

Opening the Silo - Breaking Barriers to Health Information Exchange to Improve Healthcare

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Abstract: Health information exchange has the potential to improve healthcare quality and reduce waste. Inhibiting HIE from reaching its full potential is the architecture of HIEs, as well as barriers to laws, consumer privacy, data security, and issues associated with consumer use. The Health Information Technology for Economic and Clinical Health Act and the Officer of the National Coordinator for Health Information Technology stress the importance and necessity of HIE in healthcare practice through governance, incentives, and mandates. This systematic literature review explored the issues related to health information fragmentation and restructuring health information architecture to discourage silos of information and enhance accessibility and HIE. A search was conducted using CINHALL Plus and PubMed academic databases following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. Data from 22 relevant articles were meticulously analyzed using screening criteria that revolved around the research question. Four themes emerged during this process: (1) health information fragmentation, (2) HIE architecture and silos, (3) barriers to HIE, and (4) solutions to enhance HIE. The findings and results implied that HIE has the potential to be an effective ally in health care and is a practice that has majority support from consumers on further improving its use. Additionally, the results provide healthcare leaders and providers an opportunity to explore the growing health information fragmentation issue and further investigate specific methods of action or solutions.

Keywords— health information exchange, information fragmentation, and health information barriers

1. INTRODUCTION

Integrating the electronic health record (EHR) in healthcare practice is key to improving access to medical information within organizations. However, despite the proliferating research that identifies health information exchange (HIE) as an effective tool for reducing costs, improving quality, and improving healthcare outcomes, its current architecture is not optimal for sharing health information outside parent organizations instrumental to achieving those ends, [8]. In the U.S., if an exchange needs to occur between sites with differing HER vendors, the process becomes administratively burdensome, possibly including (but not limited to) request forms, printing the record for fees, and sending via secure fax or U.S. mail [6].

The development of EMR technologies has led to health information silos owned by each parent organization that can create a lack of access to the necessary information to treat a patient and thus poses a danger to patient care [3]. To access data external to the organization, information requests must be made to the organizations with the needed information, which can be a timely process that can negatively impact health outcomes. While much is known about the specific barriers to health information exchange [7], this research aims to go beyond identifying the obstacles and, more specifically, identify and offer solutions to the challenges and health information fragmentation problem.

The research question was two-fold: (1) how do we address the issues related to health information fragmentation,

and (2) how do we restructure health information architecture to break open and discourage silos of information for enhanced accessibility and HIE? The focus is more on ideological processes and less on specific technological systems and specifications.

This study aimed to determine via systematic literature review the necessary actions required to break open the existing silos and the barriers to interoperability of health information exchange to improve healthcare.

Methods

After utilizing keywords to search Google Scholar to narrow down the research topic choice, articles were chosen in line with the research question: (1) how do we address the issues related to health information fragmentation, and (2) how do we restructure health information architecture to break open and discourage silos of information for enhanced accessibility and HIE? A literature search transpired using Cumulative Index to Nursing and Allied Health Literature (CINHALL) Plus and PubMed databases following the Preferred Reporting Items for Systematic Literature Reviews and Meta-Analysis (PRISMA) guidelines [5]. These Method phases included (a) searching for relevant studies, (b) screening for inclusion and exclusion criteria, (c) data extraction based on the screening criteria, (d) synthesis of the data to identify key themes, and (e) reporting and dissemination of the findings [5]. Searching the academic databases utilizing keywords and phrases: health information exchange, information fragmentation, and health information

barriers provided consistent parameters in choosing the best articles to review the topic and answer the research question.

For the inclusion of articles to review, publications had to meet all the following criteria: (a) works that were published between 2018 and 2022, (b) written in English, (c) published peer-reviewed journal articles, (d) full-text articles, and (e) with a focus on health information exchange, and health information fragmentation. The first academic database resulted in 122 articles when the applied filters were in place. The second academic database yielded 47 articles when the applied filters were in place (see Fig. 1). Excluded from this review are any articles that do not meet the inclusion criteria.

