# Optimized clinical decision support (CDS) using FHIR-based CDS Hooks

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Pharmacy Health Information Technology Collaborative

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## 1. PURPOSE

This document explores how using CDS Hooks, a FHIR-based (Fast Healthcare Interoperability Resources) open source specification that connects to authoritative clinical source content, can assist vendors and clinicians optimize clinical decision support (CDS) in real-time. Use case scenarios are presented to illustrate how CDS Hooks may be used in decision making for evidence-based, patient-centered care.

## 2. OVERVIEW

"Clinical decision support (CDS) provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care."[1]

Pharmacists provide evidence-based patient care in all settings, from chronic disease state management in the community setting to life-threatening care managment in critical care units (e.g., COVID-19). Clinical technology platforms, such as electronic health records (EHRs), pharmacy management/information systems, and mobile clinical applications, empower the pharmacist to align patient care with the most recent clinical guidelines. To enhance clinical decision making, more advanced platforms have clinical decision support systems (CDSSs) that enable targeted and customizable CDS. Traditionally, pharmacists rely on their system vendors to create clinical support tools that guide their approach. This approach, however, is self-limiting both for pharmacists and system vendors.

### Types of Clinical Decision Support

There are two types of CDS: passive and active. Passive CDS does not interrupt workflow, but unobtrusively directs the user to the appropriate selection of therapy[2] (e.g., limiting the route of administration of vinca alkaloids to IV piggyback only in order entry). Typically, passive CDS does not require patient-specific data to guide the user toward the appropriate therapy[3], while active CDS is patient-specific and is either interruptive or non-interruptive.[4]

Active interruptive CDS is synchronous; presented to the clinician during workflow. The clinical guidance given can be based on authoritative clinical databases[5] (e.g., drug-therapy alert based on Clinical Pharmacogenetics Implementation Consortium (CPIC) guidelines) or rules-based (e.g., facility-specific guidance on ordering parameters required to prescribe remdesivir for COVID-19 patients). Active non-interruptive CDS is asynchronous; presented to the end user in the form of a worklist or queue[6] (e.g., rules-based antimicrobial stewardship worklist) and may be manifested by the same data sources as active interruptive CDS (e.g., clinical databases and/or customized rules).

**Passive CDS**

This type of CDS directs the user toward the most appropriate practices unobtrusively; examples are order sets and limited selections in drop-down lists or check boxes.

**Active CDS**

**Noninterruptive CDS**

With noninterruptive CDS, new patient information (e.g., lab values, allergy information) is posted to work queue/lists or forms for resolution at a time convenient to the clinician.

**Interruptive CDS**

With interruptive CDS, just-in-time alerts are presented directly to the user, and the user is required to take some action to respond to the alert (e.g., drug interaction and dose checking at order entry). Two kinds of active interruptive message systems are in frequent use.

**Free-form, Rule-based Alerts**

The alerts give all practice settings more flexibility to develop the characteristics of messages without the benefit of predefined data.

**Database-driven Alerts**

These alerts utilize a large database containing drug interaction, dose range and condition, and allergy interaction content.

*(Originally published in "ASHP Guidelines on the Design of Database-Driven Clinical Decision Support: Strategic Directions for Drug Database and Electronic Health Records Vendors" © (2015), American Society of Health-System Pharmacists, Inc. All rights reserved. Reprinted with permission.)*[7]

Optimized CDS enhances quality of care, prevents errors and adverse events, and promotes cost-benefits. Currently, there is no standardized adoption of CDS standards across clinical technology platforms (EHRs, pharmacy management/information systems, clinical modules, clinical technology platforms) and the practice settings they support. The presentation of CDS builds differ from one EHR to the next, and rules are customized to facility-level needs. Inconsistency in updating clinical databases and customized rules can result in outdated (and perhaps irrelevant) clinical decision support information presented to end users. Furthermore, clinical data parameters used to evoke CDS responses differ from platform to platform (e.g., drug description, lab value, and allergy data), making it challenging to recommend gold-standard CDS builds across various platforms without extensive mapping and testing.

