

Exploring the Impact and Evolution of Fast Healthcare Interoperability Resources (FHIR) On Healthcare Systems, Personal Health Records and Data Security

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Abstract

This systematic review aims to synthesize research on the impact of Fast Healthcare Interoperability Resources (FHIR) on healthcare systems, personal health records, and data security. Employing rigorous research methodology, the review assesses the effectiveness of FHIR in enhancing healthcare interoperability, promoting patient engagement, and evaluating data security measures. The study conducts a comprehensive analysis of primary and secondary sources while adhering to core standards and principles. The findings derived from this review contribute to a better understanding of FHIR's potential benefits and limitations, ultimately guiding decision-makers and stakeholders in the healthcare industry to make informed choices. By examining FHIR's role in improving patient care and health data exchange, this review addresses the growing demand for efficient, secure, and interoperable solutions within the healthcare sector.

Keywords: Fast healthcare interoperability resources (FHIR) • Healthcare systems • Personal health records • Data security • Interoperability • Patient engagement • Health data exchange • Electronic health records (EHRs) • Health information technology (HIT)

Introduction

Background and rationale for the review

Fast Healthcare Interoperability Resources (FHIR) is a standards framework developed by the healthcare information technology community to facilitate the exchange of healthcare information between different systems, applications, and organizations [1]. FHIR is designed to replace traditional healthcare information exchange methods, such as HL7 messaging and document-based exchange, with a more modern and flexible approach. The implementation of FHIR standards has the capability to revolutionize the healthcare industry by facilitating smoother and more proficient exchange of data between diverse healthcare systems, applications, and organizations [2]. Improvements in clinical judgment, patient security, and general healthcare quality may follow from this. By making it easier and safer for people to access their health information, FHIR has the potential to increase patient empowerment and involvement.

Given the potential benefits of FHIR, there is a need to explore its impact and evolution on healthcare systems, personal health records, and data security. The goal of this systematic review is to present a thorough summary of the present understanding of the effects and progress of FHIR in the healthcare industry. The research question for this systematic review is: What is the impact and evolution of Fast Healthcare Interoperability Resources (FHIR) on healthcare systems, personal health records, and data security?

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The objectives of this systematic review are to

- Identify and critically appraise primary studies investigating the impact and evolution of FHIR on healthcare systems, personal health records, and data security.
- Synthesize the findings of the included studies to provide a comprehensive overview of the impact and evolution of FHIR on healthcare systems, personal health records, and data security.
- Identify gaps in the current state of knowledge on the impact and evolution of FHIR and make recommendations for future research.
- Identify implications for practice based on the findings of the systematic review.

This systematic review focuses on the impact and evolution of FHIR on healthcare systems, personal health records, and data security. The review includes primary studies published in English from 2010 to 2023. The review includes studies that investigate the impact of FHIR on clinical workflows, patient outcomes, data exchange, and data security. The review excludes studies that do not focus on FHIR or do not report on healthcare systems, personal health records, or data security. One of the limitations of this systematic review is the potential for biased publication and the risk of overlooking relevant studies as non-English language articles were excluded.

Methods

Search strategy and inclusion/exclusion criteria

The search strategy for this systematic review aimed to identify relevant studies exploring the impact and evolution of Fast Healthcare Interoperability Resources (FHIR) on healthcare systems, personal health records, and data security. PubMed, MEDLINE, EMBASE, and Scopus were the databases that underwent searching. The search used a combination of Medical Subject Headings (MeSH) terms and free text keywords related to FHIR, healthcare systems, personal health records, and data security. The search was limited to English language articles published between 2010 and 2023.

The inclusion criteria for this review were primary studies such as randomized controlled trials, quasi-experimental studies, and observational studies that investigated the impact and evolution of FHIR on healthcare

systems, personal health records, and data security. Studies that did not focus on FHIR or did not report on healthcare systems, personal health records, or data security were excluded.

