

The Office of the National Coordinator for  
Health Information Technology



Public Health – EHR Vendors Collaboration Initiative  
Webinar

EHR Integrated Decision Support

October 17, 2017

Putting the **I** in Health **IT**  
[www.HealthIT.gov](http://www.HealthIT.gov)

<https://www.cdc.gov/ehrmeaningfuluse/public-health-ehr-vendors-collaboration-initiative.html>

**Meaningful Use**

- Meaningful Use
- Introduction
- Calendar
- Connect with Others -
- CDC Meaningful Use ListServ
- Meaningful Use Community -
- Public Health - EHR Vendors Collaboration Initiative**
- Joint Public Health Forum & CDC Nationwide
- Meaningful Use (MU) Public Health (PH) Reporting Requirements Task Force
- Community of Practice (CoP)
- ELR Task Force +
- Jurisdiction Meaningful Use Websites
- S & I Framework
- Reportable Conditions Knowledge Management System
- External Links

**Meaningful Use**

[CDC](#) > [Meaningful Use](#) > [Connect with Others](#) > [Meaningful Use Community](#)

## Public Health - EHR Vendors Collaboration Initiative

[f](#) [t](#) [+](#)

### In Focus

Special Session # 7-Zika Virus Disease Update

*Coming Up! Special Session # 7: Zika Virus Disease Update for Electronic Health Record (EHR) Vendors, Health Information Technology Developers, Public Health, and Clinical Healthcare Partners on Nov 2, 2016 1:00 PM- 2:00 PM EDT*

*Please pre-register for the webinar by clicking the link below:*

<https://attendee.gotowebinar.com/register/3504905897385264131>

Abstract

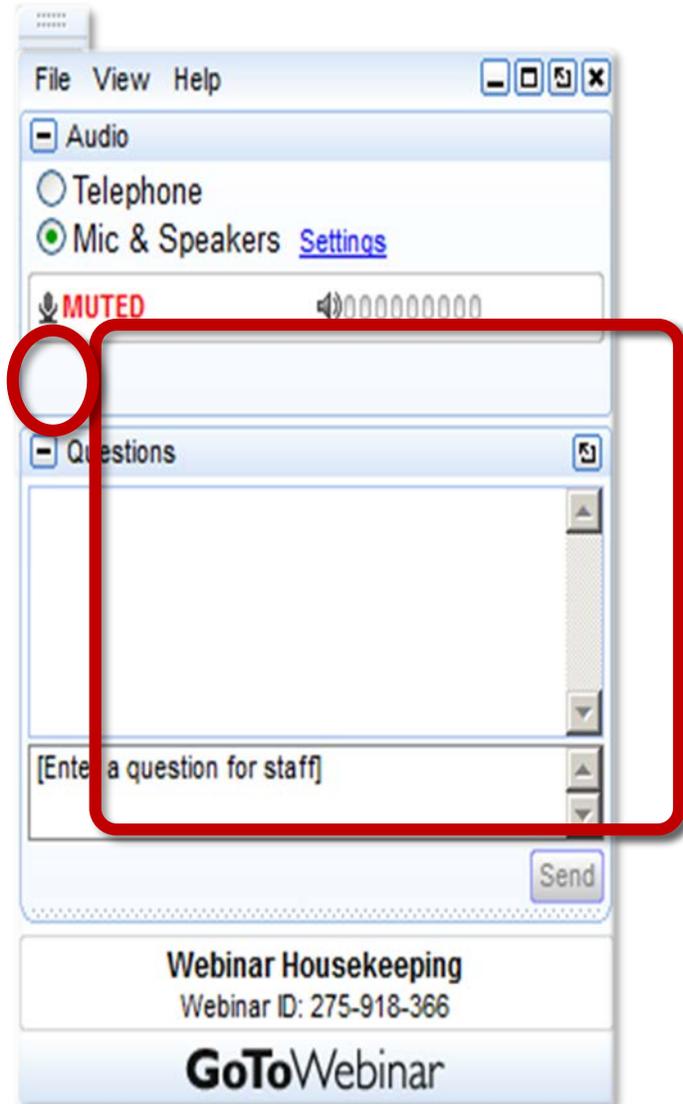
This webinar will be focused on the recommendations around Ask at Order Entry (AOE)\* for pregnancy status in Zika virus (ZIKV) laboratory test orders with the possibility of a broader discussion on the capture of pregnancy status in electronic health records, per the clinical workflow and an update on the algorithm for ZIKV risk assessment in pregnant women, based on the latest Centers for Disease Control and Prevention (CDC) guidelines.

Terms explained-

\* Ask at Order Entry (AOE)-Some tests, such as microbiology cultures and those that determine heavy metal ion concentration, require additional

## Question and Answer Session

How to submit or ask questions for the panel members?



### Submit or Ask Questions

- Submit your text question and comments using the Question Panel
- Please raise your hand to be unmuted for verbal questions.

