Clinical Decision Support Innovation Collaborative

Making Patient Apps Interoperable With the Health IT Ecosystem

This resource for app developers explains considerations for developing patient-facing applications (apps) that are interoperable with clinical health information technology (IT) systems, including electronic health records (EHRs). It describes the ideal state of interoperability between clinical health IT systems and patient-facing apps, the types of data that can be exchanged, and the key data standards for interoperability. It focuses on and provides examples of patient-facing apps that are prescribed, recommended, or monitored by clinicians and approved by health systems for integration with clinical IT systems.

Patient-Facing PC CDS Applications

The commercial patient engagement and patient-centered clinical decision support (PC CDS) app market is expanding rapidly,[1] providing patients access to hundreds of apps to support health and well-being. These apps—which may be associated with Bluetooth®-enabled digital health devices (e.g., "wearables") and/or other digital engagement technologies, like text messaging, interactive voice response, and chatbots—can collect patient-generated health data (PGHD), such as vital signs and patient-reported outcomes (PROs), behaviors, and preferences.

Patient-facing apps have the potential to improve patient-centered care and support PC CDS. However, most apps are not interoperable or have limited interoperability with clinical health IT systems, such as EHR systems. As a result, patient data collected by apps are often not seamlessly integrated into clinical systems and workflows. Rather, data may remain in the app or in a stand-alone online interface, separate from the EHR. This forces clinicians to access multiple systems to review the data, which adds burden and reduces the likelihood that they will use the data in decision making. Further, the data collected by these systems may be excluded as an input for PC CDS, resulting in PC CDS that is potentially less relevant or meaningful for patients.

What is PC CDS?

Patient-centered clinical decision support (PC CDS) encompasses a spectrum of decision making tools that significantly incorporate patient-centered factors related to knowledge, data, delivery, and use. **Knowledge** refers to the use of comparative effectiveness research (CER) or patient-centered outcomes research (PCOR) findings. **Data** focuses on the incorporation of patient-generated health data, patient preferences, social determinants of health, and other patient-specific information. **Delivery** refers to directly engaging patients and/or caregivers across different settings. Finally, **use** focuses on facilitating bi-directional information exchange in support of patient-centered care, including shared decision making.[2]

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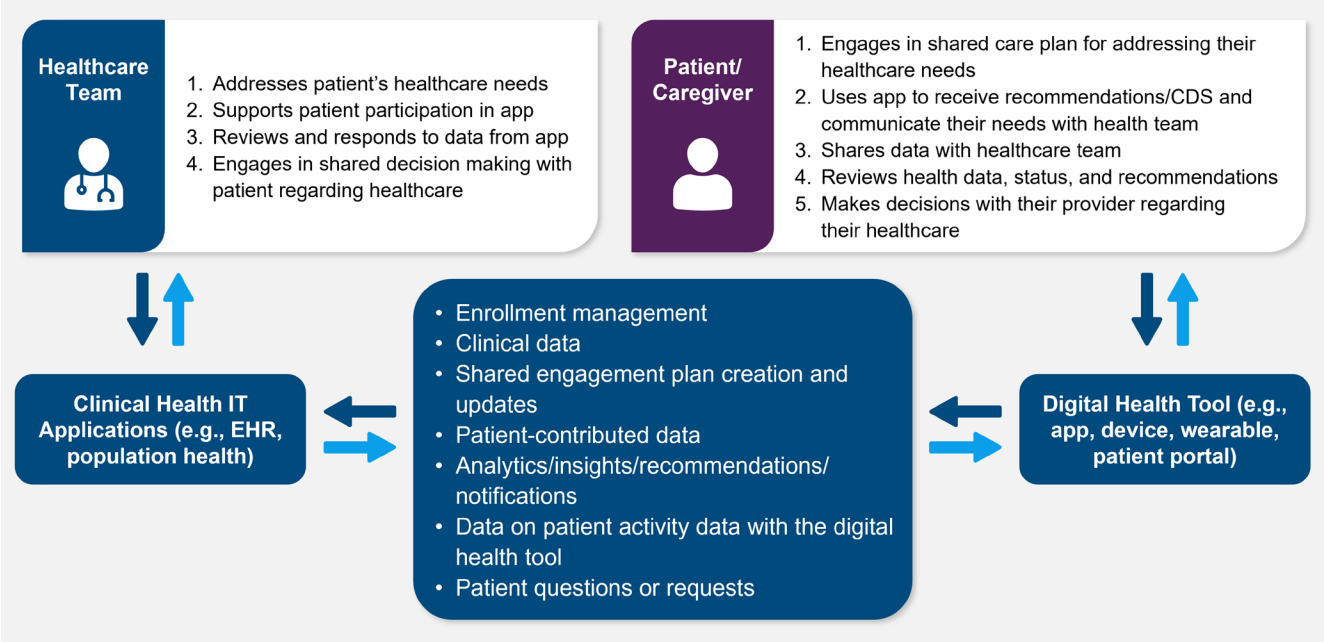
The Integrated PC CDS Ecosystem

Interoperability between patient-facing digital health tools and apps and clinician-facing EHRs is fundamental to realizing the potential of PC CDS. Exhibit 1 depicts the ideal flow of information bidirectionally between the clinician and patient technologies, which can allow both clinicians and patients to review and make decisions based on that information.

