Findings from the 2022 Yearbook Section on Health Information Exchange

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Summary

Objectives: To summarize the recent literature and research and present a selection of the best papers published in 2021 related to health information exchange (HIE).

Methods: A systematic review of the literature was performed by the two section editors with the help of a medical librarian. We searched bibliographic databases for HIE-related papers using both MeSH headings and keywords in titles and abstracts. A shortlist of candidate 15 best papers was first selected by section editors before being peer-reviewed by independent external reviewers.

Results: Major themes of the set of 15 articles included the issues to be addressed in building and maintaining HIEs, HIE implementation barriers and facilitators, and the outcomes of using HIEs. The outcomes of using HIE encompassed the impact on patient care and the ability of HIEs to provide a repository of data for further research.

Conclusions: The growth of HIE has followed a course very similar to the growth of electronic health records (EHRs). Initial foci of research included technical issues in the deployment, followed by research on barriers to use. Now that EHRs are more widely implemented and used, the newer research involves the use of the electronic data contained in them. Although HIEs are currently at an earlier stage of maturity and development than EHRs and most of the articles in this review focused on implementation barriers, we have seen the beginning of research on the large amount of longitudinal and diverse data that HIEs can make available. As the implementation and use of HIEs continue to increase and become more widely deployed, we can expect that research about HIE and leveraging HIEs and the data they collect, will continue to increase.

1 Introduction

As electronic health records (EHRs) have become more ubiquitous and more routinely used, many of the research issues and issues of health information management (HIM) related to EHRs have evolved. When EHRs were initially developed, adopted, deployed and used in healthcare, topics of change management related to moving from paper-based charting to EHRs, EHR adoption, barriers and facilitators of the use of EHRs, best practices for EHR implementation, and healthcare provider receptivity to use of EHRs dominated early research studies [1-7]. More recently, now that healthcare data are routinely captured in electronic form, there has been an increase in studies related to mining the data in EHRs for use in research and quality improvement, studies of descriptive and predictive data analytic methods to analyze and use the data, and more interest in, and public policy actions requiring, information exchange among healthcare organizations [8-10]. Health information exchange as a verb (the process of accessing and sharing a patient's clinical and health information electronically) and as a noun (the organization that is responsible for the oversight of the exchange of information and that provides technology and services to share data) have grown over time. Health information exchanges (HIEs) can be community, regional, local, public, or private entities. HIEs can be government-run, for-profit and non-profit. As this synopsis shows, the research is increasing on implementation issues, best practices, barriers and facilitators, stakeholder perceptions and attitudes, and even how HIE can facilitate the delivery of care, population and public health, and quality improvement. Because HIE is a growing area of interest, this synopsis focuses on HIE and addresses topics relevant to many diverse stakeholders engaged in HIM and HIE.

The survey paper by Sarkar explores key HIE-related themes using a unique methodology that focuses on utilizing MeSH headings to identify key topics [11]. Although we used a somewhat different method for this synopsis of best papers to review the 2021 research related to HIM and HIE, there is some overlap of themes as well as differences so that this synopsis and the survey paper provide complementary assessments of the recent HIE literature.

2 Methods

In January 2022, with the assistance of a medical librarian, the co-editors conducted a search of both PubMed and Embase using both MeSH headings and keywords in the titles and abstracts with a focus on HIE. The publication year was 2021. The search strategy was as follows. A search of PubMed was done first using the following search terms: ("Health Information Exchange"[Mesh] OR Health-Information-Exchange* [tiab] OR Medical-Information-Exchange* [tiab] OR "Health Information Management"[Mesh] OR "Health Information Management" [tiab] OR Health Information Management Journal[Journal] OR J AHIMA[Journal]) AND 2021[dp]".

For Embase, the following search strategy was used: ('medical information system'/exp/mj OR 'clinical information system':ti,ab OR

'clinical pharmacy information systems':ti,ab OR 'health information exchange':ti,ab OR 'health information management':ti,ab OR 'health information manager':ti,ab OR 'health information network':ti,ab OR 'health information system':ti,ab OR 'health information systems':ti,ab OR 'is-h med':ti,ab OR 'medical information service':ti,ab OR 'health information management journal') AND ('article'/it OR 'article in press'/it OR 'review'/it) AND [2021-2021]/py. There were 748 articles after eliminating duplicates and articles without abstracts.

The 748 unique articles were rated by both section editors, who excluded articles that were opinion pieces, editorials, reviews, or not relevant to HIE. Each of the two section editors independently judged the relevance and the quality of the articles. Articles that either co-editor rated as not appropriate were excluded automatically. The rest of the articles were discussed, and disagreements adjudicated to arrive at 15 articles that, based primarily on the abstracts, were judged to be of good quality. The full texts of these 15 articles were then rated independently by both section editors, two of the Yearbook editors, and several external peer reviewers.