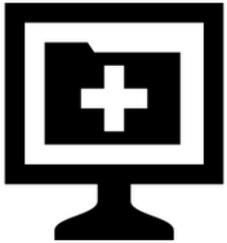
# EHR Integrated Decision Support

Kevin Shekleton and Bryn Rhodes  
Oct 18, 2017

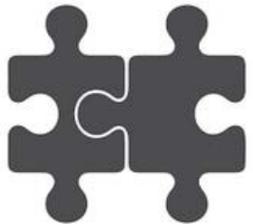
# EHR Integrated Clinical Decision Support



Clinical decision support (CDS) provides the right information, to the right person, at the right time



96% of non-Federal acute care hospitals have a certified EHR in 2015 [ONC Data Brief 35](#)



Decision support should be integrated with the EHR to provide seamless user-experience

# Infobutton



HL7 Standard for [Context Aware Knowledge Retrieval](#) provides a standard mechanism to retrieve context-specific clinical knowledge from online resources



Over 500 vendor products certified against Infobutton EHR requirements ([ONC Certified Product List](#))



Dozens of Infobutton content and service providers ([Open Infobutton HL7 Enabled Knowledge Resources](#))

# SMART Platform



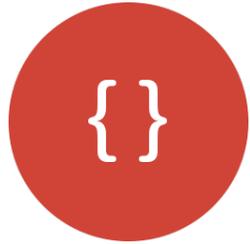
Provides a platform to build healthcare applications



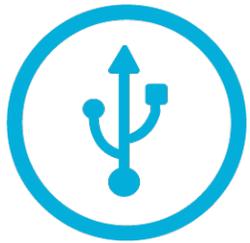
Applications can run against any vendor implementing SMART



Generally web apps  
(though not a requirement)



API specification for RESTful clinical resources



Applications portable against any vendor implementing FHIR services



Any application capable of making HTTPS calls can consume FHIR services

# SMART Platform Benefits



Defines how apps are launched



Authorization (OAuth 2)



Authentication (OpenID Connect)



Context sharing between EHR and app



Discover EHR FHIR service endpoint

# The problem with SMART apps



## Bilirubin Chart

Newborns < 120 hours old

Bilirubin results that are either:

- Not documented

- Outside of the accepted range

The user needs to know the app is **available**

The user needs to know the app is **relevant**

The user has to **find** the app and launch it

CDS HOOKS

# CDS Hooks

*A vendor agnostic remote decision support specification*



Created by the team  
behind SMART



Open source (Apache)

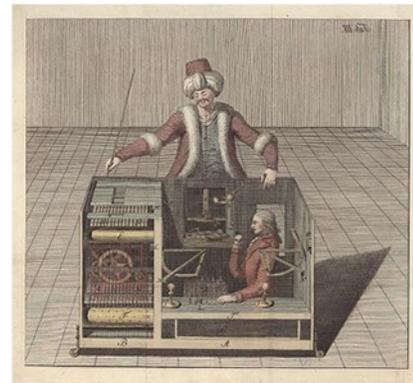
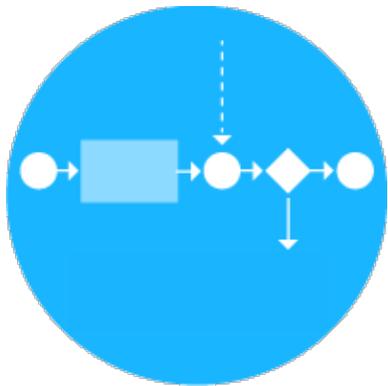


Emerging standard with  
active development and  
widespread participation  
from stakeholders

# CDS Service

A service that is:

invoked by the EHR via a **hook**,  
evaluates **its own logic** using FHIR data,  
returns decision support via **cards**



