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How AI Analytical Models Can Use FHIR (Fast Healthcare Interoperability Resources) Data

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Abstract

In the ever-evolving landscape of healthcare, the integration of artificial intelligence (AI) has emerged as a transformative force. Analytical Models (AMs) is a subset of AI used in this space. AMs are used to provide novel predictive functionality that can help advance the quality and outcomes of healthcare. The goal advanced by the organization behind FHIR, FHIR Fast Healthcare Interoperability Resources (FHIR), is to enable electronic health exchange of electronically processed data between health record systems. In order to build a robust framework through which healthcare providers can exchange such information, FHIR Instant Messaging (IM) was developed as an API for health record systems. The framework used to develop IM is known as the Resource Description Framework Specification Versions. This study delves into the symbiotic relationship between AI analytical models and the Fast Healthcare Interoperability Resources (FHIR) data standard, aiming to unlock new dimensions of interoperability and data-driven decision-making within the healthcare sector. With the healthcare systems continuing to grapple with the challenges of siloed data and inefficiencies in information exchange, it becomes important to have a comprehensive exploration of how AI can bridge these gaps. Leveraging the FHIR standard as a robust foundation, it becomes significant to elucidate the potential of AI in harnessing patient data. They are also facilitating seamless data exchange among healthcare stakeholders while also empowering clinicians with actionable insights.

Keywords

Analytical Models (Ams), AI, FHIR, (Fast Healthcare Interoperability Resources) Data, Healthcare, API, IT, Data, Data Driven Ideas

1. Introduction

The healthcare industry stands at a crossroads where technology and data-driven

innovation have the potential to reshape patient care. Through technology, many institutions are, streamline processes, and improve outcomes. According to research by Saripalle et al. (2019), with the continuous rapid digital transformation, one of the most promising and transformative frontiers is the integration of artificial intelligence (AI) with healthcare data. The research by Semler et al. (2018) states that AI has the power to revolutionize the practice of medicine, making it easier for doctors to detect disease and streamline communication between clinicians and their patients. However, the use of AI is contingent on data availability, quality and integrity. In addition, other research work by Gruendner et al. (2021) claims that the integration of AI with healthcare data has the potential to affect patient care in multiple ways, from alerting providers about elevated risk of conditions. the ideas are also supported by Vorisek et al. (2022), who state that through providing actionable insights for improving treatment outcomes, or alleviating suffering during end-of-life care. There are a number of healthcare organizations that are currently pioneering best practices in this domain. They have proven the role AI can play in analyzing patient data and extracting unique information that can boost healthcare providers' decision-making.

Among the various data standards and frameworks that have emerged to facilitate interoperability and data exchange in healthcare, Fast Healthcare Interoperability Resources (FHIR) has gained prominence as a leading standard Rosenau et al. (2022). Adds that the ideas standard is developed by the American Foundation for Medical Excellence (AmeriCorps), which was established in 1990. The organization aims to advance and promote best practices in healthcare quality and efficiency through a broad range of initiatives, including the creation of FHIR. The specification is a set of standards that provide a common foundation for sharing clinical data within various healthcare domains. FHIR was initially developed as a set of standards for electronic health records (EHRs) and electronic health information exchange (e-HIE). Later on, it has been extended to include patient-level data such as imaging, laboratory values and test results.

Healthcare systems worldwide are grappling with the challenges of disparate and often siloed data repositories. The ability to access data that is stored in disparate institutions is crucial to enable bi-directional communication, for instance when a patient visits different hospitals. Gruendner et al. (2020) maintains that FHIR has emerged as an essential standard that aims to facilitate data exchange among healthcare providers and other stakeholders within the same organization, supporting interoperability. Ayaz et al. (2021) also prove that it is a common foundation upon which multiple healthcare domains can build applications that are able to interoperation. A significant problem is the transparency of information and artificial intelligence algorithms (He et al., 2019). On the same note, these AI models can result in less strain on healthcare professionals slice it exempts them from taking a lot of time and effort to engage in specific tasks that require a lot of labor according to Gulden et al. (2021). FHIR's design

enables systems to share data between different organizations or platforms, which streamlines communication and lowers the cost of information exchange. In order to build a robust framework through which healthcare providers can exchange such information, FHIR IM was developed as an API for health record systems.

