to a common goal[44] and therefore make use of the available resources more efficiently [45]. Collaboration in healthcare is essential for the development of practices where members from various healthcare professions with different knowledge, skills, innovations and capabilities work together to carry out a series of tasks for meeting the shared healthcare delivery targets [46]. Effective collaboration occurs when the tools needed to facilitate collaborators are available and they are appropriate [47], [48]. More activities that require collaboration are enabled by various information tools[49] such as EHRs. Activities such

as communication between clinicians, sharing of patient and health information, sharing experience, power and responsibility and sharing of resources can be improved with the use of EHR systems, and hence contribute in facilitating decision making.

Although clinical diagnostic decision making has been an individual practice where clinicians work solely to reach at a decision regarding patient treatment, ideally diagnostic decision making should be a collaborative practice among clinicians and other healthcare professionals[50] because of complexity of healthcare practices. Diagnostic process requires collaboration among clinicians and other healthcare professionals across different healthcare settings and EHR systems can be enhanced to support this engagement. With EHRs capability in sharing and exchange data, it is possible for data to be transferred from one clinician to another and from one healthcare professional to another. This allows for these professionals to give their views and opinion on a matter at hand and by doing so help in facilitating decision making. This is evidenced by embedded case study by Vos et al[43] at five outpatient clinics of a Dutch hospital that had implemented an organization-wide EHRs. In the study authors indicate that EHR can help health professionals coordinate patient care on an informed basis at any time and place but the only problem is that EHRs does not allow asynchronous patient record use. The study further explains EHRs through a patient file affords joint decision-making on the shared data. Moreover, just like in coordination because of lack of full interoperability not all relevant medical data can easily be shared across facilities and outside the hospital. However, it is enough to say if EHRs is interoperable then collaboration among healthcare professionals can be made possible and thus facilitate decision making.

Besides, interoperable EHRs can also ensure collaboration between healthcare professionals and their patients during clinical practices. This model of communication where healthcare providers and patients to contribute in clinical decisions in unique ways is explained by Lenert, Dunlea, Del Fiol, & Hall[51]. The model is about shared decision making between healthcare providers and

patients. In the study researchers show that the model allows decisions to be shared in two way discussions, where clinicians offer their opinions about the health risks and benefits and patients describe their preferences and values. Researchers further explain that this kind of decision making cannot occur if the patients and providers do not have a mutual understanding of the treatment options that exist and patient preferences. This requires the systems that patient use and that of providers be interoperable to facilitate this kind of exchange of information. Similarly, EHRs interoperability allows for collaboration between the healthcare professionals and public health practitioners[13].

Moreover, interoperable EHRs can play a major role in collaboration between providers. The study by Chase et al [52] examined the role of the EHR in building relationships, communicating, coordinating, and collaborative decision-making. The study concluded that organizational and technical innovations are needed if the EHR is to truly support collaborative behaviors including collaborative decision making. This is to say according to the study, where it was found that EHRs performance varied, for EHRs to be meaningful it should be interoperable. In the EHRs was found to only play four major collaborative roles which include data repository, messenger, orchestrator and monitor.

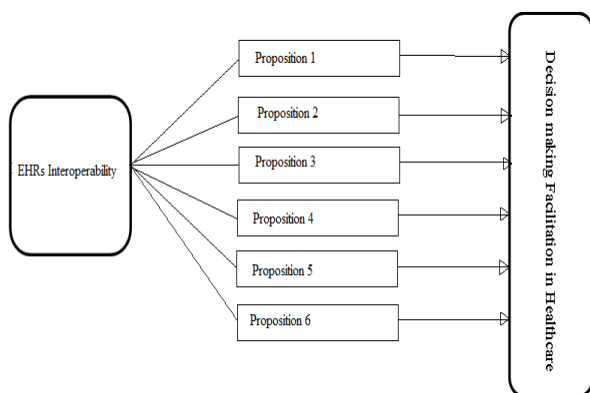
Furthermore, through the interoperable EHRs policy makers and healthcare facilities managers can collaborate so as to put in place supportive environment to provide efficient and effective healthcare through contributing to the productivity and effectiveness of healthcare professionals. This kind of collaboration can be made possible through exchange of information by the two parties.