2. RESULTS

Two questions were researched: (1) how do we address the issues related to health information fragmentation, and (2) how do we restructure health information architecture to break open and discourage silos of information for enhanced accessibility and HIE? An intense literature search and review transpired using two academic databases: CINHAI Plus and PubMed. We used an established literature search, selection, and data analytics process [5].

A final decision transpired by comparing and finalizing the summary findings from each article (see Fig. 1). Based on the data from 66 studies chosen, 22 were found to be relevant to the research questions. Table 1 lists the title of the articles and key summation findings from these 22 articles.

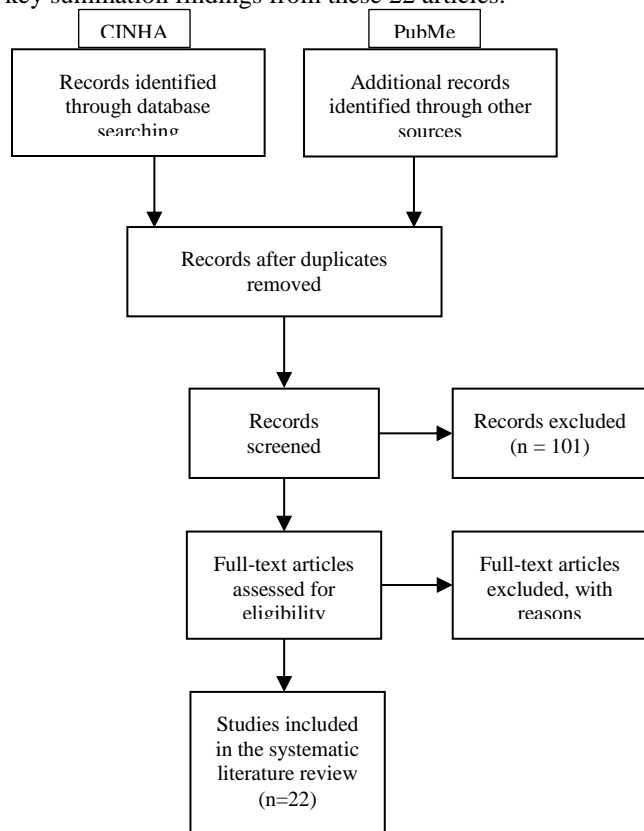


Fig. 1. PRISMA Flow Diagram [4].

Table 1: Summarized findings of the literature

Title	Findings
Designing Payment Contracts for Healthcare Services to Induce Information Sharing: The Adoption and the Value of Health Information Exchanges (HIEs) [1]	As payment models evolve, it is necessary to review and assess the value of HIE and the government incentives provided to encourage HIE adoption.
Comparison of Consumers' Perspectives on Different Health Information Exchange (HIE) Mechanisms: An Experimental Study [2]	Patient-controlled HIE models are most favorable amongst that set of stakeholders. Continued public engagement is necessary to ensure patients are aware of multiple information exchange mechanisms.
Benefits and Concerns Associated with Blockchain-Based Health Information Exchange (HIE): a Qualitative Study from Physicians' Perspectives [3]	There are individual issues, organizational issues, technological issues, and market-related issues that are indicative of blockchain-based HIE being a field that is worthy of additional exploration.
Emerging and Established Trends to Support Secure Health Information Exchange [4]	Limitations of HIE sharing patterns are identified. Information is provided on the technical aspects, as well as mentions of innovative techniques and guidelines for implementation.