2. Materials and Methods

This paper used a literature review as its qualitative approach to get relevant information about the limitations, benefits, and hurdles that arise from using the AI models on FHIR data in the healthcare sector. Through such, this paper can give the readers a proper comprehension of these implications and make them understand how these models have revolutionized healthcare by affecting and influencing FHIR data. Thus this paper will evaluate the various kinds of literature like academic journals, publications, reports, and others associated with using the various AI models in healthcare. Through such, this paper obtains proper knowledge on applying the different models in this sector and how they affect the patients, their health, and healthcare service provisions. Through analyzing the different works of literature, this paper will focus on FHIR data, uncovering the essentiality that such data entails and brings in healthcare regarding the exchange of information in healthcare. To get the appropriate literature for this paper, the author depended on searching the various databases that have academic papers like Scopus and PubMed, and such increased the possibilities of getting more accurate and informative academic papers and journals that the author thus used to build on and make this report and make significant contributions from the discoveries that this paper will make. Also, during the search process, the author used specific keywords to increase the credibility and accuracy of the academic articles and journals obtained. Some of these include healthcare practice, FHIR data, and AI analytics. Such also ensured that the author does not have to conduct a broad reach but instead has a confined search which saves more time and increases the accuracy of the search. The author will also utilize the exclusion and inclusion standards to ascertain compatibility between the focus areas of this paper and the literature that the author obtains and utilizes to generate this paper.

Additionally, this paper will screen the literature by utilizing their abstracts and titles to determine whether or not they are relevant to the areas of focus of this paper. Upon finding the various studies that have a good relevance to this paper, the author will get the rest of their contents to have a detailed analysis and comprehension of the contents while also analyzing the additions they can make in this paper, how reliable they are and also if they are of good or recommended quality. Consequently, the results also showed that ethical issues arise because of the AI models used in the FHIR data according to De et al. (2021). The author will get various information from these sources, including recommendations, limitations, findings, various artificial intelligence models applied, methodology,

and the study's objectives. The author will thus focus on determining the limitations, benefits, obstacles, and theses that are repetitive in these sources and have connections with the FHIR data experiencing the use of the artificial intelligence models. Through such determination, the author can pinpoint the gaps that the field of research and literature possesses and have a good background in the healthcare sector.

Therefore, this paper will scrutinize the data it has obtained to dive deeper into its area of focus by getting to know the outcomes, trends, and patterns related to these areas. The author will thus provide an interpretation of the findings to determine how the artificial intelligence models can affect the healthcare sector and also pinpoint the various issues surrounding using these artificial intelligence models in healthcare. This paper will use the literature review data to construct its discussions and findings so that the readers can better comprehend these AI models and their applicability in the healthcare sector by incorporating them into the FHIR data.

3. Results

3.1. Issues with Using AI Models within FHIR Data

The analysis of the various sources in the literature review revealed that the various healthcare providers using FHIR may have issues with data which in some cases can have inaccurate or incomplete parts, thus making it more complicated to use such data, and such is an issue since complete data is always crucial. De et al. (2021) found that it can be challenging to deploy or train the various artificial intelligence models correctly because of the nature of the FHIR data, as such data portrays itself as primarily having increased dimensions and being heterogeneous. Given its flexibility and ability to be expanded to suit subsequent needs, FHIR is also supported by the academic community (Saripalle et al., 2019).

This paper also found that the healthcare sector may not enjoy the integration of artificial intelligence since it is challenging to integrate and implement the various artificial intelligence models because the various healthcare sectors that are supposed to have a shared connection when using FHIR encounter the interoperability issues which thus hinder such implementation and integration.

3.2. The Advantages of Using Artificial Intelligence Models upon FHIR Data

The literature review of this paper found that the use of these artificial intelligence models effectively pinpoints the FHIR trends, relationships, and patterns which might be invisible or beyond the reach of the people analyzing healthcare. Therefore through such, the healthcare sector benefits since it can detect various diseases at their early stages, provide patients with customized medical interventions, and have higher healthcare service provision. This study by Chua et al. (2021) also found that the healthcare sector can save resources and time by automating heavy and oversized tasks as they utilize various artificial intelligence

models in their practices.