The three 'Best Papers' (Table 1) were selected based on factors that included having a high average rating from the reviewers including recommendations for inclusion as one of the best papers, diversity of research approaches or focal area, geographic diversity, and setting diversity. Below we discuss the major themes of the 15 research papers from 2021 that were candidates for being selected as a 'Best Paper for 2021'.

3 Results

Although the 15 articles were all published in 2021, they address themes that reflect the different stages of HIE development. The first theme involves research on the building, deployment, and maintenance of HIEs. The next theme, with the largest number of studies, involves studies of the barriers to using HIE and the factors influencing its use. This theme is followed by research on the outcomes on patient care of using HIE, and the last theme is research. Looked at

Table 1 Best paper selection of articles for the IMIA Yearbook of Medical Informatics 2022 in the section 'Health Information Exchange'. The articles are listed in alphabetical order of the first author's surname.

Section
Health Information Exchange
■ Nsaghurwe A, Dwivedi V, Ndesanjo W, Bamsi H, Busiga M, Nyella E, Massawe JV, Smith D, Onyejekwe K, Metzger J, Taylor P. One country's journey to interoperability: Tanzania's experience developing and implementing a national health information exchange. BMC Med Inform Decis Mak 2021 Apr 29;21(1):139.
■ Chen J, Amaize A, Barath D. Evaluating Telehealth Adoption and Related Barriers Among Hospitals Located in Rural and Urban Areas. J Rural Health 2021 Sep;37(4):801-11.
■ D'Amore JD, McCrary LK, Denson J, Li C, Vitale CJ, Tokachichu P, Sittig DF, McCoy AB, Wright A. Clinical data sharing improves quality measurement and patient safety. J Am Med Inform Assoc 2021 Jul 14;28(7):1534-42.

another way, these themes are similar to Donabedian's categories of Structure, Process and Outcome [12], which have been used to examine the impact of HIE [13].

3.1 Building and Maintaining Health Information Exchange Organizations

Adler-Milstein and her colleagues have been conducting surveys of state and local health information organizations (HIOs) in the US since 2007. In their 2021 article, they describe the changes over time [9]. These organizations are essentially EHR vendor-neutral and participants include healthcare facilities that utilize a variety of EHR vendors. One of the most interesting changes over time is that there was an increase in new organizations, peaking in 2012 and decreasing in subsequent surveys in 2014 and 2019. However, the percentage of financially viable HIOs has shown a steady increase over that time. Another important finding from their most recent survey was that technology challenges, which plagued earlier HIOs, have decreased. Because the researchers specifically excluded vendor-specific networks such as those sponsored by EHR vendors, they do not have data on their growth. However, respondents to the survey indicated that these vendor-sponsored networks were perceived as their greatest threat.

While Adler-Milstein *et al.*, provided a broad view of the history of over 150 HIOs in the US over a long period of time, Nsaghur-

we *et al.*, provide a detailed picture of the steps needed to create a viable nationwide HIE [14]. This study is one of the Best Papers for this section, because although this is described for a single country, i.e. Tanzania, it has applicability to many others considering such development. The five steps identified by the authors are described in detail in the Appendix. The steps require addressing both governance and technical issues, as well as training. One of the key elements is achieving agreement on the standards and codes adopted to assure interoperability. The importance of agreeing on coding standards has been a key technical problem inhibiting HIE, which was also addressed in an article by Shanbehzadeh and colleagues in the context of developing public health surveillance systems in Iran [15]. The structural elements are important to consider as systems are initially designed, but once they are built, process elements related to facilitators and barriers to use become important to consider.

3.2 Facilitators and Barriers to HIE

Several articles examined factors influencing the use of HIE, sometimes in the context of examining barriers as well. Chuang and colleagues utilized a questionnaire based on the Technology Continuance Theory which included questions related to 'confirmation, perceived usefulness, perceived ease of use, attitude, satisfaction and continuance intention' to investigate continued usage of a cloud-based medication repository in Taiwan [16]. They found that satisfaction and attitude were

the only dimensions that predicted continued use. Park *et al.*, looked at structural factors in hospitals that had varying rates of HIE usage in Korea [17]. They found that the extent of HIE use was related to the number of nurses and the nurse-to-bed ratio.

The articles studying barriers to HIE use collectively examined a variety of settings and countries, although each article had a particular focus. The exchange settings included hospital-hospital, ambulatory-hospital, hospital-public health agencies, and HIE in the context of telehealth in rural and urban settings. Many of the studies that focused on barriers also found that respondents reported positive aspects of HIE that included the quality of the information, the appreciation of access to the information, and the impact having this information had on clinical care [18-20]. However, despite appreciating the value of the information received, there were still barriers that made HIE difficult.