## Enter CDS Hooks: Connecting CDS to Workflow

CDS Hooks is a Health Level 7 (HL7) FHIR-based specification that brings authoritative clinical content from outside resources (e.g., blood pressure guidelines from the American Heart Association) into the CDS workflow. CDS Hooks uses interoperability standards to connect to the authoritative source[8] content. The information delivered to a CDSS is formatted in a standardized way with FHIR to exchange health care information electronically. FHIR can be used as a stand-alone data exchange standard or in partnerships with other widely used standards. This standard provides clinical staff with real time, updated CDS tools that run parallel to the workflow while providing patient care.

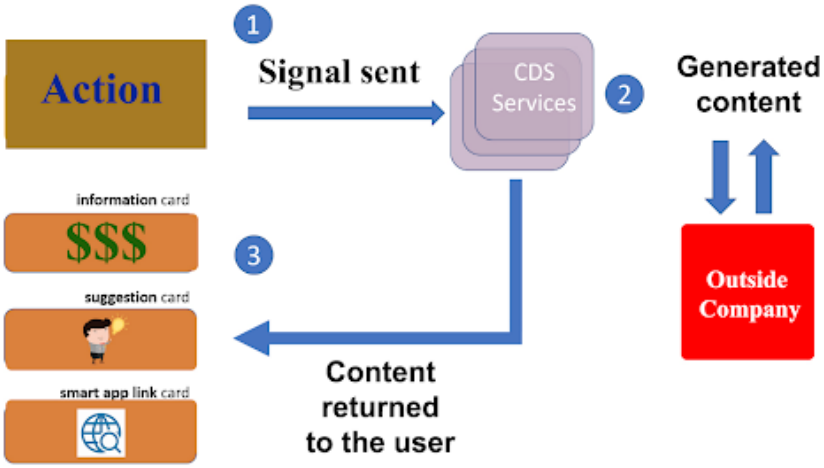
## How CDS Hooks Work?

An activity or action performed by a clinician triggers CDS Hooks and sends a signal to the CDSS within the clinical technology platform.[9] This CDSS pulls content from the authoritative content holder (an outside company that curates clinical information) that is relayed to the clinician who triggered the initial action. For example, a clinician is caring for a patient with type 2 diabetes who is not well controlled with metformin. When action by the clinician about this patient is triggered inside the system, information from nationally recognized diabetes guidelines (e.g., American Diabetes Association) is retrieved by CDS Hooks and presented in the workflow to aid in clinical decision making.

Information retrieved through CDS Hooks is generally provided in an information card, suggestion

card, or app link card.[10] Examples:

- Information card could contain the cost of a medication.
- Suggestion card may provide a recommendation suggesting a particular medication based on current guideline recommendations.
- App link card contains a link to an external application (often a SMART app) that can help in managing a particular disease state.




## 3. DISCUSSION

### How Can CDS Hooks Be Used?

CDS Hooks has a multitude of uses that can be integrated into the CDS workflow for such aspects as: prior authorization, immunizations, pharmacogenomics, chronic disease management, opioid management, and cardiovascular risk assessment in the emergency department. (See Appendix 1 for further examples of how CDS Hooks can be used).

### ePrescribing Workflow: Prior Authorization

Prior authorizations during electronic prescribing (ePrescribing) require significant effort that can impact the amount of time a clinician can spend with their patients. Because of wide adoption of the NCPDP SCRIPT standard for electronic prior authorization (ePA) for drugs, the use of CDS Hooks for ePA in the ePrescribing of drugs is not recommended. The implementation of CDS Hooks has the potential to improve ePA on the medical side if used with HL7's Da Vinci implementation guide and forms[12] (see Appendix 2 for further information about HL7 Da Vinci). This would improve data exchange between payers (e.g., insurers) and EHRs for requesting and approving prior authorizations. Electronic prior authorization service is currently available; however, the underlying technology may not be the most efficient for this service. Therefore, vendors and payers should work together to improve data exchange using CDS Hooks. While a lot of current functionality allows for real-time formulary information (e.g., tier 1, tier 2) to be exchanged, additional clinical information should be included with the exchange of formulary information. Including clinical information can improve the prior authorization process based on clinical appropriateness. Automation using CDS Hooks is key to improving workflow at the point where care decisions are made.