D. Conceptual Framework

From the literatures surveyed, the **Error! Reference source not found.** summarizes a list of propositions emerged from the study. In addition, it refers to some relevant studies that support the propositions. The **Error! Reference source not found.** illustrates the propositions of the study in a framework.

Table 1: Propositions emerged from studies

	Proposition	Relevant studies
Proposition 1	EHRs Interoperability allows for collaborative model among clinicians and other healthcare professionals ,which contribute in shared decision making	Noteboom, Motorny, Qureshi, & Sarnika [53], Vos et al.[43], Garde, Chen, & Leslie (2009)
Proposition 2	EHRs Interoperability allows for collaborative model between clinicians and their patients, which contribute in shared decision making	Noteboom, Motorny, Qureshi, & Sarnika [53], Tiase et al [55]
Proposition 3	EHRs Interoperability allows for collaborative model among clinicians and facility managers, which contribute in decision making	Noteboom, Motorny, Qureshi, & Sarnika [53],
Proposition 4	EHRs Interoperability allows for collaborative model between healthcare facilities, which contribute in decision making	Noteboom, Motorny, Qureshi, & Sarnika [53], se et al. [52], Mallah, Guelpa, Marsh, Mallah, & Rooj (2010)
Proposition 5	EHRs Interoperability allows for collaborative model among public health practitioners, clinical researchers and other healthcare professionals ,which contribute in shared decision making	Noteboom, Motorny, Qureshi, & Sarnika [53], Cowie et al., [13], Dogac [57], Sartipi & Yarmand [58]
Proposition 6	EHRs Interoperability allows for collaborative model among healthcare professionals, which contribute in cost saving decision making	Noteboom, Motorny, Qureshi, & Sarnika [53], Roadmap [29]



IV. DISCUSSION

The study intended to increase understanding of the relationship that exists between EHRs interoperability and its ability to facilitate decision making. The study explored on different concepts relating to EHRs interoperability and decision making. So the study identified that collaboration that is enabled through EHRs interoperability plays a great role to make EHRs be able to facilitate decision making in healthcare sector. Several Collaborative models have been discussed in the study, such as patient and health professionals, between health professionals, health professionals and public health professionals and health facilities leaders. Through collaboration decision making is made easy, where data is shared between the stakeholders and hence make the process of decision making to be effective and efficient. Through exploration of research studies, researchers propose a conceptual framework in **Error! Reference source not found.** explaining six propositions as they contribute to decision making facilitation.

ACKNOWLEDGMENT

Special thanks of gratitude to the University of Dodoma for the opportunity and facilitation of its staffs in studying and conducting research.

REFERENCES

- [1] F. Aliyu, H. Wimmer, L. M. Powell, and C. R. Jr, “An International Review and Study on Perceptions of Security , Adoption , and Implementation of Electronic Health Records,” pp. 1–8, 2020.
- [2] T. D. Gunter and N. P. Terry, “The Emergence of National Electronic Health Record Architectures in the United States and Australia: Models, Costs, and Questions,” *Med. Internet Res.*, 2005.
- [3] C. H. Tsai, A. Eghdam, N. Davoody, G. Wright, S. Flowerday, and S. Koch, “Effects of electronic health record implementation and barriers to adoption and use: A scoping review and qualitative analysis of the content,” *Life*, vol. 10, no. 12, pp. 1–27, 2020, doi: 10.3390/life10120327.
- [4] E. W. Jamoom, N. Yang, and E. Hing, “Adoption of Certified Electronic Health Record Systems and Electronic Information Sharing in Physician Offices: United States, 2013 and 2014,” *NCHS Data Brief*, no. 236, pp. 1–8, 2016.
- [5] MoHSW, “THE UNITED REPUBLIC OF TANZANIA: Tanzania National eHealth Strategy 2012 - 2018,” *Natl. eHealth Strateg.*, no. May 2013, pp. 1–44, 2013.
- [6] R. Campbell, “The Five Rights of Clinical Decision Support: CDS Tools Helpful for Meeting Meaningful Use,” *J. AHIMA*, 2013, [Online]. Available: <https://library.ahima.org/doc?oid=300027#.YJuUD6gzbuIU>.