Dixon *et al.,* examined the challenges in exchange of information between the US Veterans' Affairs (VA) hospitals and community hospitals, where the veterans sometime received care [18]. They interviewed hospital leaders and found that the leaders were supportive of HIE, but that the biggest barriers were human and organizational rather than technical. An interesting finding was that some of the human barriers involved memories of failed attempts at information exchange, reiterating the importance of addressing the governance, training, and other organizational and human issues at the outset of designing systems.

Similar results were found in a study by Watkinson and colleagues in England, although they interviewed users and implementation teams of Cerner's HIE platform in various hospitals across England [19]. While users appreciated the benefits of the increased accessibility of information, they also highlighted organizational issues related to inadequate communication, unclear accountability, and inadequate training and lack of user involvement as barriers.

While some of these same organizational issues, such as training needs and impact on workflow were barriers to HIE in ambulatory settings, studies by Chandrasekaran *et al.*, in the US and Centemero and Rechel in Switzerland found that technical barriers and technical support were more problematic for ambulatory sites [20, 21]. Chandrasekaran *et al.*, found that the training issues were more problematic for clinic-to-clinic exchange while the technical issues were more of a barrier in clinic-hospital exchange [21]. Chen et al., in another of the papers selected as Best Paper, specifically examined the infrastructure to support telehealth in rural and urban settings and found that rural settings did not have the requisite HIE infrastructure [22]. Finally, Walker and colleagues studied the barriers to data exchange between hospitals and public health agencies [23]. They found that technical barriers were a problem, in many cases not because the hospitals lacked technical capability for HIE, but because the local public health agencies were not equipped to receive the reports electronically. Additionally, organizational and environmental factors posed barriers. The authors also found that hospitals with more advanced capabilities reported experiencing more problems with public health data exchange, which they hypothesized was attributable to less technologically advanced hospitals doing less exchange.

The overall picture that these studies present is that technical barriers, while problematic in lower resource settings, such as rural areas, ambulatory settings, and the public health sector, are not the only barriers. Once the technology is more fully developed, organizational, workflow, and training barriers still need to be addressed. These findings highlight the importance of addressing all of the five steps that Nsaghurwe *et al.*, proposed and why the leadership and governance issues that they see as a first step are so important [14]. Many of the barriers identified in these studies are likely reasons for the early failures of HIOs, but as the study by Adler-Milstein and colleagues showed [9], while many HIOs faced challenges early on, the surviving ones are now more financially viable. As HIE becomes more widespread and viable, we are also beginning to see studies that examine the outcomes of HIE.

3.3 Outcomes of Using HIE

The studies we reviewed included studies of the impact of HIE on clinical care and research that focuses on the use of the information available through HIE. Nakayama *et al.*, conducted a randomized controlled trial with low to moderate risk patients 65 years or older [24]. In the intervention group, general practitioners in rural areas were advised by specialists via HIE. In the control group, there was no advice through HIE. Although they did not find differences between groups in mortality and adverse events, within the intervention group, if the general practitioners followed the specialists' advice, there was a statistically significant decrease in both adverse events and mortality. Another study from Taiwan showed that increased use of data in a cloud-based HIE was correlated with decreased stays in the emergency department, although the correlation does not mean the use of the system actually led to the decreased length of stay [25]. Both of these studies, however, illustrate that once barriers are addressed and HIE is more routinely used, it will be possible to get more robust data on the impact of HIE use on health outcomes.

In addition to directly examining the impact of clinicians using HIE to obtain data to make decisions on individual patients, once there is extensive data from multiple sites available, those data can provide a source for research on a variety of conditions. Tortolero and colleagues assembled data from a statewide HIE in Texas to examine factors associated with developing COVID-19 [26]. They focused on tobacco use and found that older patients with a history of smoking increased the fatality rate. D'Amore *et al.*, one of the best papers, examined quality metrics for the 79% of patients treated at more than one hospital. The researchers compared longitudinal data obtained from a Kansas HIE to the metrics that would have been determined, as they usually are, by the individual hospitals, using EHRs [27]. A total of 15% of all quality measure calculations changed ($P < .001$) when including HIE data sources, affecting 19% of patients. Changes in quality measure calculations were observed across measures and organizations.

4 Conclusion

As can be seen from this review, the research on HIE appears to be following a similar trajectory as that for EHRs. While there has been considerable maturing of HIE in the

US, many of the studies from other parts of the world and the US as well, are still focused on studying the barriers and facilitators when deploying the technology. The barriers to adopting, implementing, and using HIE, like those for EHRs, initially may involve technical challenges, but ultimately the people and organizational issues need to be addressed for the systems to be effectively used. Once there is more use of these systems, the impact on outcomes can be studied and the vast amount of data that are now available in electronic form, in individual institutions with EHRs, and across institutions with HIE, can be leveraged for analytics and research.

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