### Immunizations

Immunizations are a great example of how peer reviewed authoritative sources of information can inform clinical decision making using CDS Hooks. Based on the most current patient data collected and entered into a FHIR-enabled system, the pharmacist's system would leverage CDS Hooks[13] to return automated, patient-specific recommendations for immunizations based on nationally recognized guidelines, such as those from the Advisory Committee on Immunization Practices (ACIP).[14] For example, a pharmacist in an ambulatory care clinic meets with a 50-year-old, healthy patient for a consultation. After the patient's clinical information is entered into the EHR, the CDSS could utilize CDS Hooks to pull recommendations from ACIP within the vendor's proprietary CDSS immunization algorithm, suggesting the patient be given a herpes zoster vaccine and an influenza vaccine.

### Pharmacogenomics

Pharmacogenomics (PGx) driven treatment selection is a rapidly emerging technology that is providing more personalized care to patients based on their genetic makeup. CPIC published recommendations based on gene/drug levels (A,B,C,D). Those recommendations provide actionable interventions for changing a patient's medication. As an example, a patient, during a recent inpatient stay, requires appropriate anticoagulation that includes clopidogrel. CPIC recommendations, with sufficient evidence (level A), were cross referenced with the appropriate drug code (RxNorm) to create the appropriate CDS.[15] As the clinician selects clopidogrel in the EHR, this propagates the PGx data via the medication prescribed hook. The hook references the appropriate data source and retrieves the CPIC recommendation.

### Chronic Disease Management

CDS Hooks can be used in the management of numerous chronic disease states. For this discussion, hypertension is the disease state, and the American Heart Association (AHA) is the authoritative source. During a transition of care event, a patient was started on hydrochlorothiazide 12.5 mg for hypertension. When the pharmacist reviews the patient profile prior to filling the prescription, CDS Hooks is triggered for the individual patient by the drug description and diagnosis code. The pharmacist gets a suggestion card that AHA guidelines first-line therapy is an ACE (angiotensin-converting enzyme) inhibitor or ARB (angiotensin receptor blocker). Based on the AHA guideline, the pharmacist makes a therapy recommendation to the patient's primary care provider.

### Opioid Management

CDS Hooks can facilitate safer opioid prescribing. In this scenario, an organization notices that their providers favor a SMART on FHIR[16] application (app) to calculate morphine milligram equivalents (MMEs), but it requires them to open the app on another tab within the EHR. The organization can define the hook context and leverage CDS Hooks to present the MME guidance from the Centers for Disease Control and Prevention (CDC).[17] If the prescriber's EHR does not have an MME calculation algorithm, the use of CDS Hooks helps the prescriber obtain an authoritative reference for calculating MME. CDS Hooks would bring in conversion data from an authoritative source when switching from one opioid to another to ensure the correct dose is given to the patient, thus preventing overdosages/underdosages. If CDC updates MME guidance, CDS Hooks would linked to the updated version.

### Cardiovascular Risk Assessment Using Smart on FHIR not CDS Hooks

Although the following example doesn't utilize CDS Hooks specifically, it is an example of using CDS on FHIR[18] from a data repository that is easily accessible for clinical use.

A specific CDS use-case involving incorporating standardized data from a data repository into an EHR Dashboard to improve chest pain patient care in the emergency department comes from the Indiana University Health Emergency Department. Researchers used the Indiana Network of Patient Care (INPC), the nation's largest interorganizational clinical data repository and the primary platform

that enables the Indiana Health Information Exchange (IHIE), to pull clinical information into the newly-created Chest Pain Dashboard within their existing Cerner EHR.[19] The dashboard works on a custom written FHIR interface with the INPC that pulls selected data resources to external applications in compliance with FHIR standards. Simply put, the dashboard pulls key data from the INPC, using FHIR standards, and displays the data in an easy to view dashboard within the EHR.

In regard to the physician's workflow, the physician simply logs into the EHR, and with one click, opens the dashboard without having to login to a separate interface. The dashboard then communicates with the FHIR-on-INPC Server and searches for five data elements important to managing patients with the chief complaint of chest pain. The data collected are displayed within the dashboard for viewing.