- [7] C. M. Ruland, H. Brynhi, R. Andersen, and T. Brynhi, "Developing a shared electronic health record for patients and clinicians," *Stud. Health Technol. Inform.*, vol. 136, pp. 57–62, 2008.
- [8] F. F. Odekunle, R. O. Odekunle, and S. Shankar, "Why sub-Saharan Africa lags in electronic health record adoption and possible strategies to increase its adoption in this region.," *Int. J. Health Sci. (Qassim)*, vol. 11, no. 4, pp. 59–64, 2017, [Online]. Available: <http://www.ncbi.nlm.nih.gov/pubmed/29085270%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC5654179>.
- [9] M. Godbole and A. Agarwal, "Clinical data driven decision support in healthcare informatics," *Int. J. Eng. Res. Technol.*, vol. 13, no. 1, pp. 107–116, 2020, doi: 10.37624/ijert/13.1.2020.107-116.
- [10] S. Liao, J. Xiao, Y. Xie, and F. Gu, "Towards use of electronic health records: Cancer classification," *Simul. Ser.*, vol. 49, no. 6, pp. 36–45, 2017, doi: 10.22360/springsim.2017.msm.008.
- [11] M. A. Chanyalew, M. Yitayal, A. Atnafu, and B. Tilahun, "Routine health information system utilization for evidence-based decision making in Amhara national regional state, northwest Ethiopia: a multi-level analysis," *BMC Med. Inform. Decis. Mak.*, vol. 21, no. 1, pp. 1–10, 2021, doi: 10.1186/s12911-021-01400-5.
- [12] A. M. Shiferaw, D. T. Zegeye, S. Assefa, and M. K. Yenit, "Routine health information system utilization and factors associated thereof among health workers at government health institutions in East Gojjam Zone, Northwest Ethiopia," *BMC Med. Inform. Decis. Mak.*, vol. 17, no. 1, pp. 1–9, 2017, doi: 10.1186/s12911-017-0509-2.
- [13] M. R. Cowie *et al.*, "Electronic health records to facilitate clinical research," *Clin. Res. Cardiol.*, vol. 106, no. 1, pp. 1–9, 2017, doi: 10.1007/s00392-016-1025-6.
- [14] X. Zeng, "Electronic Records in Health Care systems are touted as one of system that provides quality," vol. 69, no. 2, pp. 108–111, 2008.
- [15] M. F. Furukawa, V. Patel, D. Charles, M. Swain, and F. Mostashari, "Hospital electronic health information exchange grew substantially in 2008-12," *Health Aff.*, vol. 32, no. 8, pp. 1346–1354, 2013, doi: 10.1377/hlthaff.2013.0010.
- [16] MoHCDGEC, "Tanzania Health Enterprise Architecture (TzHEA)," no. September, 2020.
- [17] C. E. Toronto and R. Remington, *A Step-by-Step Guide to Conducting an Integrative Review*. 2020.
- [18] R. J. Torraco, "Writing Integrative Reviews of the Literature," *Int. J. Adult Vocat. Educ. Technol.*, vol. 7, no. 3, pp. 62–70, 2016, doi: 10.4018/ijavet.2016070106.
- [19] M. Kumar and J. Mostafa, "Electronic health records for better health in the lower- and middle-income countries: A landscape study," *Libr. Hi Tech*, vol. 38, no. 4, pp. 751–767, 2020, doi: 10.1108/LHT-09-2019-0179.
- [20] G. Watts, "The Tanzanian digital health agenda," *Lancet Digit. Heal.*, vol. 2, no. 2, pp. e62–e63, 2020, doi: 10.1016/s2589-7500(20)30005-4.