# Example Hooks

## patient-view

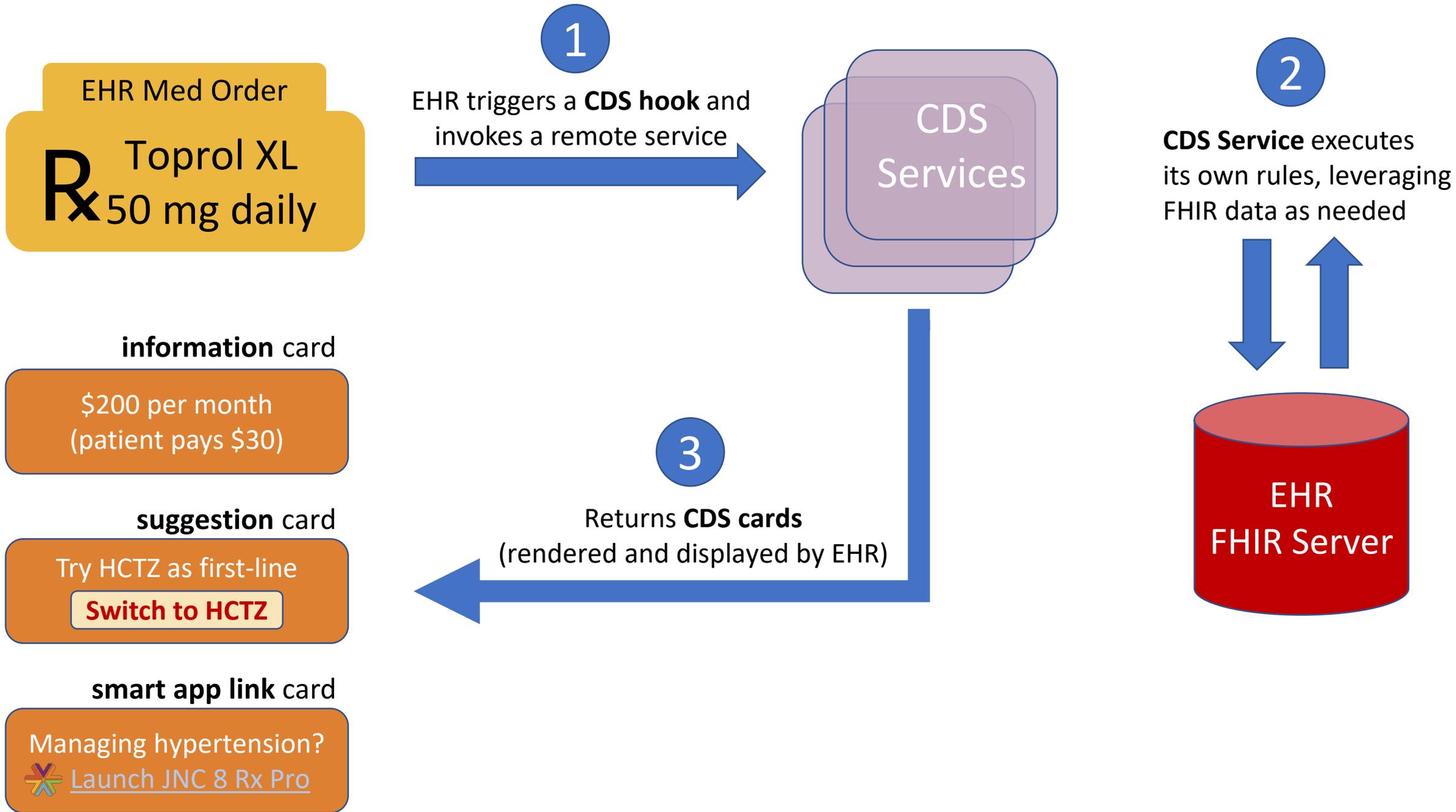
When a patient's chart is opened

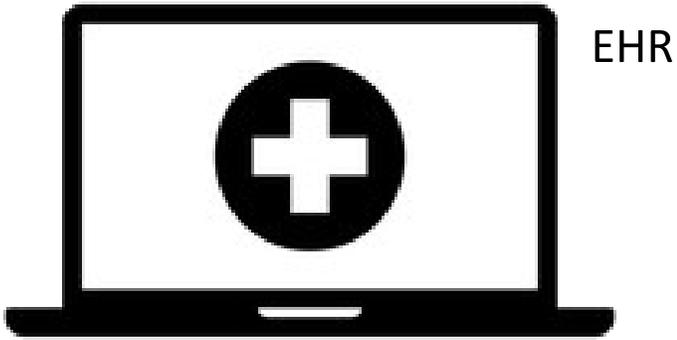
## medication-prescribe

When a medication is selected for prescription

## order-review

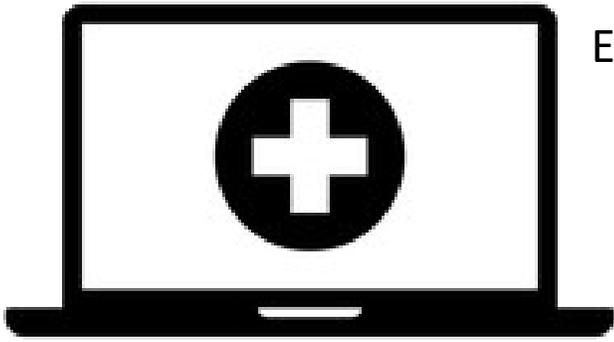
Viewing pending orders for signing





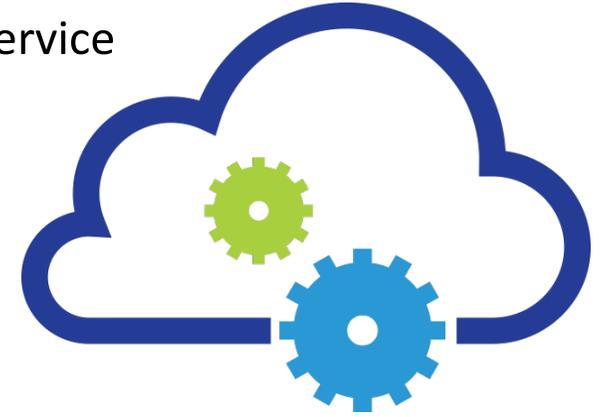
POST <https://example.com/cds-services/example-service>

```
{  
  "hook": "patient-view",  
  "fhirServer": "https://fhir.example.com",  
  "user": "Practitioner/789",  
  "patient": "123",  
  "encounter": "456",  
  ...  
}
```



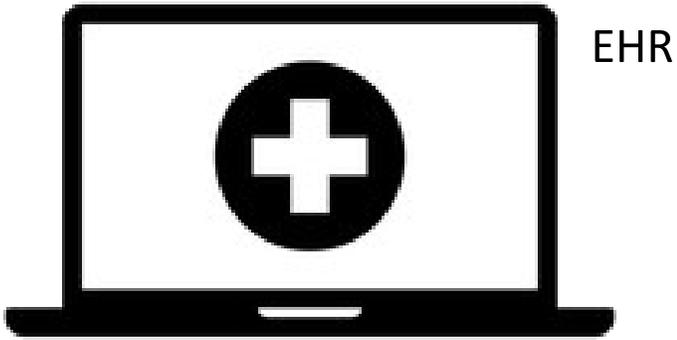
EHR

CDS Service



POST <https://example.com/cds-services/example-service>





POST <https://example.com/cds-services/example-service>

HTTP 1.1/ 200 OK

```
{  
  "cards": [  
    {  
      "summary": "Example card",  
      "indicator": "info",  
      "source": {  
        "name": "Demo CDS Service"  
      }  
    }  
  ]  
}
```

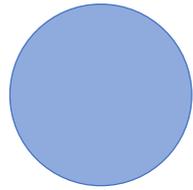
# Cards

- A CDS Service can return any number of cards
- The EHR renders each card as it sees fit
- Each card must have:
  - A concise summary (140 characters)
  - An indicator noting the importance of the card
  - Information on the organization or data set that is the source of the card's data

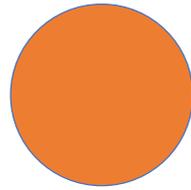
# CDS Service Response JSON

```
{  
  "cards": [  
    {  
      "summary": "Example card",  
      "indicator": "info",  
      "source": {  
        "name": "Demo CDS Service"  
      }  
    }  
  ]  
}
```

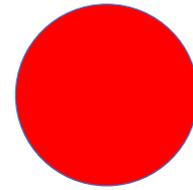
# Card Indicator



Informational



Warning



Hard Stop

# Common Card Examples



## Information Only

Textual information for the provider



## Suggestions

Proposed actions encoded as FHIR resources



## App Links

Proposed SMART app that should be used

### Medication Information

ADRA2A (C/C): The genotype of this patient suggests a reduced response to certain ADHD medications.

