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Application Programming Interfaces (APIs) in Health Care: Findings from a Current-State Assessment

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Abstract. Interest in application programming interfaces (APIs) as a means to increase health data access and exchange among patients, health care providers, and payers has become an important area for development. In an effort to better understand the various contexts in which APIs can be applied, we explored different use cases. While APIs and our collective understanding of the best ways to implement and use them continue to develop, in the coming years the use of proprietary and standards-based APIs could be key to the sustainability of applied clinical informatics research, as well as associated improvements in patient engagement, clinical decision making, efficiency, quality and safety of the healthcare delivery system.

Keywords. APIs, interoperability, standards, FHIR®, EHRs

1. Introduction

Application programming interfaces (APIs) serve as a go-between among data systems—using interoperable processes to exchange data and specific standards to ensure the data can be understood by receiving systems. APIs are well known in the smartphone realm for allowing multiple applications to interact (for example, when a customer review platform seamlessly integrates a map utility to show the location of a restaurant) [1]. APIs are frequently used to facilitate bank transactions and are integral to the way many companies conduct web-based business [2]. In health care, APIs can enable different health information technology (health IT) systems (regardless of vendor, region, health system, etc.) to share data of mutual interest. Moreover, they can allow virtually instant access to data (e.g., right place, right time for health care providers) [3]; and they create an opportunity for third-party developers to build interoperable solutions that supplement or complement the traditional vendor-led health IT offerings [4]. Given the public-sector and industry interest in APIs as a key feature of an interoperable health

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system, this paper elucidates the current state of the field with regard to technical and non-technical considerations associated with *API use for data access and exchange.*

2. Methods

We used an eight-dimension socio-technical model developed by Sittig and Singh to assess key dimensions of health IT [5]. The model gives consideration of technical aspects (e.g., hardware, software, and standards) and non-technical aspects (e.g., clinical workflows, internal policies, procedures, and work environment) involved in the design, development, implementation, use, and evaluation of safe and effective health IT [6]. We employed the following methods to conduct the current-state assessment and mapped key findings to the socio-technical mode dimensions.

Literature Review. Searches of the published literature were conducted in PubMed. Given that much of the innovative work in this area is emergent and has not necessarily been published in scientific journals, the peer-reviewed literature review was complemented by reviews of the grey and white literature. We identified 390 peer-reviewed articles and over 100 resources from the grey literature, the majority of which were then excluded based on a title and abstract review. We conducted full text reviews of 39 peer-reviewed articles and 90 articles and reports identified through a Google search. In total, we included 20 peer-reviewed articles and 41 articles from the grey literature (n=61).

Key Informant Interviews. We recruited 13 key informants who provided additional perspective and helped fill gaps we found in the literature. The informant group consisted of representatives from academic institutions and health care delivery organizations (n=5); EHR vendors with predominant U.S. market share (n=2); and app developers and third-party data sharing platform providers (n=6). We developed an outline of core themes to discuss, and then developed discussion guides that were tailored to the expertise of each type of informant. Key discussion themes included an exploration of current API use cases, the use of read and write capabilities, challenges related to advancing write capabilities, and the characteristics of "open" APIs. We reviewed the notes by theme, synthesizing the responses across interviews, and within informant types.

EHR Vendor App Gallery Review. To determine the types of apps available in the marketplace, we performed an environmental scan of three EHR vendor app galleries [7,8,9] and the SMART® app gallery [10] and identified 271 available applications. As a first step, we categorized the applications based on whether they were primarily provider-facing, patient-facing, or both. We then assigned each application to a category based on 'intended purpose,' which included patient education and engagement, population health analytics, clinical decision support and patient safety, care coordination, administration, and finance.

Technical Expert Panel. The TEP convened in December 2018 to discuss the present and future applications of APIs in health care. The meeting consisted of a review of findings from the literature review and key informant interviews, followed by in-depth discussion of four thematic areas in the field: 1) use cases and standards for APIs; 2) challenges, technical concerns, and facilitators for read and write capabilities; 3) outlook for future development of write capabilities; and 4) current costs associated with API development, implementation, and use.

3. Findings

While the use of APIs in health care delivery and research is increasing at an astonishing pace, broad use of APIs is still in the pilot stage. The promise of APIs liberating data and contributing to value-based care principles is much discussed in the popular press, with more limited representation in the peer-reviewed and grey literature.