## 4. CONCLUSION

It is imperative that all stakeholders work together to optimize clinical decision support using available resources, including CDS Hooks and FHIR. Clinicians can actively utilize and provide feedback to optimize the use of CDS Hooks. Professional organizations, government entities, and authoritative clinical sources are necessary to ensure that clinical content consists of the most up-to-date recommendations for patient care. With the rapid advances in medical knowledge, technology companies must work with clinicians and authoritative resources to implement usable clinical decision support tools such as CDS Hooks. Electronic health records, pharmacy management systems, and other clinical application vendors should be encouraged to adopt innovative solutions, such as CDS Hooks and FHIR, which can achieve enhanced functionality with focused development effort. Other important CDS considerations that need to be addressed include: alert fatigue, clinician experience, and insertion of CDS tools into clinical workflow. Stakeholders working together can provide high quality and cost effective patient care using the most up-to-date clinical recommendations presented at the point of care.

## 5. GLOSSARY

Authoritative source: A managed repository of valid or trusted data that is recognized by an appropriate set of governance entities.

CDC: Centers for Disease Control and Prevention.

CDS: Clinical decision support.

CDSS: Clinical decision support system. Computer-based programs that analyze data within EHRs to assist health care providers with implementing evidence-based guidelines.

CDS Hooks: An HL7 published specification for clinical decision support.

EHR: Electronic health records.

FHIR: Fast Healthcare Interoperability Resources – a data standard developed by HL7 for health care data exchange with a focus on quick implementation. FHIR is built using a set of modular components called "resources" assembled into systems. FHIR is flexible enough to be used in mobile phone applications (apps), cloud communications, EHR-based data sharing, server communication,

and more.

HL7: Health Level 7 – an ANSI-accredited standards developing organization dedicated to providing a comprehensive framework and related standards for the exchange, integration, sharing and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services.

## 6. RESOURCES

### Cardiology

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### FHIR

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### Immunizations

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### Pharmacogenomics

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### Agency for Healthcare Research and Quality (AHRQ)

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Pharmacy Quality Alliance (PQA)

PQA Medication Therapy Problem Categories Framework. Accessed March 1, 2021. https://www.pqaalliance.org/assets/Measures/PQA_MTP_Categories_Framework.pdf

# 7. APPENDIX

## APPENDIX 1

### Immunization Use Cases Using CDC Immunization Guidelines

FA pharmacy notices that its system prefers a SMART on FHIR app to identify immunization schedules, but it requires them to open the app on another tab within their pharmacy management system. The pharmacy can define the hook context and leverage CDS Hooks to present the CDC immunization schedule.[20] If the pharmacy system does not have an immunization schedule algorithm, the use of CDS Hooks helps the pharmacist obtain an authoritative source for immunization schedules.

*CDC Immunization Guidance Scenario*[21]

> *Action: A Guidance Client issues an evaluate operation to a Guidance Service against the CDC Immunization Decision Support Service Module. The parameters to the module are:*
>
> *Patient – The patient for which immunization guidance will be returned. The birthdate and gender should be provided.*
>
> *Organization ID – The ID of the requesting organization. For the purposes of this connect-a-thon, use the hardcoded value 'FHIR_CONNECT_A_THON'*
>
> *Precondition: The Guidance Service must have the evaluate operation implemented and be able to process requests for the CDC Immunization Decision Support Service Module.*
>
> *Success Criteria: The Guidance Client receives appropriate immunization guidance based on the patient information provided in the request. The service provides guidance using the current CDC Immunization Guidelines. The test script is written with a male infant and receives an appropriate immunization schedule as Immunization Recommendation resources.*
>
> *Bonus Point: Handle error scenarios including:*
>
> > *Unauthorized: Perform the request with an invalid organization ID*
> >
> > *Incomplete: Perform the request without providing birth date or gender. The response will still provide an immunization schedule, but with appropriate warnings about the use of clinical judgement in administering immunizations.*
> >
> > *Malformed: Perform the request with invalid data. The response will be an Operation Outcome with an appropriate description of the error that occurred.*