Source: [RxCheck](#)

### Medication Alert for lisinopril 5 mg tablet

This medication is not recommended for Black or African American patients.

*82% of providers selected this recommendation.*

[Switch to amloride 5 mg-hydrochlorothiazide 50 mg tablet](#)

Source: [RxCheck](#)

### ASCVD Risk Alert

12% 10-year risk

69% lifetime risk

Source: [Demo CDS Service](#)

[ASCVD Risk Calculator](#)

Cards can contain any combination of information, suggestions, and links

### Medication Alert

Source: RxCheck



#### lisinopril 5 mg tablet

- This medication is not recommended for Black or African American patients.

*82% of providers selected this recommendation.*

[Switch to amiloride 5 mg-hydrochlorothiazide 50 mg tablet](#)

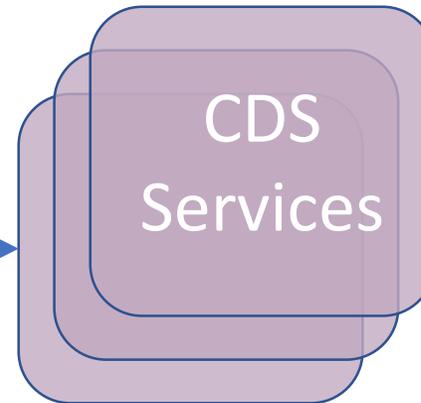
[Medication Review](#)

# Capturing user behavior for analytics

- Since CDS Services return purely JSON, they don't know how users interact with their suggestion
- Each suggestion *may* contain a **UUID**
- The UUID allows the EHR to notify the CDS Service that the user interacted with their suggestion

```
POST {cds-service}/analytics/{uuid}
```

**Base** https://example.com



**Service** /cds-services/{id}

# Discovery

GET `https://example.com/cds-services`

```
{
  "services": [
    {
      "hook": "patient-view",
      "name": "CDS Service Example",
      "description": "An example CDS service",
      "id": "example-service",
      "prefetch": {
        "patientToGreet": "Patient/{{Patient.id}}"
      }
    },
    { ... }
  ]
}
```

# CDS Service Invocation

```
{  
  "services": [  
    {  
      "hook": "patient-view",  
      "name": "CDS Service Example",  
      "description": "An example CDS service",  
      "id": "example-service",  
    }  
  ]  
}
```

POST <https://example.com/cds-services/example-service>

## Patient View

# Daniel X. Adams

ID: SMART-1288992 Birthdate: 1925-12-23

### Now seeing: Daniel Adams

Source: [CDS Service Tutorial](#)

[Learn more about CDS Hooks](#)

### Hello Daniel!

Source: [Patient greeting service](#)

### Bilirubin Chart

Source: [HSPC Bilirubin Risk Chart App](#)

Demonstration app designed to help clinician treat newborn hyperbilirubinemia appropriately.

[HSPC Bilirubin Risk Chart App](#)

### HealthyMe Patient External Clinical Records

Context Toggle

## CDS Service Exchange

Select a Service:

### Request

### Response

```
{
  "cards": [
    {
      "summary": "Hello Daniel!",
      "source": {
        "label": "Patient greeting service"
      },
      "indicator": "info",
      "suggestions": [],
      "links": []
    }
  ],
  "decisions": []
}
```



# 2017 Resolutions



Release a 1.0 specification



Launch production pilots

# Argonauts ♥ CDS Hooks



The EHR invokes a CDS service via a patient-view hook, resulting in a SMART app link card that the clinician uses to launch the SMART app.



Validate and implement the CDS Hooks security model

# What's after 1.0?



Performance: trigger guards, SLAs



Event & time based hooks



Specific use cases

(ACR ordering guidelines, CDC opioid guidelines, etc)

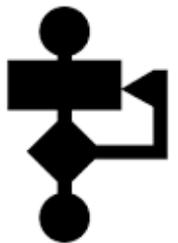
# Clinical Reasoning



Allows decision support content to be shared as FHIR resources



Artifacts that define the structure of content including rules, order sets, protocols, and questionnaires



Libraries that describe the *behavior* using logic in Clinical Quality Language (CQL)

# Opioid Prescribing Support Implementation Guide



Recommendations for primary care clinicians who are prescribing opioids for chronic pain outside of active cancer treatment, palliative care, and end-of-life care ([CDC guideline for prescribing opioids for chronic pain](#))