<p>Status of Health Information Exchange: A Comparison of Six Countries [5]</p>	<p>The status of HIE is examined among six countries in the contexts of patient scenarios involving referrals and transfers of care. Description, the status of infrastructure, and incentives are also described to aid in comparison.</p>	<p>Ireland, and Australia [10]</p>	<p>HIE is a key principle that should be addressed during care coordination between primary, oncology, and specialty providers and patients. Methods need to be pursued for the continued engagement of stakeholders and buy-in.</p>
<p>Falling Short: How State Laws Can Address Health Information Exchange Barriers and Enablers [6]</p>	<p>Further focus should be given to investigating how laws impede or promote HIE. The current HIE framework and fragmentation are discussed, as well as barriers.</p>	<p>A mixed-method service evaluation of health information exchange in England: technology acceptance and barriers and facilitators to adoption [11]</p>	<p>There are several drivers to adoption, including increased information access, improved care coordination, better-informed decision making, improved patient care, reduced duplication of procedures, and time and cost savings. Barriers include lack of awareness of the solution or value, inadequate training and lack of resources, absence of champions, lack of end-user involvement in the implementation and evaluation of HIE, and concerns with patient privacy.</p>
<p>Health Information Exchange in Emergency Medical Services [7]</p>	<p>Further focus should be given to investigating how laws impede or promote HIE. The current HIE framework and fragmentation are discussed, as well as barriers.</p>	<p>Stakeholders' perspectives and deployment strategies of health information exchange illustrated through an in-depth case study of Pakistan [12]</p>	<p>There are several drivers to adoption, including increased information access, improved care coordination, better-informed decision making, improved patient care, reduced duplication of procedures, and time and cost savings. Barriers include lack of awareness of the solution or value, inadequate training and lack of resources, absence of champions, lack of end-user involvement in the implementation and evaluation of HIE, and concerns with patient privacy.</p>
<p>Interoperable Electronic Health Records and Health Information Exchanges: Systematic Review [8]</p>	<p>Consideration should be given to focusing on HIE involving EMS having prehospital access to preexisting patient records. The necessity for further integration of EMS systems is discussed and highlights the need for additional research.</p>	<p>Mitigating Barriers to Interoperability in Health Care [13]</p>	<p>There are several drivers to adoption, including increased information access, improved care coordination, better-informed decision making, improved patient care, reduced duplication of procedures, and time and cost savings. Barriers include lack of awareness of the solution or value, inadequate training and lack of resources, absence of champions, lack of end-user involvement in the implementation and evaluation of HIE, and concerns with patient privacy.</p>
<p>The Use of Health Information Exchange to Augment Patient Handoff in Long-Term Care: A Systematic Review [9]</p>	<p>Productivity and quality of care had the highest percentages of positive outcomes of implementing interoperable Electronic Health Records (iEHRs). Use and access dimensions require further evaluation.</p>	<p>Legal Barriers to the Growth of Health Information Exchange-Boulders or Pebbles? [14]</p>	<p>Several barriers were identified that are unique to Pakistan, as well as described structure of the current HIE. More support is needed from federal and provincial governments and technical and financial support from international donors.</p>
<p>Building Personalized Cancer Follow-up Care Pathways in the United States: Lessons Learned from Implementation in England, Northern</p>	<p>The largest facilitator and barrier of HIE is workflow integration, organizational structure, missing data, inefficiency, and market conditions. The long-term care industry needs to pivot more strongly toward HIE adoption to keep up with insurers and their updated forms of payment that benefit from reducing waste.</p>	<p>Identifying Opportunities to Strengthen the Public Health Informatics Infrastructure: Exploring Hospitals' Challenges with Data Exchange [15]</p>	<p>U.S. hospitals lack infrastructure for health information integration without manual effort. Barriers are identified, in addition to the need for short and long-term strategies that include enforcing</p>