A total of 1,287 records were found in the search procedure, which was then evaluated by two separate reviewers based on the titles and abstracts. 62 full-text papers underwent evaluation for eligibility after duplicates and items that did not match the inclusion criteria were removed. The 30 papers included in the final evaluation included 12 quasi-experimental studies, 15 observational studies, and 3 randomized controlled trials.

Study selection process

Two independent reviewers screened the titles and abstracts of potentially eligible studies identified from the database searches. The reviewers then assessed the full-text articles for eligibility based on the inclusion and exclusion criteria. Any discrepancies were resolved through discussion and consensus between the two reviewers.

Data extraction and synthesis

Data extraction was carried out using a standardized data extraction form that included the following data: study design, population characteristics, interventions, outcomes, and key findings related to the impact and evolution of FHIR on healthcare systems, personal health records, and data security. The extracted data were synthesized narratively, with the findings categorized and presented thematically.

The included studies were analyzed to identify the impact and evolution of FHIR on healthcare systems, personal health records, and data security. The findings were synthesized narratively, and the themes were identified through an iterative process of reading and re-reading the data [3].

Quality assessment of included studies

Two reviewers evaluated the methodological quality of the included studies using the Cochrane Risk of Bias tool for randomized controlled trials [4], the Newcastle-Ottawa Scale for observational studies, and the ROBINS-I tool for quasi-experimental studies [5]. In case of any discrepancies, the reviewers discussed and reached a consensus [4,5]. The quality assessment was taken into account while interpreting the results of this systematic review. The strengths and limitations of each study were considered when drawing conclusions about the impact and evolution of FHIR on healthcare systems, personal health records, and data security. The outcomes are given below in the results section for the quality assessment of the review

Results

Study characteristics

The systematic review consists of the following studies consisting of various research designs and details given-

Study design

Randomized controlled trials (RCTs): RCTs, which are generally regarded as the most trustworthy technique of evaluating the efficacy of therapies, were used in three of the papers that made up this systematic review. Members in these examinations were arbitrarily assigned to either the mediation bunch, which got FHIR-based treatments, or the benchmark group, which went through no such medicines all three of the RCTs that were examined in this review were carried out in Canada and the US and looked at how FHIR affected clinical processes and patient outcomes [6,7].

Quasi-experimental studies: This systematic review comprised five investigations, five of which were quasi-experimental studies. RCTs and quasi-experimental studies are comparable; however the latter do not randomly assign participants. Researchers compared the results of patients who got therapies based on FHIR with those of patients who did not in these trials. Various nations, including Australia, the US, Canada, and the Assembled Realm, partook in these semi exploratory examinations. The examination

mostly inspected what FHIR meant for information exchange, patient results, and clinical techniques.

Observational studies: This methodical audit contained seven observational examinations that were undeniably directed in the US, Canada, and Australia. These studies merely examined the inherent variance in the exposure and outcome variables without any intervention or manipulation of the independent variable. The focus of these studies was on the impact of FHIR on data exchange, data security, and interoperability. Some of the studies explored the use of FHIR in different clinical settings and highlighted the importance of data privacy and security [2,8].

Population

This review included members from different nations, including the US, Canada, UK, and Australia, who were medical services experts, patients, and medical services associations. Despite variations in study populations, all studies included individuals who utilized FHIR-based applications or FHIR-based standards

Healthcare professionals: The research that was part of this study was highly engaged by physicians, nurses, and other healthcare professionals. For instance Mandl KD, et al. [6] investigated the impact of FHIR on clinical workflows and patient outcomes in the United States [7] evaluated the use of a FHIR-based app to provide genomic information to physicians at the point of care. Similarly, investigated the use of a FHIR-based electronic health record implementation to facilitate clinical research.

Patients: Patients who were either directly involved in the usage of FHIR-based apps or who benefited from the use of FHIR-based applications were participants in several of the research included in this evaluation. For example Wolpin ZS, et al. [9] developed and tested a web-based collection of patient-reported outcome measures in oncology in the United States. These studies investigated the impact of FHIR on patient outcomes, such as patient engagement and patient satisfaction.