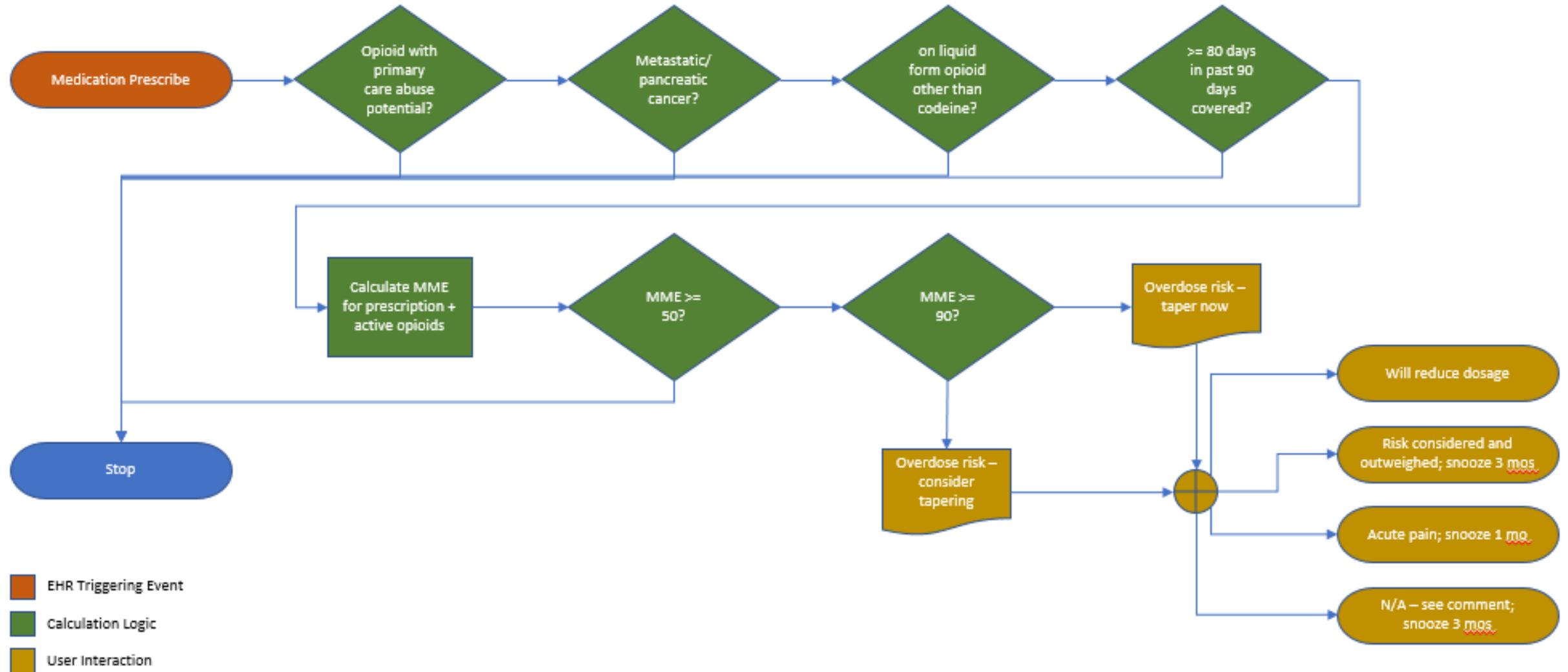


Provides FHIR Clinical Reasoning artifacts to define the workflows and behaviors recommended by the guideline



Describes how to use CDS Hooks to implement the behavior within a supporting EHR

# Opioid Management Example



# References



Specification & documentation

<http://cds-hooks.org>



Demo sandbox

<http://sandbox.cds-hooks.org>



Source code

<https://github.com/cds-hooks>

Thanks!

# Addendum

Sample content from CDS vendors  
developing on CDS Hooks

CDS HOOKS

# Healthwise helps people make better health decisions with CDS Hooks

## Review patient education at the moment in care

### Patient Education

Source: Healthwise

The following patient education resources were found.

### Conditions

**Dementia associated with another disease(2008-08-08)**

**Essential hypertension(2008-04-20)**

**Other persistent mental disorders due to conditions classified elsewhere(2007-09-15)**

- Medical History and Physical Exam for Dementia or Alzheimer's Disease,
- Memory Problems: Wandering,
- Memory Problems: Tips for Helping the Person With Daily Tasks

## Prevent medication interactions at the time of prescription

### Drug Interactions

Source: Healthwise

The following drug interactions were found.

### Interactions

**ACE INHIBITORS; ARBS; ALISKIREN/POTASSIUM PREPARATIONS (moderate)**

lisinopril (bulk) and potassium acetate may interact based on the potential interaction between ACE INHIBITORS; ARBS; ALISKIREN and POTASSIUM PREPARATIONS.

**KEEP VITAMIN K CONTENT OF DIET CONSISTENT. (serious)**

The use of warfarin (bulk) may interact with food in that FOOD HIGH IN VITAMIN K MAY DECREASE EFFECT.

# PerfectChoice™

Helping physicians make the perfect antibiotic choices.

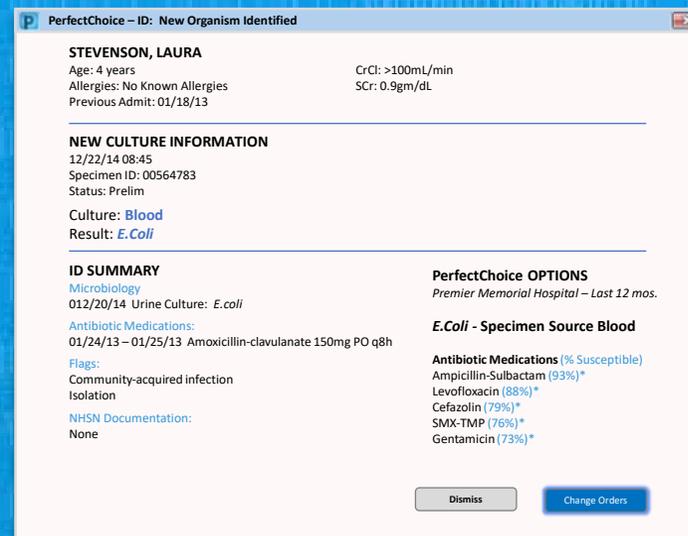
## IDENTIFY.