Exhibit 1. Integrated PC CDS Ecosystem for Prescribed Patient-Facing Apps



Summary of the Different Actors and Data Flow in the Ecosystem

The diagram above is specific to a clinician electronically prescribing an app to a patient to exchange data and recommendations. It depicts the ecosystem consisting of two broad groups of stakeholders. **Clinical teams** (e.g., doctors, nurses, health educators) interface with clinical systems, such as the EHR or health information exchange systems, to understand and address patient needs, support patient participation in the app, and review and respond to data from the patient. **Patients**, often with support from their caregivers, actively engage with digital health tools, including apps, patient portal interfaces, and wearable devices (e.g., a Bluetooth-enabled blood pressure cuff) to manage their care. Patients can use these tools to record and share data with their clinicians and use the technology to send or receive communications or alerts. Additionally, patients can view their health data to make informed healthcare decisions in collaboration with their clinicians.

Assumptions and Limitations of the Ecosystem

This depiction of the PC CDS ecosystem includes several limitations and assumptions. The diagram highlights key stakeholders and the general flow of information but does not convey the frequency and

volume of data exchanged, which will vary over time. Additionally, the ecosystem makes no assumptions about whether data is stored or written from the EHR to the app or vice versa. Finally, data flows may need to be further developed to support interoperability with other health IT systems, such as Health Information Exchanges (HIEs).

Data Standards

Data representation and exchange standards are critical for achieving interoperability because they allow for consistency in data exchange across health system infrastructures, including EHRs, PC CDS, and health system-sponsored patient apps.[4] Standard data formats are needed to integrate disparate systems, such as apps and EHRs, with unique health system infrastructures in a manner that mitigates data inaccuracy/loss, integration inconsistencies, and the need for custom interface development. Currently, several standards exist to facilitate different aspects of data exchange, as described in the ecosystem diagram.

The following standards are available for different aspects of the engagement workflow:[3]

- **Identify Patients:** Clinical Quality Language, FHIR Plan Definition, FHIR Subscription, CDS Hooks
- **Request Enrollment & Customize Engagement Plan:** FHIR Questionnaire, FHIR Questionnaire Response, FHIR Parameters, SMART on FHIR
- **Enroll & Inform Patient:** FHIR Communication Request
- **View App Data in EHR:** FHIR Create APIs for Observation, FHIR Questionnaire Response, FHIR Task
- **Pull EHR Data into App:** USCDI FHIR APIs
- **View EHR & App Data in EHR-Extender:** SMART on FHIR
- **Integrated PC CDS Analytics:** USCDI FHIR APIs, FHIR Questionnaire, and Observation APIs
- **Notify the Healthcare Team or Patient:** FHIR Communication Request
- **Display Alerts to Healthcare Team:** CDS Hooks

HL7 Fast Healthcare Interoperability Resource (FHIR®):[5] FHIR is a standard for healthcare data. It is designed to ensure that the electronic information exchanged between one system and another (such as from a patient app to an EHR) can be accurately processed by both systems due to a common "language" enabled by the standards. For example, when a clinician uses the EHR to request data from a patient's diabetes management app, the app must be FHIR-compliant and utilize a FHIR Application Program Interface (API) to enable the EHR to process the data accurately.

Standardized Coding Systems: FHIR utilizes standardized coding systems to facilitate data exchange. The coding systems are mentioned in the United States Core Data for Interoperability (USCDI)[6] specification, which continues to evolve based on public comment periods that solicit suggestions for new standards and are required by commercially certified EHRs. These include ICD-10-CM, Logical Observation Identifiers Names and Codes (LOINC®), SNOMED Clinical Terms (SNOMED CT), and RxNorm, among others.

HL7 SMART on FHIR:[7] SMART on FHIR is a framework that allows third-party applications, such as patient-facing apps or CDS tools, to share and access data from EHRs. This system is designed to securely utilize data that has been made compliant with FHIR standards within apps and EHRs.