3.1. API Use Cases

To explore the use of APIs to facilitate more efficient access to clinical documents and clinical data elements, we focused on the use of APIs in five distinct use cases: 1) to facilitate bidirectional exchange data between an EHR and external sources such as data repositories; 2) to allow external apps/devices to contribute data to an EHR system; 3) to aggregate clinical data from multiple EHRs into a single app; 4) to facilitate clinical decision-making (i.e., write or read/write); and 5) APIs for Bulk Data Access (i.e., read).

Use Case 1: APIs for Bi-Directional Exchange of Data (i.e., Write/Write). Data exchange among health care providers supports care coordination and downstream improvements in patient care and health outcomes. The focus of this use case is data exchange between two entities using an API to write data from an EHR or into an EHR. This exchange can occur between health care providers and/or between data repositories and EHRs, such as public health registries (e.g., state prescription drug monitoring program registry) and other external data warehouses (e.g., for research purposes).

Use Case 2: APIs to Contribute Data to EHRs (i.e., Write or Read/Write). APIs can enable outside entities (e.g., patients, external health care providers, or clinical laboratories) to push data into an EHR, either via an unstructured document that can be stored and viewed (e.g., a PDF) or as structured data that can be written into an EHR's structured database (e.g., via a Fast Healthcare Information Resource [FHIR®] interface or via a Clinical Document Architecture document). Examples of the types of data that a patient may want to write or store in an EHR include patient-generated health data (PGHD) from a wearable device or patient-reported outcomes from a health survey.

Use Case 3: APIs to Aggregate Patient Data (i.e., Read). This use case involves pulling or querying patient data from multiple EHRs to a single point, such as a smart phone application under control of the patient, where the data can be aggregated across the multiple sources, displayed to and used by the data requester. While personal health record (PHR) solutions and EHR "view, download, and transmit" (VDT) capabilities allow patients to access their health information, there are currently limited solutions available that support a consolidated view of a patient's health information across providers and across visits. Specifically, we were interested in market-based solutions using APIs to read data from multiple EHRs to create longitudinal patient records.

Use Case 4: APIs to Facilitate Clinical Decision-Making (i.e., Write or Read/Write). There are three instantiations of this use case. The first represents the emergence of specialty APIs, such as CDS Hooks, that enable an HCO to access information from outside data sources (e.g., servers, data warehouses/repositories) to initiate an app or decision support function within the EHR. TEP participants also described two new provider-facing use cases: business-to-business exchanges between HCOs, and surveillance and predictive modeling apps designed to assist providers with care delivery optimization, population health management and risk calculation. The former represents an example of an app with no user interface and/or apps that either do not use clinical data or do not have direct applications for patient care.

Use Case 5: APIs for Bulk Data Access (i.e., Read). Currently, most APIs are designed to access data for a single patient. However, to be useful for population health and other kinds of research, APIs must also facilitate bulk queries for data from multiple patients. The Da Vinci Project, an effort under way at HL7 with private industry partners, is attempting to use FHIR®-based APIs to address value-based purchasing needs such as population health management, which will necessarily involve bulk queries of multiple patient records [11].

3.2. Use of Read and Write APIs

Currently, read-only APIs predominate, particularly for patient-facing apps. There are comparatively limited examples of write APIs beginning to emerge for low risk, tightly constrained functions like scheduling. Some of these read and/or write APIs leverage the HL7 US Core Implementation Guide profiles and resources developed for the 2015 Edition Common Clinical Data Set. When a FHIR® API is being used to read or write data, mapping is needed between the native EHR database and FHIR®.

3.3. API Standards

Discussions with EHR vendors and TEP members indicate that many of them have made investments in proprietary APIs over many years, supporting both read and write capabilities. FHIR® R1 achieved DSTU status only 5 years ago and is now recognized as an important standard for representing and exchanging EHI. Given the EHR vendors' prior investments in proprietary APIs, and that the standard has multiple versions and is still maturing, FHIR® adoption is not widespread. Only an estimated 32 percent of EHR vendors are supporting the FHIR® version 2 Draft Standard for Trial Use (DSTU2) released in 2015 [12].

3.4. Current Challenges and Technical Concerns

Both the literature and interviews demonstrated the reluctance of health care providers, HCOs, and EHR vendors to allow external data, including PGHD, to be fully integrated (i.e., written) into an EHR. Concerns raised included the volume of data providers would need to review; liability issues if providers overlooked EHI that in retrospect had an arguable potential to improve clinical outcomes; potential for cyber-attacks; potential for information overload from the myriad false positives; and issues around maintenance and display of data provenance. In spite of the associated concerns, some leading HCOs report exploring use cases for write capabilities, in highly constrained environments.