PerfectChoice Notification: Based on new culture information and facility antibiogram, the following antinfectives have the highest likelihood (% susceptible) of effectively treating the infection.

Source:  
Launch Premier TheraDoc for more details.

Know the priority patients with new microbiology results with automated surveillance that notifies clinicians in their workflow.

## DECIDE.



**PerfectChoice – ID: New Organism Identified**

**STEVENS ON, LAURA**  
Age: 4 years  
Allergies: No Known Allergies  
Previous Admit: 01/18/13  
CrCl: >100mL/min  
SCr: 0.9gm/dL

**NEW CULTURE INFORMATION**  
12/22/14 08:45  
Specimen ID: 00564783  
Status: Prelim  
Culture: Blood  
Result: *E.Coli*

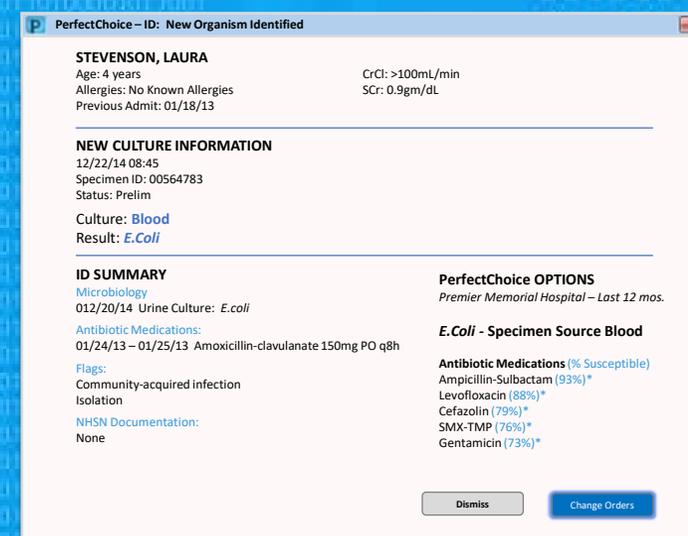
**ID SUMMARY**  
Microbiology  
012/20/14 Urine Culture: *E.coli*  
Antibiotic Medications:  
01/24/13 – 01/25/13 Amoxicillin-clavulanate 150mg PO q8h  
Flags:  
Community-acquired infection  
Isolation  
NHSN Documentation:  
None

**PerfectChoice OPTIONS**  
Premier Memorial Hospital – Last 12 mos.  
*E.Coli* - Specimen Source Blood  
Antibiotic Medications (% Susceptible)  
Ampicillin-Sulbactam (93%)\*  
Levofloxacin (88%)\*  
Cefazolin (79%)\*  
SMX-TMP (76%)\*  
Gentamicin (73%)\*

Dismiss Change Orders

View the best antibiotic options based on facility antibiogram in context of the patient's relevant clinical data to reach the right decision.

## ACT.



**PerfectChoice – ID: New Organism Identified**

**STEVENS ON, LAURA**  
Age: 4 years  
Allergies: No Known Allergies  
Previous Admit: 01/18/13  
CrCl: >100mL/min  
SCr: 0.9gm/dL

**NEW CULTURE INFORMATION**  
12/22/14 08:45  
Specimen ID: 00564783  
Status: Prelim  
Culture: Blood  
Result: *E.Coli*

**ID SUMMARY**  
Microbiology  
012/20/14 Urine Culture: *E.coli*  
Antibiotic Medications:  
01/24/13 – 01/25/13 Amoxicillin-clavulanate 150mg PO q8h  
Flags:  
Community-acquired infection  
Isolation  
NHSN Documentation:  
None

**PerfectChoice OPTIONS**  
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Antibiotic Medications (% Susceptible)  
Ampicillin-Sulbactam (93%)\*  
Levofloxacin (88%)\*  
Cefazolin (79%)\*  
SMX-TMP (76%)\*  
Gentamicin (73%)\*

Dismiss Change Orders

Access the EMR to make the appropriate medication order decisions.

# surescripts<sup>®</sup> Medication Management for Adherence (CDS Hooks)

## Real-time medication adherence insights delivered directly into workflow during patient visits

**Patient View**

**Daniel X. Adams**  
Birthdate: 1925-12-23

**Hello Daniel!**  
*Source: Patient greeting service*

**Medication Management for Adherence**  
*Source: Powered by Surescripts*  
The PDC (Proportion of Days Covered) is calculated by the Pharmacy Benefit Management (PBM) or Health Plan based on claims data. The PDC score is used to communicate the patient's overall adherence.

🔗 Lowest PDC score 47% Diabetes as of 10/13/2016 12:17:38 AM

**Medication Adherence Profile**

**⚠️ 47% Diabetes** 10/25/2016

Medication	Filled	Supply
METFORMIN HCL - 30.0 MG NDC: 68382075810	9/25/2016	30 days

**✅ 85% Cholesterol** 10/25/2016

Medication	Filled	Supply
LOVASTATIN - 90.0 MG NDC: 68180046803	9/25/2016	90 days

## Bi-directional communication to enable users to provide real-time feedback

**Medication Adherence** Received: 10/25/2016  
Adams, Daniel - DOB: 12/23/1925

Health plan records show this patient may not be taking their diabetes medication as instructed. Please talk to your patient about adherence.