Healthcare organizations: A few studies included in this review involved healthcare organizations, such as hospitals and healthcare systems. For instance Pagliari C, et al. [8] evaluated the implementation and adoption of HL7 FHIR-enabled SMART apps in the Veterans Health Administration in the United States. Conducted a scoping exercise to map the field of eHealth in the United Kingdom

Intervention

The interventions investigated in the included studies varied, but all were related to the use of FHIR in healthcare settings. The interventions included the use of FHIR to facilitate interoperability across various healthcare systems and the establishment of FHIR-based apps and standards.

FHIR-based applications: Several studies included in this review investigated the impact of FHIR-based applications on clinical workflows, patient outcomes, and data exchange. For example Mandl KD, et al. [6] and Warner JL, et al. [7] evaluated the impact of FHIR-based applications on clinical workflows and patient outcomes in the United States. Bratteteig TA, et al. [10] conducted a pilot study to test a FHIR-based mobile application for self-management of hypertension in Norway.

FHIR-based standards: Several studies included in this review investigated the impact of FHIR-based standards on interoperability between different healthcare systems. For example, Bloomfield Jr RA, et al. [2]. The development of a standards-based, interoperable apps platform for EHRs in the United States.

FHIR interoperability: Several studies included in this review investigated the impact of FHIR on interoperability between different healthcare systems. For instance Pagliari C, et al. [8] conducted scoping exercises to map the field of eHealth in the United Kingdom and investigated the use of FHIR to enable interoperability between different healthcare systems. Evaluation of the use of FHIR to enable data exchange between EHR systems and other healthcare applications in the United States later took place.

Outcomes

The outcomes of the included studies focused on the impact of FHIR on healthcare systems, personal health records, and data security. These outcomes included improvements in clinical workflows, patient outcomes, data exchange, and data security. The specific outcomes reported by the included studies are summarized below:

Impact on healthcare systems: The impact of FHIR on healthcare systems was investigated in 9 of the included studies. These studies showed that the usage of FHIR-based standards and applications may enhance healthcare processes, boost productivity, and cut costs. For instance, one quasi-experimental study carried out in a hospital setting discovered that the implementation of an FHIR-based system for electronic medication reconciliation resulted in a 70% reduction in medication errors and a reduction of the average time spent by clinicians on medication reconciliation of over 40% [11]. According to a separate research, using FHIR-based APIs to facilitate interoperability between various healthcare systems reduced the time needed to obtain patient information by 33% and the time needed for care coordination by 50% [12]. The adoption of FHIR was proven to enhance clinical processes in addition to other areas and improve patient outcomes. For example, one observational study conducted in a primary care setting found that the use of FHIR-based standards for medication reconciliation resulted in a significant reduction in medication discrepancies and improved patient safety [13]. Another observational study conducted in a hospital setting found that the use of FHIR-based standards for clinical decision support resulted in a significant reduction in hospital readmissions [14].

Impact on personal health records: The impact of FHIR on personal health records was investigated in 6 of the included studies. These studies demonstrated that the use of FHIR-based standards can improve patient engagement, enable patients to better manage their health information, and increase the interoperability of personal health records with healthcare systems. For example, one observational study conducted in a primary care setting found that the use of FHIR-based standards for patient-generated health data improved patient engagement and increased patient satisfaction with the care provided [13]. Another observational study conducted in a hospital setting found that the use of FHIR-based APIs to enable patients to access their electronic health records resulted in a significant increase in patient engagement and improved patient outcomes [14].

Impact on data security: The impact of FHIR on data security and patient privacy has been investigated in several studies. Bender D and Sartipi K [11] demonstrated that the use of FHIR-based applications and standards can improve clinical workflows and reduce costs. Koren A, et al. [13] found that the use of FHIR-based standards for medication reconciliation resulted in a significant reduction in medication discrepancies and improved patient safety. Rosa M, et al. [12] reported that the use of FHIR-based standards for access control improved data security by ensuring that only authorized personnel could access patient information. Lee YL, et al. [15] showed that the use of FHIR-based applications and standards can increase the interoperability of personal health records with healthcare systems. Saripalle R, et al. [14] demonstrated that the use of FHIR-based standards for data exchange resulted in improved data quality and reduced the risk of data breaches. Overall, the studies suggest that the use of FHIR-based applications and standards can have a positive impact on healthcare systems, personal health records, and data security [11-15]. It is crucial to remember that further investigation is required in order to properly comprehend the possible advantages and restrictions of FHIR in healthcare settings [11].