- [21] B. R. Kikoba, E. Kalinga, and J. Lungo, *Integrating electronic medical records data into national health reporting system to enhance health data reporting and use at the facility level*, vol. 551, no. July. Springer International Publishing, 2019.
- [22] L. Nehemiah, "Towards EHR Interoperability in Tanzania Hospitals: Issues, Challenges and Opportunities," *Int. J. Comput. Sci. Eng. Appl.*, vol. 4, no. 4, pp. 29–36, 2014, doi: 10.5121/ijcsea.2014.4404.
- [23] The Pew Charitable Trusts, "Electronic Health Records—Interoperability," 2020. <https://www.pewtrusts.org/en/research-and-analysis/articles/2016/11/electronic-health-records-interoperability>.
- [24] I. (HIMSS) Healthcare Information and Management Systems Society, "Healthcare Information and Management Systems Society. What is interoperability?" <https://www.himss.org/resources/interoperability-healthcare#:~:text=It is the ability of,information and optimize the health>.
- [25] J. Dash, D. M. Haller, J. Sommer, and N. J. Perron, "Use of email, cell phone and text message between patients and primary-care physicians: cross-sectional study in a French-speaking part of Switzerland," *BMC Health Serv. Res.*, pp. 20–25, 2016, doi: 10.1186/s12913-016-1776-9.
- [26] J. Antoun, "Electronic mail communication between physicians and patients: a review of challenges and opportunities," vol. 33, no. 2, pp. 121–126, 2016, doi: 10.1093/fampra/cm101.
- [27] E. C. Webber, D. Brick, J. P. Scibilia, and P. Dehnel, "Electronic Communication of the Health Record and Information With Pediatric Patients and Their Guardians," vol. 144, no. 1, 2021.
- [28] M. M. M. Pai, R. Ganiga, and R. M. Pai, "Standard electronic health record (EHR) framework for Indian healthcare system," *Heal. Serv. Outcomes Res. Methodol.*, no. 0123456789, 2021, doi: 10.1007/s10742-020-00238-0.
- [29] I. Roadmap, "Connecting Health and Care for the Nation," 2009.
- [30] H. Liu, X. Q. Hou, G. Hu, J. Li, and Y. Q. Ding, "Development of an EHR System for Sharing – A Semantic Perspective," pp. 113–117, 2009, doi: 10.3233/978-1-60750-044-5-113.
- [31] W. E. Hammond and D. Ph, "A Perspective on Interoperability," pp. 1–12, 2008.
- [32] N. Howard and J. Ermilio, "EHR Interoperability: Public Health Benefits & Privacy Considerations," 2020. [Online]. Available: <https://www.covingtondigitalhealth.com>.
- [33] O. Iroju, A. Soriyan, I. Gambo, and J. Olaleke, "Interoperability in Healthcare: Benefits, Challenges and Resolutions," vol. 3, no. 1, pp. 262–270, 2013.
- [34] Z. Silveira, N. Reis, T. A. Maia, and M. S. Marcolino, "Is There Evidence of Cost Benefits of Electronic Medical Records, Standards, or Interoperability in Hospital Information Systems? Overview of Systematic Reviews Corresponding Author:," vol. 5, 2017, doi: 10.2196/medinform.7400.