**Please respond:**

Is adherence a confirmed issue?

Yes

Why is adherence an issue?

- Patient has been educated on importance of adherence and plans to resume therapy
- Patient refuses drug due to cost
- Patient refuses drug due to side effects
- Patient refuses drug due to other reasons
- An unlisted reason

# Stanson Health's CDS Hooks service

## Clinical Advisory

A **Choosing Wisely**® recommendation from the **American Geriatrics Society** states:  
Don't use benzodiazepines or other sedative-hypnotics in older adults as first choice for insomnia, agitation or delirium. [more...](#)

lorazepam 1 mg tablet [orderId: 117278]

remove order

EDUCATION



1

2

3

4

5

6

OVERRIDE

DISMISS

A **Choosing Wisely**® recommendation from the **American College of Cardiology** states:  
Don't perform annual stress cardiac imaging or advanced non-invasive imaging as part of routine follow-up in asymptomatic patients. [more...](#)

*you are able to narrow this down when accepting*

select order to remove

- a. **Computed tomography angiography of coronary arteries** [orderId: 1234]
- b. **Positron emission tomography myocardial stress imaging using rubidium 81** [orderId: 1235]

EDUCATION



1

2

3

4

OVERRIDE

DISMISS

Real time, workflow  
integrated, patient  
specific, evidence based

Reduces low-value and  
unnecessary care

stanson  health

preparing for risk at the point of care

## Build custom differentials from patient information

**Daniel X. Adams**  
 Birthdate: 1925-12-23

**Recently viewed Diagnoses from VisualDx**  
 Add new Conditions to the problem list

[Urticaria](#)
[Creutzfeldt-Jakob Disease](#)
[Lead Poisoning](#)

**DDx of Medication Reactions in VisualDx**  
[Lisinopril](#)
[Hydrochlorothiazide](#)

**Build a Custom Differential in VisualDx**  
 Select a finding to be the Chief Complaint

[Hypertension](#)

**Diagnosis Summaries and Images in VisualDx**  
[Primary Hypertension](#)
[Osteoarthritis](#)
[Dementia](#)
[Alzheimer Disease](#)

## Find diagnosis summaries and textbook differentials

### Differential Diagnosis & Pitfalls

- Drug toxicity
- Chronic ethanol consumption (ie, alcohol use disorder)
- [Lead poisoning](#)
- Carbon monoxide poisoning
- Multi-infarct dementia
- Depression
- Complex partial seizures
- Autoimmune encephalopathy
- Creutzfeldt-jakob disease

### Differential Diagnosis of a 80+ year old Male

with [Lisinopril](#) [Rash](#) [Reaction 0 to 5 Days After Drug](#) [Smooth Plaque](#) [ADD OR REMOVE FINDINGS](#)



**Urticaria** ✕

VERY COMMON OR IMPORTANT DIAGNOSIS

Raised, erythematous wheals caused by the release of histamine and other vasoactive substances from mast cells. Urticaria can be triggered by a variety of mechanisms, both allergic and nonallergic. Pruritus, prickling and stinging sensations, or pain may occur with urticaria. Usually resolve within 24 hours without skin sequelae.

[View Diagnosis Details](#)

**Other Resources:**  
[UpToDate](#) [PubMed](#)

Matches 4 of 4 findings: [Edit findings](#)

[Lisinopril](#) ✓
 [Rash](#) ✓
 [Reaction 0 to 5 Days After Drug](#) ✓
 [Smooth Plaque](#) ✓

## Update record with new diagnoses and findings

**Recently viewed Diagnoses from VisualDx**  
 Add new Conditions to the problem list

[Urticaria](#)
[Creutzfeldt-Jakob Disease](#)
[Lead Poisoning](#)

## Find patient handouts

**Diagnoses with Patient Handouts in VisualDx**

[Urticaria](#)

# CDS Hooks Dose Calculator

Prevent ADEs with system-calculated, safe, patient-specific doses

Med ordering workflow: pediatric patient, sulfamethoxazole/trimethoprim

 **Baby Girl**

DOB: 05/01/2016    [mommy.girl@hotmail.com](mailto:mommy.girl@hotmail.com)  
Age: 5    855-293-0593  
Height: 25.00 inches    309-637-4622  
Weight: 13.63 kgs    42 Richmond Terrace,  
Gender: Female    known, IA, 10301

Common Sigs

## FDB OrderKnowledge Sigs

Common ambulatory sigs for sulfamethoxazole 200 mg-trimethoprim 40 mg/5 mL oral suspension

[\[5 mg/kg\] 9 mL by mouth every 12 hours](#)

[\[150 mg/m<sup>2</sup>\] 6 mL by mouth every day; administer 3 consecutive days per week](#)

Source: *First Databank*

[First Databank Dose Calculator](#)

### Dosage Calculation: sulfamethoxazole 200 mg-trimethoprim 40 mg/5 mL oral suspen

Calculated Dosage Amount:	68 mg
Dosage (5 mg/kg) x Patient Weight (13.63 kgs)	
<b>Rounded Dosage Amount:</b>	<b>72.0 mg</b>
Not to Exceed:	160.00 mg
<b>Variance Amount Low:</b>	61.34 mg
Low variance (0.9 mg) x Calculated Dosage Amount (68 mg)	
<b>Variance Amount High:</b>	74.96 mg
High variance (1.1 mg) x Calculated Dosage Amount (68 mg)	
Dosing Rounding Increment:	1 mL

Leverages FDB Cloud Connector web services

Calculations happen in real-time using current knowledge base

- See common orders for this patient based on their age and the ordered drug
- Smart logic knows this order should be dosed as trimethoprim
- Select from safe rounded admin amounts

# meducation<sup>®</sup>

## (CDS Hooks)

### Meducation Personalized Medication Information

#### meducation<sup>®</sup>

Meducation<sup>®</sup> provides patient-specific medication instructions & regimen summaries at 5-8 grade reading level & 21 languages to reduce errors & improve adherence.