*Price Check Guidance Request Scenario (CDS-Hooks)*

> *Action: A Guidance Client requests a CMS Price Check from a Guidance Service*
>
> *Precondition: The Guidance Service must have the evaluate operation implemented and be able to process requests for the CMS Price Check Decision Support Service Module*

*Success Criteria: The Guidance Client receives an appropriately filled Guidance Response and the appropriate actions describing the result of the price check as described in the CDS Hooks overview.*

## APPENDIX 2

### HL7 Da Vinci Prior Authorization Support (PAS) Synopsis[22]

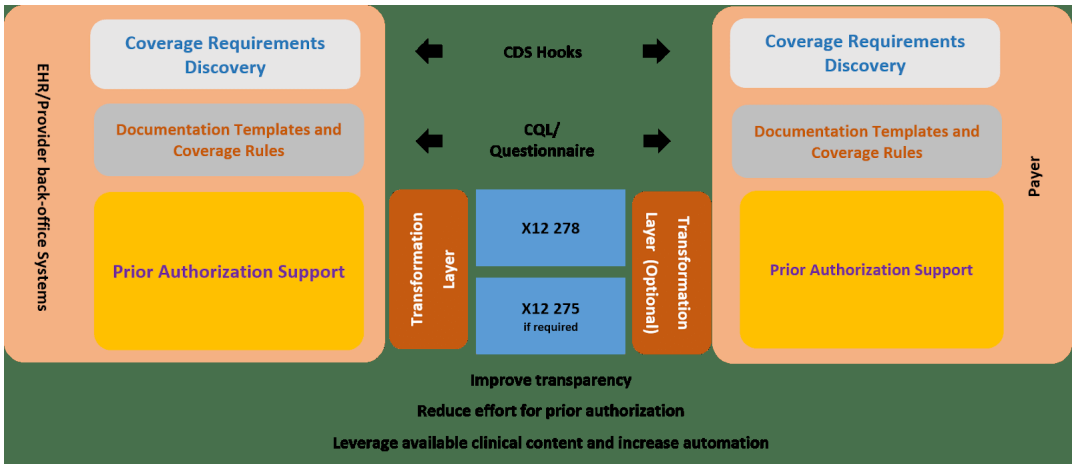
*Prior authorization is an essential process in the management of healthcare costs by payer organizations. However, the process of requesting and receiving prior authorizations can be slow and inefficient. U.S. regulations mandate that X12 be used for communicating prior authorization requests and responses. However, few electronic health record (EHR) systems have implemented this interface. As a result, prior authorizations are often solicited by fax or by using payer-specific portals where clinicians re-key relevant information. Fax submission requires manual transcription on the payer side and may result in significant back-and-forth requesting additional information prior to a decision being made. Re-keying information is inefficient and can result in data entry errors.*

*This implementation guide strives to enable direct submission of prior authorization requests from EHR systems using a standard already widely supported by most EHRs / FHIR. To meet regulatory requirements, these FHIR interfaces will communicate with an intermediary who, when necessary, can convert the FHIR requests to the corresponding X12 instances prior to passing the requests to the payer. Responses are handled by a reverse mechanism (payer to intermediary as X12, then converted to FHIR and passed to the EHR). Direct submission of prior authorization requests from the EHR will reduce costs for both providers and payers and result in faster prior authorization decisions - resulting in improved patient care and experience.*

*When combined with the Da Vinci Coverage requirements Discovery (CRD) and Documentation Templates and Rules (DTR) implementation guides, direct submission of prior authorization requests will further increase efficiency by ensuring that authorizations are always sent when (and only when) necessary and that such requests will almost always contain all relevant information needed to make the authorization decision on initial submission.*

*The implementation guide also defines capabilities around the management of prior authorization requests, including checking the status of a previously submitted request, revising a previously submitted request and cancelling a request.*

*A high-level summary of how all of these IGs will work together can be seen below.*



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3. Ibid., p. 31.

4. Ibid.

5. Ibid., p. 32.

6. Ibid.

7. Ibid., p. 31.

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## 9. ACKNOWLEDGEMENTS

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