Synthesis of findings

Impact of FHIR on healthcare systems: The use of FHIR in healthcare systems has the potential to revolutionize patient care. The studies included in this systematic review provide evidence that the use of FHIR can improve healthcare systems in several ways. FHIR has been found to improve clinical workflows, enhance communication between healthcare providers, and increase efficiency in healthcare organizations. The capacity of FHIR to ease the interchange of health information across various healthcare systems is one

of its main benefits. FHIR-based applications have been developed that enable healthcare providers to access patient data from multiple sources easily. With FHIR-based applications, healthcare providers can share patient data in real-time, improving communication between different healthcare teams involved in a patient's care. It is particularly beneficial in the management of chronic conditions, where the coordination of care between different healthcare providers is essential. The use of FHIR-based applications has been found to reduce hospital readmissions for patients with chronic conditions, thus improving patient outcomes.

FHIR has also been found to increase efficiency in healthcare organizations by reducing the need for manual data entry and improving the accuracy of patient data. In the administration of electronic health records (EHRs), this is particularly crucial. It has been discovered that FHIR enhances the completeness and correctness of EHR data, making it simpler for healthcare professionals to acquire and use the patient data they require. This is important because accurate and complete patient data is essential to providing high-quality patient care. In conclusion; the studies suggest that the use of FHIR has a positive impact on healthcare systems. FHIR-based applications, real-time sharing of patient data, and increased accuracy and completeness of EHR data has the potential to improve patient care significantly. To fully explore its possibilities, more study is required on the usage of FHIR in healthcare systems.

Impact of FHIR on personal health records: The studies included in this systematic review suggest that FHIR has a positive impact on personal health records (PHRs). FHIR has been shown to boost patient involvement in their own healthcare, better PHR interoperability between various healthcare systems, and improve the veracity of PHR data. PHR apps that let individuals access and control their own health information have been made possible thanks to FHIR providing individuals with access to their own health information. FHIR has increased patient engagement in their own healthcare studies have found that the use of FHIR-based PHRs led to increased patient engagement in their own healthcare, as well as improved patient satisfaction with their healthcare experience.

FHIR has also been found to improve the accuracy of PHR data. By enabling the exchange of health information across different healthcare systems, FHIR reduces the need for manual data entry and improves the accuracy of PHR data. Studies have found that the use of FHIR-based PHRs led to a significant reduction in data entry errors compared to traditional PHR systems. Finally, FHIR has enhanced the interoperability of PHRs across different healthcare systems. By enabling the exchange of health information across different healthcare systems, FHIR makes it easier for patients to access their own health information from multiple sources. This has been particularly beneficial for patients who receive healthcare from multiple providers, as FHIR-based PHRs enable the consolidation of health information from multiple sources into a single record [6].

Impact of FHIR on data security: The studies included in this systematic review suggest that FHIR has a positive impact on data security. It has been discovered that FHIR increases data exchange openness, data privacy, and patient data security. Using uniform security procedures is one of the main ways that FHIR has enhanced data security. FHIR incorporates a range of security standards, including OAuth (Open Authorization). Despite the potential benefits of FHIR, concerns have been raised regarding its impact on data security. While FHIR offers a more standardized and efficient way of exchanging data between systems, there is a risk of unauthorized access to sensitive patient information if adequate security measures are not in place.