[Interact with Meducation PMI Viewer](#)

### Meducation Regimen Summary

#### meducation<sup>®</sup>

Meducation<sup>®</sup> provides patient-specific medication instructions & regimen summaries at 5-8 grade reading level & 21 languages to reduce errors & improve adherence.

[Interact with MeducationRS](#)

#### EVERY DAY: Medicine you need to use every day.

	Morning	Noon	Evening	Bedtime	
Aspirin Enteric Coated Tablet 81 mg	1				Take by MOUTH. For heart.
Accupril Tablet 10mg	1				Take by MOUTH. For high blood pressure.
Humalog Insulin Solution 100 IU/mL	12 units	14 units	16 units		INJECTION medicine. For diabetes.
Biaxin Oral Suspension 125mg/5 mL	10 mL		10 mL		Take by MOUTH. For infection. Use for 10 days.
Lipitor Tablet 40 mg				1	Take by MOUTH. For high cholesterol.

#### AS NEEDED: Medicine you should use as needed.

ProAir HFA Inhaler 90 mcg/inh	Use the medicine every 3 to 4 hours. Inhale one to two (1-2) puffs each time.	BREATHING medicine. For asthma attack. Use the medicine as needed for your symptoms.
-------------------------------	---	--

If you take any medication that is not on this list, please tell your healthcare provider.



ProAir HFA Inhaler 90 mcg/inh



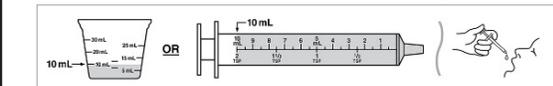
#### Biaxin Oral Suspension 125 mg/5 mL

The medicine is used to treat infection.

#### How to take medicine

Take the medicine by mouth twice a day.  
Drink 10 mL each time.

Morning	Noon	Evening	Bedtime
10 mL		10 mL	



Use the medicine for a total of 10 days.

#### Instructions

Take the medicine with food.

Keep this medicine at room temperature.

After using the medicine for the total number of days, throw away any left over medicine.

It is important that you keep taking each dose of this medicine on time even if you are feeling well.

If you forget to take a dose on time, take it as soon as you remember. If it is almost time for the next dose, do not take the missed dose. Return to your normal dosing schedule. Do not take 2 doses of this medicine at one time.

Please tell your doctor and pharmacist about all the medicines you take. Include both prescription and over-the-counter medicines. Also tell them about any vitamins, herbal medicines, or anything else you take for your health.



### Disease Guideline



### Hypertension



### Medication Alert



### lisinopril 5 mg tablet

- This medication is not recommended for Black or African American patients.

[Switch to amloride 5 mg-hydrochlorothiazide 50 mg tablet](#)

Optimize pharmacy spend using **actionable recommendations.**

<b>Hypertension</b> + acebutolol 200 mg capsule <small>★ CMS Triple Win ahead</small>	Est. Cost ⓘ <b>\$55</b>	Actual Adherence ⓘ <b>98%</b>
	<a href="#">Alternatives</a>	<a href="#">Fill Rates</a>
<b>Seasonal Affective Disorder</b> + Wellbutrin XL (bupropion HCl) 150 mg tablet extended release 24 hr	Est. Cost ⓘ <b>\$1,081</b>	Actual Adherence ⓘ <b>73%</b>
	<a href="#">Alternatives</a>	<a href="#">Fill Rates</a>

Improve outcomes through **consistent prescribing.**

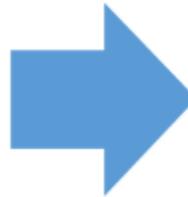
Name	Patients	GDR ⓘ	Prescribing Compliance	Prescriptions	High-risk Meds	Total Spend	Potential Savings		
Jamil Miller	52	94%	87%	310	22	\$2,467	\$713		
Darron Durgan	24	98%	76%	279	14	\$3,322	\$616		

Drive performance metrics (e.g., adherence) through **prescribing behavior surveillance.**

# Precision Link at Boston Children's: PGx Recommendations via CDS Hooks

Adjusting medication order based upon genomic data

An **azathioprine** prescription  
based upon a patient's  
expression of **TPMT enzyme**



## Normal metabolizer

### PGX Recommendation

Start with normal starting dose (e.g., 2-3 mg/kg/d) and adjust doses of azathioprine based on disease-specific guidelines. Allow 2 weeks to reach steady state after each dose adjustment.

## Intermediate metabolizer

### PGX Recommendation

If disease treatment normally starts at the "full dose", consider starting at 30-70% of target dose (e.g., 1-1.5 mg/kg/d), and titrate based on tolerance. Allow 2-4 weeks to reach steady state after each dose adjustment.

## Poor metabolizer

### PGX Recommendation

Consider alternative agents. If using azathioprine start with drastically reduced doses (reduce daily dose by 10-fold and dose thrice weekly instead of daily) and adjust doses of azathioprine based on degree of myelosuppression and disease-specific guidelines. Allow 4-6 weeks to reach steady state after each dose adjustment. Azathioprine is the likely cause of myelosuppression.