- [35] A. Gordon, "Accelerating Electronic Information Sharing to Improve Quality and Reduce Costs in Health Care.," 2012.
- [36] P. Shelle, S. Morton, and E. Keeler, "Costs and benefits of health information technology," 2006, doi: 10.23970/ahrqepcerta132.
- [37] C. Căndeia, G. Căndeia, and Z. B. Constantin, "ArdoCare - A collaborative medical decision support system," in *ArdoCare-a collaborative medical decision support system*, 2019, vol. 162, no. Itqm 2019, pp. 762–769, doi: 10.1016/j.procs.2019.12.048.
- [38] S. J. Miah, N. Hasan, and J. Gammack, "Follow-up decision support tool for public healthcare: A design research perspective," *Healthc. Inform. Res.*, vol. 25, no. 4, pp. 313–323, 2019, doi: 10.4258/hir.2019.25.4.313.
- [39] H. Osop and T. Sahama, "Electronic Health Records: Improvement to Healthcare Decision-Making," 2016.
- [40] D. L. McGee, "Electronic Health Records(EHR) and Clinical Decision Support," 2018.
- [41] S. Parasrampur and J. Henry, "Hospitals' Use of Electronic Health Records Data, 2015-2017," *Off. Natl. Coord. Data Br.*, no. 46, pp. 2015–2017, 2019.
- [42] L. Lo Presti, M. Testa, V. Marino, and P. Singer, "Engagement in healthcare systems: Adopting digital tools for a sustainable approach," *Sustain.*, vol. 11, no. 1, pp. 1–15, 2019, doi: 10.3390/su11010220.
- [43] J. F. J. Vos, A. Boonstra, A. Kooistra, M. Seelen, and M. Van Offenbeek, "The influence of electronic health record use on collaboration among medical specialties," *BMC Health Serv. Res.*, vol. 20, no. 1, pp. 1–12, 2020, doi: 10.1186/s12913-020-05542-6.
- [44] L. Morley and A. Cashell, "Collaboration in Health Care," *J. Med. Imaging Radiat. Sci.*, vol. 48, no. 2, pp. 207–216, 2017, doi: 10.1016/j.jmir.2017.02.071.
- [45] N. Amoo, R. Malby, and K. Mervyn, "Innovation and sustainability in a large-scale healthcare improvement collaborative - seven propositions for achieving system-wide innovation and sustainability," *Int. J. Sustain. Strateg. Manag.*, vol. 5, no. 2, p. 149, 2016, doi: 10.1504/ijssm.2016.080465.
- [46] B. K. Kaini, "Interprofessional Team Collaboration in Health Care," *Glob. J. Med. Res. Interdiscip.*, vol. 17, no. 2, 2017, [Online]. Available: https://www.academia.edu/33146990/Interprofessional_Team_Collaboration_in_Health_Care?email_work_card=title.
- [47] J. S. Olson and G. M. Olson, "Collaboration Technologies and Their Use," pp. 1–17, 2010.
- [48] S. Brody, "Web-based tools for collaborative research," *Libr. Hi Tech News*, vol. 34, no. 8, pp. 8–19, 2017, doi: 10.1108/LHTN-08-2017-0062.
- [49] Z. Yu and Z. Zhang, "Development of online collaboration tools (OCT) for collaborative innovation design," *Int. J. Syst. Innov.*, vol. 6, no. 1, pp. 55–70, 2020.
- [50] S. J. Weaver, S. M. Dy, and M. A. Rosen, "Team-training in healthcare: A narrative synthesis of the literature," *BMJ Qual. Saf.*, vol. 23, no. 5, pp. 359–372, 2014, doi: 10.1136/bmjqs-2013-001848.
- [51] L. Lenert, R. Dunlea, G. Del Fiore, and L. K. Hall, "A Model to Support Shared Decision Making in Electronic Health Records Systems," *Med. Decis. Mak.*, vol. 34, no. 8, pp. 987–995, Nov. 2014, doi: 10.1177/0272989X14550102.
- [52] D. A. Chase *et al.*, "The EHR's roles in collaboration between providers: A qualitative study," *AMIA Annu. Symp. Proc.*, vol. 2014, no. November, pp. 1718–1727, 2014.
- [53] C. B. Noteboom, S. P. Motorny, S. Qureshi, and S. Sarnikar, "Meaningful use of electronic health records for physician collaboration: A patient centered health care perspective," in *Proceedings of the Annual Hawaii International Conference on System Sciences*, 2014, no. January, pp. 656–666, doi: 10.1109/HICSS.2014.87.
- [54] S. Garde, R. Chen, and H. Leslie, "Archetype-Based Knowledge Management for Semantic Interoperability of Electronic Health Records," pp. 1007–1011, 2009, doi: 10.3233/978-1-60750-044-5-1007.
- [55] V. L. Tiase *et al.*, "Patient-generated health data and electronic health record integration: Protocol for a scoping review," *BMJ Open*, vol. 9, no. 12, pp. 1–5, 2019, doi: 10.1136/bmjopen-2019-033073.
- [56] A. Al Mallah, P. Guelpa, S. Marsh, A. Mallah, and V. Rooij, "Integrating genomic-based clinical decision support into electronic health records R eview," vol. 7, pp. 163–170, 2010.
- [57] A. Dogac, "Interoperability in eHealth Systems," no. July, pp. 2026–2027, 2008.
- [58] K. Sartipi and M. H. Yarmand, "Standard-based Data and Service Interoperability in eHealth Systems Standard-based Data and Service Interoperability in eHealth Systems," no. June, 2014, doi: 10.1109/ICSM.2008.4658067.