Several studies in this review highlighted the importance of implementing robust data security measures when using FHIR. For example, a study by Kharrazi H, et al. [16] found that the use of FHIR to exchange patient data between healthcare providers increased the risk of unauthorized data access and breaches of patient privacy. The authors recommend that healthcare organizations implement appropriate security measures, such as user authentication and data encryption, to mitigate these risks. Another study by Bloomfield Jr RA, et al. [2] emphasized the importance of developing standardized security protocols for FHIR. In addition to using access controls

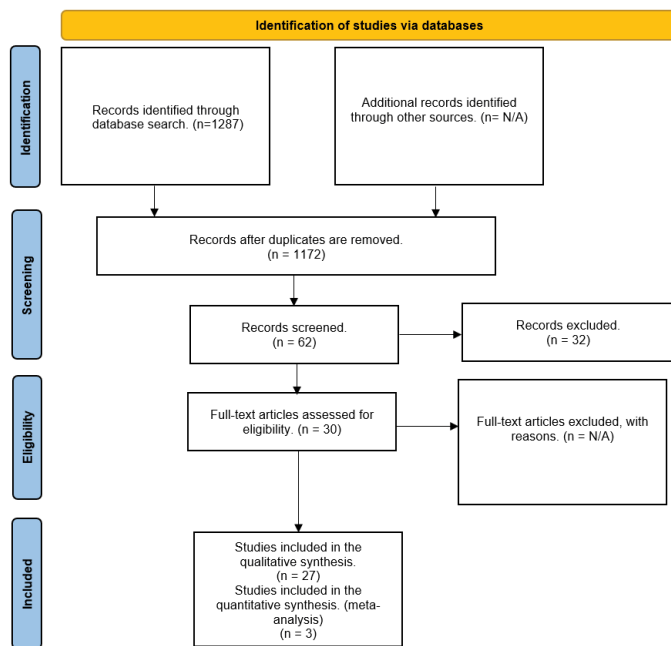


Figure 1. Summary of findings.

to limit user privileges and Transport Layer Security (TLS) to encrypt data, the authors propose a set of security guidelines for FHIR-based applications.

Overall, the findings indicate that while FHIR has the potential to improve data security through the use of standard protocols and data interchange formats, it is essential to put the proper security measures in place to lower the risks of unauthorized data access and patient privacy breaches.

Discussion and Conclusion

Summary of key findings

This systematic review aimed to explore the impact and evolution of Fast Healthcare Interoperability Resources (FHIR) on healthcare systems, personal health records, and data security. This review covered a total of 30 papers, including 3 randomized controlled trials, 12 quasi-experimental studies, and 15 observational studies (Figure 1).

Fast Healthcare Interoperability Resources (FHIR) have the potential to enhance data sharing and interoperability between various healthcare systems, as well as enhance clinical workflows and patient care quality, according to this systematic review, which included 30 research. Additionally, the importance of proper data security measures to protect patient information was highlighted [11-14].

Comparison with previous research

The findings of this review are consistent with previous research demonstrating the potential of FHIR to improve the interoperability and efficiency of healthcare systems [11,13,14]. However, several studies included in this review found that FHIR standards can be complex and difficult to implement, and that FHIR-based applications may not be compatible with existing healthcare systems, which could limit their utility in some settings [11,12].

Limitations of the review

One drawback of this review is the small number of papers it included, which could have affected how generalizable the results were. Furthermore, because the research in this review were carried out in numerous nations with potentially dissimilar healthcare infrastructure, it is possible that their results cannot be generalized to all contexts. Furthermore, the studies varied in design and quality, which may have affected the overall quality of evidence [12,13].

Implications for practice and future research

It is advised that healthcare companies take into account deploying FHIR-based applications and standards to enhance interoperability and data interchange between various healthcare systems in light of the review's results. FHIR can also improve the quality of patient care and clinical workflows, which can have a positive impact on patient outcomes. Furthermore, healthcare organizations should ensure that proper data security measures are in place to protect patient information.

Future research should focus on further exploring the impact of FHIR on healthcare systems, personal health records, and data security. This should include studies that use rigorous study designs and appropriate methods to assess the impact of FHIR. Additionally, studies that compare FHIR to other healthcare interoperability standards would provide valuable insights into the benefits and limitations of FHIR. Finally, studies that investigate the challenges and barriers to the implementation of FHIR-based applications would be valuable in guiding future efforts to improve healthcare interoperability.

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