Specifically, SMART on FHIR provides a means of authentication and authorization for apps to access data inside an EHR. For example, an insulin dosing calculator app would be built within an EHR using SMART on FHIR. Thus, when the clinician opens a patient's chart, the SMART on FHIR app automatically pulls FHIR-compatible data from the EHR and from the diabetes app without requiring the doctor to leave the EHR.

HL7 CDS Hooks:[8] CDS Hooks provides a framework for real-time CDS within EHR workflows. It allows external services to be triggered based on pre-set clinical events (e.g., when a clinician prescribes a medication or when they open a patient's record in the EHR) and returns the relevant recommendation/alert to the clinician. For example, when a clinician opens a patient's chart, they may be advised by a CDS Hook that the patient has a history of smoking tobacco products and has completed lung cancer screening education. A link in the CDS message may then allow the clinician to launch a shared decision-making SMART on FHIR app.

Exhibit 2. Examples of Patient Apps Using Interoperability Standards

Example 1: Patient-Directed App for Data Collection and Management to Support Shared Decision Making in Primary Care *Mobile Patient-Reported Outcomes for Value and Effectiveness (mPROVE)*[9]	**Example 2: Patient-Directed Risk Assessment App for Screening** *MyLungHealth App*[10]
Purpose. The patient-facing mPROVE app collects and tracks PROs data for adults with depression, hypertension, or type 2 diabetes. The data are written to the EHR to facilitate shared decision making regarding the patient's care in an adult primary care practice setting.	**Purpose.** Developed by the University of Utah Health and New York University Langone Health, the MyLungHealth app is a patient-centered intervention delivered via a mobile app that integrates data with EHRs. It is automatically prescribed to patients meeting specified eligibility criteria to improve lung cancer screening rates.
Workflow. The mobile app allows patients to capture and review their PROs between clinical visits after being prompted by a push notification. Primary care clinicians can visualize the PRO data via a dashboard known as BRIDGE. If patients enter values that exceed a clinically significant threshold, the primary care clinician receives an EHR alert.	**Workflow.** Patients complete a pre-visit questionnaire and are invited to review the multimedia educational resources on lung cancer in the app. Providers get a non-interruptive EHR message notifying them that the patient has used the MyLungHealth educational tool. When the patient schedules a primary care visit, they complete a pre-visit questionnaire through the MyLungHealth app. Upon completion of the questionnaire, the patient is automatically invited to use the MyLungHealth educational tool based on the results of the questionnaire.
Standards. The BRIDGE data visualization is an HL7 SMART on FHIR application that launches from within the EHR.	**Standards.** The app uses the HL7 SMART on FHIR standard for EHR interoperability.

Additional Considerations for App Developers

Exhibit 3 summarizes several opportunities for app developers to further advance PC CDS standards to support the interoperability of patient apps with the EHR and other health IT systems. To read more about standards for patient app interoperability with the health IT ecosystem, read the larger CDSiC report, Standards and Regulatory Frameworks Workgroup: Improving Interoperability of Patient Apps with the Health IT Ecosystem.

Exhibit 3. Considerations and Recommendations for App Developers to Advance Interoperability

Consideration	Recommendation
Thoughtfully design clinician notifications to avoid alert fatigue and workflow disruption.	Align alerts with clinical priorities and workflows; use standardized APIs for notification exchange (e.g., CDS Hooks). Where possible, use data visualizations to ensure user-friendliness and accessibility.
App developers must navigate IT and security policies across various healthcare systems, including the variability in EHR systems and standards, as well as data access and security protocols.	Use standards-based APIs; ensure compliance with industry-standard security frameworks to meet industry standards.
Be aware of app vendor-specific data requirements if working with multiple EHR vendors.	Track vendor-specific considerations and use standardized approaches where possible.
Standards are at different levels of maturity and adoption across health systems and EHR products. Both FHIR and USCDI have different versions of standards.	Engage with standards development organizations (SDOs) and EHR developers to understand what is available for use. Engagement could include participating in SDO working groups and committees, attending industry conferences (e.g., HIMSS, AMIA), and contributing to open-source and pilot projects.
There are few APIs that apps can use to communicate with patients and clinicians or to facilitate communication between them to help patients self-manage aspects of their care.[11]	Develop FHIR-based, patient-facing APIs that enable patients' secure communication with their care team.

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ABOUT THE CDSiC

The Clinical Decision Support Innovation Collaborative (CDSiC) aims to advance the design, development, dissemination, implementation, use, measurement, and evaluation of evidence-based, shareable, interoperable, and publicly available patient-centered clinical decision support to improve health outcomes of all patients by creating a proving ground of innovation. This resource for app developers conveys key concepts and standards related to the interoperability of clinician-prescribed/monitored patient apps with the health IT ecosystem.

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