3.3. Artificial Intelligence Models' Restrictions towards FHIR Data

This paper discovered that even though these AI models can create avenues of effectiveness in the healthcare sector, they can also create issues like misunderstanding and exploiting patient data, which is sensitive and requires proper handling and comprehension. According to the work of Namli (2023), such results in the emergence of privacy and data issues in the healthcare sector, and such is an area that is critical since any alteration or misinterpretation of the data can result in worse results that can negatively affect the patients and the operations in the healthcare sector. Another finding was that using these AI models in healthcare FHIR data could make it hard for practitioners to authenticate and comprehend the logic underlying these models' forecasts which was by Pfaff et al. (2019) and Balch et al. (2023).

3.4. Instances of Effective Application of Artificial Intelligence Models to FHIR Data

Through its literature review, this study discovered areas where these AI models have been successfully utilized and implemented in the healthcare sector. Some of these included forecasting the possible negative implications and outcomes or pinpointing people with more exposure to getting particular illnesses by integrating FHIR data to investigate the patients' medical histories.

The FHIR standards from HL7 offer an established framework for digitally transferring medical data (Ehwerhemuepha et al., 2020). This study also found that healthcare professionals and providers can minimize illnesses or the possibility of admitting patients into healthcare facilities by implementing safeguards and aggressively responding to various healthcare issues when using artificial intelligence algorithms.

Also, this study discovered that healthcare professionals and providers could effectively apply these models by instantaneously evaluating the FHIR data to increase operational productivity, restructure the healthcare institutions' processes, and maximize the distribution of resources. These models can also be utilized by the various healthcare facilities to avoid different obstacles and improve patient outcomes because they can continuously adjust their resources according to the movement of patients.

e.g., as showed in above **Figure 1** HL7 FHIR to overcome the interoperability problem by also considering the FAIR data principles. As a first step, rather than starting directly from defining input parameters for an AI model/service, If we define a common health data model and data interface with rich machine-processable metadata for the AI use case in hand from the clinical perspective. In other words, we are trying to model the raw data that is produced within the related workflow (e.g., data representing a prescription given to the patient residing in EHR) as this is the integration you need when you want to use an AI model as a decision support service in clinical practice.

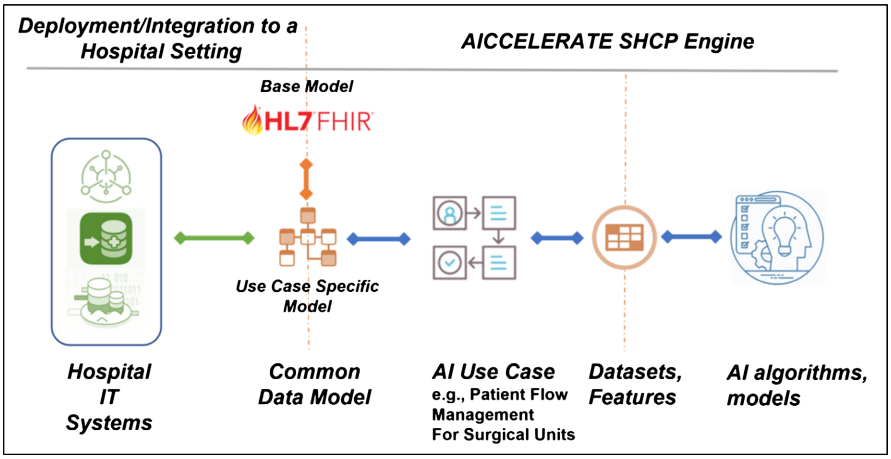

Figure 1. (Namli, 2023) The workings of the AI models into FHIR Data. (https://aiccelerate.eu/health-data-preparation-for-artificial-intelligence-ai/).