<p>Use of electronic health records from a statewide health information exchange to support public health surveillance of diabetes and hypertension [16]</p>	<p>policies that prohibit information blocking. There are still legal barriers that persist to HIE; however, many have been alleviated and, in some cases, through a deeper understanding of the laws in question. Lowering the cost of HIE or increasing incentives may boost participation more than reducing legal barriers.</p>	<p>Modernization [21] Vendor of choice and the effectiveness of policies to promote health information exchange [22]</p>	<p>There are multiple barriers to effective communication and HIE in inter-municipal healthcare services. Confounding those barriers are related to lack of EHR usability, inefficient workflow processes, incompatibility of digital systems, and privacy concerns.</p>
<p>COVID-19 highlights the need for laboratory data sharing and interoperability [17]</p>	<p>Hospitals and public health agencies have had barriers to HIE highlighted due to the COVID-19 pandemic. Factors identified to improve exchange include further developing the health informatics workforce, improving data standards, and increasing clarity of policy specifications and reporting.</p>		<p>Providing school nurses with EHR access allows for better care coordination for children. There are barriers and requirements for success, including parental consent, time and technology investments, potent change agents for buy-in, and understanding legal concerns.</p>
<p>Barriers to exchanging healthcare information in inter-municipal healthcare-services: a qualitative case study [18]</p>	<p>Gaps were identified in the use of HIE data for surveillance. Fragmented EHR systems are problematic, but improving HIE data quality through increased use of structured variables can help it become more valuable.</p>		<p>Multisectoral efforts (private, state, federal) are substantial to ensuring those roles are clearly understood for addressing barriers such as data access, connecting existing systems, guidance, incentives, and measures coordination. Several solutions are discussed.</p>
<p>Linking School Nurses with Health Care Systems using EHRs: An Integrative Review [19]</p>			<p>In addition to simultaneous organizational restructuring, core operating clinical and administrative systems are being replaced. Both can successfully achieve careful planning and strategy organized around a singular, unified leadership.</p>
<p>Timely, Granular, and Actionable: Informatics in the Public Health 3.0 Era [20]</p>	<p>The COVID-19 pandemic has highlighted the need for interoperability, especially in the context of laboratory information. A lack of data or access to data leads to fragmentation and slows response to the pandemic.</p>		<p>The likelihood of a hospital exchanging clinical information with other hospitals outside its health system increases if they have the same EHR vendor. Vendor market concentration is an important consideration when attempting to improve HIE.</p>
<p>Military Health System Transformation Implications on Health Information Technology</p>			

The data retrieved from the 22 articles connected to categorizing the frequency of occurrence regarding the causes of health information fragmentation, the issues with health information exchange architecture and silos, the barriers to HIE, and possible solutions for enhancing HIE led to the development of four main themes. Each theme directly

relates to the research question. The following themes included: (1) health information fragmentation, (2) HIE architecture and silos, (3) barriers to HIE, and (4) solutions to enhance HIE.

Table 2: Frequency of occurrence in the literature

Theme	Occurrences	Instances of Attributes (n)	Percentage (%)
Theme 1: Health information fragmentation	1, 2, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 22	13	59%
Theme 2: HIE architecture and silos	1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 14, 15, 17, 18, 20, 21, 22	17	77%
Theme 3: Barriers to HIE	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22	20	87%
Theme 4: Solutions to enhance HIE	1, 2, 4, 6, 8, 10, 11, 12, 13, 14, 17, 19, 20, 21, 22	15	68%

From the research findings, 59% 13 out of 22 of the articles mentioned theme one, health information fragmentation, which included articles 1, 2, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, and 22. From the results, 77% 17 of 22 articles mentioned theme two, HIE architecture and silos, including articles 1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 14, 15, 17, 18, 20, 21, and 22. The findings also show 87%, 20 out of the 22 articles mentioned theme three, barriers to HIE, including articles 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, and 22. Also included in the findings, 68% 15 out of 22 articles mentioned theme four, solutions to enhance HIE, which included articles 1, 2, 4, 6, 8, 10, 11, 12, 13, 14, 17, 19, 20, 21, and 22.

3. DISCUSSION

The development of the electronic health record (EHR) was an innovation that forever changed the landscape of health information exchange (HIE). This systematic review aimed to address the issues related to health information fragmentation and determine possible methods of restructuring health information architecture to break open and discourage silos of information for enhanced accessibility and HIE. Twenty-two peer-reviewed articles published between 2018 and 2022 were considered in the study, which allowed for a current analysis of the issues related to health information fragmentation and ideas for restructuring health information architecture for optimal HIE. The data results shown in Table 2 indicate the main themes that emerged from the literature analysis. The four main themes found within the research included: (1) health information fragmentation (1, 2, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 22), (2) HIE architecture and silos (1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 14, 15, 17, 18, 20, 21, 22), (3) barriers to HIE (2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22), and (4) solutions to enhance HIE (1, 2, 4, 6, 8, 10, 11, 12, 13, 14, 17, 19, 20, 21, 22).