In spite of the technical challenges and associated concerns, HCOs are venturing into API write capabilities and reported during interviews that they see tremendous value in doing so. Some leading HCOs are exploring a range of use cases for write capabilities, but are doing so within secure, highly controlled environments. Specifically, the HCOs are developing apps themselves and making them available to their providers on HCO-issued and -controlled devices, which can be quickly deactivated in case of loss or theft. These HCO apps use proprietary APIs by and large.

4. Discussion of Findings

The use of standards-based APIs to support exchange is still very much in its infancy. A multitude of app marketplaces are becoming available, offering numerous apps. The majority of apps are targeted at providers, with far fewer supporting patient access to data. Where consensus technical standards are being used, they are largely FHIR®-based, which is a positive indication of the market's support for interoperable solutions. The current focus is on read APIs, with very limited use of write APIs. The following sections discuss lessons learned from our work.

4.1. Enhanced Support for Write Implementation

To advance write capabilities, FHIR® implementation guides need to be updated to include write access (currently, it is focused on read access). Some informants argued that, in developing write implementation guides through community stakeholder consensus process, a practical path would involve taking a use case driven approach—starting with less complicated write functions (e.g., scheduling) and gradually moving to more complicated functions (e.g., medication ordering). Informants suggested a number of potential simple use cases that would improve provider clinical decision making and patient contributions to the medical record:

- Posting Documents: Writing simple documents to the EHR from third-party apps that serve as an information filter
- Questionnaires: Writing questionnaire responses back into the HER.
- Defining FHIR® Resources: This would assist in using PGHD and PROs in the calculation of clinical risk scores.
- Innovating the User Interface with Machine Learning and Predictive Analytics: Presenting actionable information at point of care.
- Patient Data Corrections: Developing an app that allows patients to contact their providers and request edits to their record (e.g., medication lists).
- Leveraging specialized APIs: This includes CDS Hooks and other APIs that process data and provide clinical decision support.

When considering the future of write APIs, discussion of the utility of pursuing APIs within a given use case will help establish industry standards for write implementation incrementally and in high value areas.

4.2. Patient-Generated Health Data and Patient-Reported Outcomes

Interest in the incorporation of PGHD and PRO information to inform, enable, and recognize better care has grown, but questions remain as to how these data can be best captured and used. Concerns related to these data encompass not only their accuracy and reliability, but their clinical utility. TEP participants expressed concern about the preparedness of providers and HCOs to manage an influx of raw PGHD/PRO data, and a lack of mechanisms to incorporate these data into their clinical workflows in an efficient and meaningful way. One possibility noted was that apps be developed to filter and summarize raw PGHD/PRO data, before they are transmitted to the provider. For purposes of this assessment, it is important to note that these questions include whether such data should written into the EHR, especially in raw form, or if its potential would be more effectively realized by using alternative approaches to derive clinically meaningful, actionable information from these data and deliver that information in usable forms at helpful points in care delivery processes.

4.3. Development of a Robust Normative Standard for FHIR®

While significant progress has been made in the evolution of the FHIR® standard, multiple FHIR® versions are being pursued by vendors and developers. The lack of a stable normative standard has been highly problematic for interoperability among those currently using different versions of the FHIR® standard. HL7's recent release of a new version of FHIR® as a normative standard will help ameliorate the challenges posed by variability in versioning across the market as new versions are implemented over time.

5. Conclusion

The literature review, key informant interviews, app gallery review, and TEP input provide a significant window into the current API landscape—including a market focus on provider-centric use cases; insight into the rationale behind the emphasis on read instead of write technology; the players involved; and complexities related to standards and security. There are numerous unmet needs with regard to patient-facing apps, including facilitating data access, aggregating data into a patient-controlled health record, and strategies for effective capture and use of PGHD and PROs. Many of the available apps use consensus technical standards, but many others remain proprietary. Where consensus technical standards are being used, they are largely FHIR®-based, which is a positive indication of the market's shift towards developing interoperable solutions. Most of the activity is focused on read APIs, however, with very limited use of write APIs. Thus, while APIs are being touted as a solution to the interoperability challenges within the health system, they remain an emerging technology that is likely to be one piece of a multi-pronged approach to data exchange, integration, and use.

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