4. Discussion

The integration of artificial intelligence (AI) analytical models with Fast Healthcare Interoperability Resources (FHIR) data standards represents a significant stride towards transforming healthcare into a more efficient domain. In the absence of comprehensive information exchange, healthcare providers are faced with a plethora of challenges, including lack of actionable insights. Additionally, the results by Ayaz et al. (2023) indicate that healthcare professionals can provide better patient care to their respective patients using these AI models. According to the findings of He et al. (2019), they increase efficiency in the healthcare sector by minimizing the possibilities of errors. A remedy to this problem has been suggested by FHIR IM, which is a framework used to facilitate data exchange between healthcare providers and other stakeholders within the same organization. The framework provides clinical staff with access to actionable insights and data, which can help them improve the quality of care delivered and reduce the cost of patient visits. The ability of AI to enhance FHIR IM lends credence to the notion that AI will play an important role in systematically streamlining clinical processes through greater interoperation.

5. Enhanced Interoperability and Data Accessibility

This research demonstrates that the integration of AI with FHIR data standards greatly enhances interoperability within healthcare systems. FHIR's standardized data format, coupled with AI's data processing capabilities. AI enables clinical staff to access data that is stored in disparate institutions and draw insights on treatment outcomes. According to Ayaz et al. (2023), such makes such data have varying formats and structures, which thus makes it challenging to generate AI models that can use and deal with this data. Based on the research of Chua et al. (2021).

As showed in the above **Figure 2** Statistical biases associated with artificial intelligence (AI) algorithm predictions. AI-based tools look for patterns of association

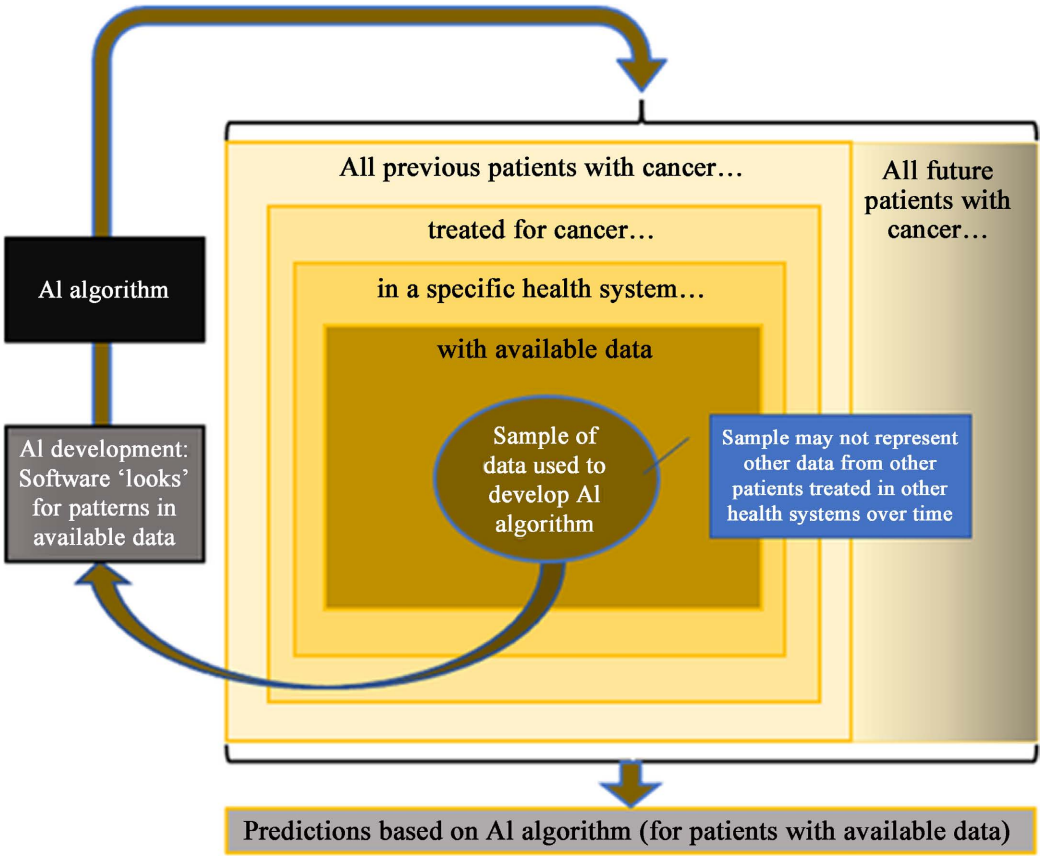

Figure 2. (Chua et al., 2021): AI forecasting based on patients medical records. https://onlinelibrary.wiley.com/doi/10.1002/cam4.3935.