Theme one provided data on health information fragmentation. The discussion of health information fragmentation occurred in 59% of the articles in the literature review (1, 2, 6, 7, 9, 10, 11, 12, 13, 15, 16, 17, 22). The findings indicate that health information fragmentation is a growing concern in healthcare that can become exacerbated by inadequate HIE (as a practice) or HIE systems. In complement to theme one, theme two findings showed that 77% of authors (1, 2, 4, 5, 6, 7, 8, 9, 11, 13, 14, 15, 17, 18, 20, 21, 22) pointed out HIE architecture and silos to be an imminent concern that contributes to health information fragmentation and inadequate HIE.

Theme three generated data on the barriers to HIE (2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22). Common barriers mentioned for effective HIE included: patient privacy (2, 3, 4, 5, 6, 7, 11, 12, 18), confusion surrounding privacy laws (13, 14, 15, 19, 20), and technology vendors limiting HIE with other vendors by design (8, 9, 13, 15, 16, 22). Despite these barriers to HIE, several studies mentioned their survey data of HIE consumer respondents who supported HIE and its benefits in improving health care despite those barriers and concerns (Esmaeilzadeh & Mirzaei, 2018) and (Esmaeilzadeh, 2022). Theme four, solutions to enhance HIE, was present in 68% of the researched articles (1, 2, 4, 6, 8, 10, 11, 12, 13, 14, 17, 19, 20, 21, 22). These authors agree that health care has many benefits in practicing effective HIE. However, they also noted that the current status quo is not as effective as anticipated and will need major restructuring to demonstrate the full capability of HIE.

Despite the above findings, there are several limitations to this study that included: (a) time constraints of the twelve-week data collection and analysis process, (b) the limitation of two academic databases due to the time restraints, (c) the exclusion of other databases which may have had additional

qualifying articles, (d) the exclusion of non-English language articles, and (e) the subjective nature of the reviewers. The literature review involved conducting a preliminary search strategy using Google Scholar first. A secondary process incorporated CINHAL Plus and PubMed for reviewing full-text, peer-reviewed journal articles. Keywords related to the research question guided the database searches, and a few articles may exist for review using different terminology while searching the academic databases.

The limitations mentioned above were minimized by following the PRISMA guidelines and protocol. We triangulated and filtered down the information collected, starting at 167 articles from CINHAL Plus and PubMed, until a data saturation level occurred and no additional information for developing themes existed. Ensuring each article was reviewed and relevant to the research question helped minimize this limitation's effect. Despite the limitations of this study, the evidence supports that HIE has the potential to be an effective ally in health care and is a practice that has majority support from consumers on further improving its use that demands attention.

Future research can utilize this study to determine a multi-factored approach to restructuring HIE information systems to be more conducive to interoperability. The growing concern for health information fragmentation can be a driver toward accelerating these efforts, as fragmentation will only worsen over time if unaddressed. This research can also be a starting point toward further researching the federal laws inhibiting HIE and provide ideas for real incentives and regulations that encourage HIE, such as regulating vendors to design their systems to exchange information between other vendors or systems designs effectively. Healthcare leaders can use these findings to seize on the benefits of HIE, address the common patient privacy concerns, and champion HIE efforts within their organizations. HIE will continue to be a necessary practice in healthcare, so all stakeholders must ensure to use it to its fullest potential.

4. CONCLUSION

HIE is a practice accepted widely by stakeholders but needs much improvement to reach its full potential benefits. This systematic literature review aimed to explore issues related to health information fragmentation and possible methods of restructuring health information architecture to discourage silos for enhanced accessibility and HIE. The study resulted in four themes for addressing health information fragmentation issues, the importance of HIE architecture design, and how HIE architecture can be restructured to discourage and break open silos of information. The main themes included: (1) health information fragmentation, (2) HIE architecture and silos, (3) barriers to HIE, and (4) solutions to enhance HIE. The findings indicated that health information fragmentation is a growing concern that requires additional stakeholders' attention. The results show the need to restructure the current HIE architecture to allow for effective HIE regardless of vendor. Further research can include a

greater focus on barriers to effective HIE, including but not limited to ambiguous laws, issues of privacy, data security, and the need for vendors to promote interoperability with each other. The implications of these findings provide healthcare leaders and providers an opportunity to explore the growing health information fragmentation issue and further investigate specific methods of action or solutions.

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