in the data made available to them; they do not establish causation. The sample of data used to develop an AI algorithm may not represent data from other patients treated in other health systems over time. For example, if most of the data used to develop an AI algorithm came from patients < 65 years old treated before 2018, then an AI algorithm may not provide reliable estimates for patients > 65 years old treated after 2020. And also according to Ehwerhemuepha et al. (2020), the results indicate that healthcare facilities that depend on FHIR use various systems that can have interoperability. The most remarkable dimension of FHIR IM is the ability to incorporate additional data standards with FHIR, including Imaging, lab results, and other metadata. This allows healthcare providers to effectively analyze and interpret such information more efficiently. It also supports intra-organizational communication, thereby improving the efficiency of clinical processes. An important challenge with regard to healthcare data is the persistence of silos or disconnected systems. This can pose considerable challenges for clinicians seeking to collect comprehensive patient information at the point of care. facilitates seamless data exchange between healthcare stakeholders.

6. Data-Driven Decision Support

One of the most significant contributions of our study is the application of AI

analytical models for data-driven decision support. The FHIR IM framework is designed to support decision making through the provision of actionable insights based on patient data. AI-driven insights can be used to improve the quality of care as well as the efficiency of clinical processes. For example, during treatment, clinicians can access patient-level data from different EHRs and aggregate them into a unified dashboard or interface. This facilitates seamless access to comprehensive information and enables healthcare providers to draw insights on treatment outcomes. These capabilities empower healthcare professionals to make informed decisions, leading to improved patient outcomes and resource utilization.

Healthcare institutions and professionals should create stringent safety precautions and abide by the laws that safeguard data to ensure that the patient's medical information remains private and confidential. Also, the AI models possess complicated algorithms that they utilize in these FHIR data, which may not be transparent even though these healthcare professionals may depend on them.

Healthcare practitioners and institutions need models that use simpler algorithms or expound on their forecasting. Finally, the results also indicate that there are certain instances where these AI models have been used successfully on the FHIR data in the healthcare setting, and such provides hopes for further implementation of these models in healthcare while expanding its capabilities and functioning for better results.

In the future, researchers should conduct more profound research on the FHIR data quality improvement approaches, like data cleaning. They should also research the creation of dedicated algorithms or artificial intelligence models to manage and deal with the FHIR data's increased dimensionality and heterogeneity. Also, in the future, the researchers need to analyze the possible ways the AI models' effectiveness and performance may be compromised by interoperability in the healthcare sector. Future research should also expand on and analyze how to improve the possibilities of getting explanations from these models on their actions and predictions by creating models that healthcare professionals can interpret.

7. Conclusion

In conclusion, in an era where healthcare is increasingly data-centric and technologically advanced, the integration of artificial intelligence (AI) analytical models with Fast Healthcare Interoperability Resources (FHIR) data standards emerges as a pivotal advancement. The combination of AI and FHIR provides clinicians with access to a wealth of patient-level data, thereby facilitating use-of-case decision support. The prospect of realizing optimized patient outcomes as well as cost reductions is an inevitable outcome, which can play a role in shaping the future of healthcare. This study has explored the profound impact and implications of this convergence, shedding light on the transformative potential it holds for healthcare systems, professionals, and, most importantly, patients. The

integration of AI with FHIR data standards has the capacity to break down the long-standing barriers to interoperability within the healthcare landscape. FHIR IM is a framework that is poised to revolutionize the exchange of patient data among healthcare stakeholders. A significant challenge in today's technologically advanced healthcare industry is the lack of comprehensive information access. As previously outlined, this can create a challenging environment for clinicians attempting to draw actionable insights from data. Artificial intelligence has been identified as an effective strategy for overcoming these issues and enabling healthcare organizations to expedite patient care processes through improved information accessibility.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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