

Remote Decision Support with



Kevin Shekleton
HSPC HIT Developers Conference
March 31, 2017



ITEM
MAGIC
WEAPON
ARMOR
STATUS

KEVIN
SHEKLETON
DISTINGUISHED
ENGINEER

HP
13 / 37

 15 YEARS

 @kpshek

If you're going to take
a picture of a slide, do it now

Slides:

bit.ly/cds-hooks-hspc2017

The problem with SMART apps



Bilirubin Chart

Newborns < 120 hours old

Transcutaneous bilirubin results that are either:

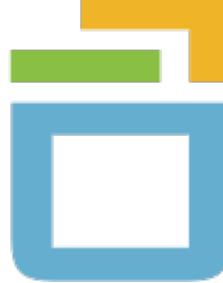
- Not documented

- 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

C D S H  O K S

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

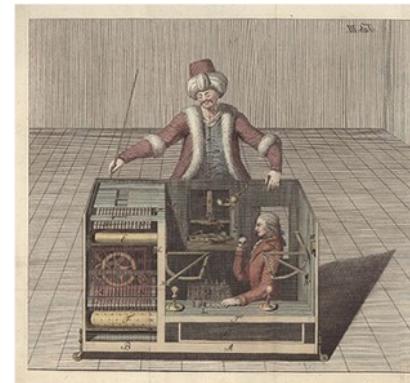
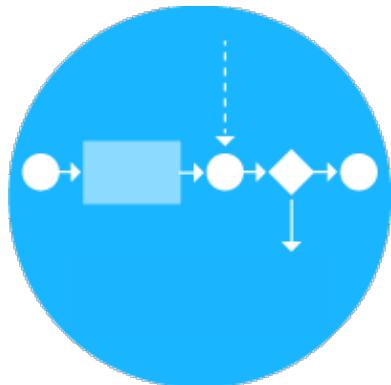
CDS Service

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

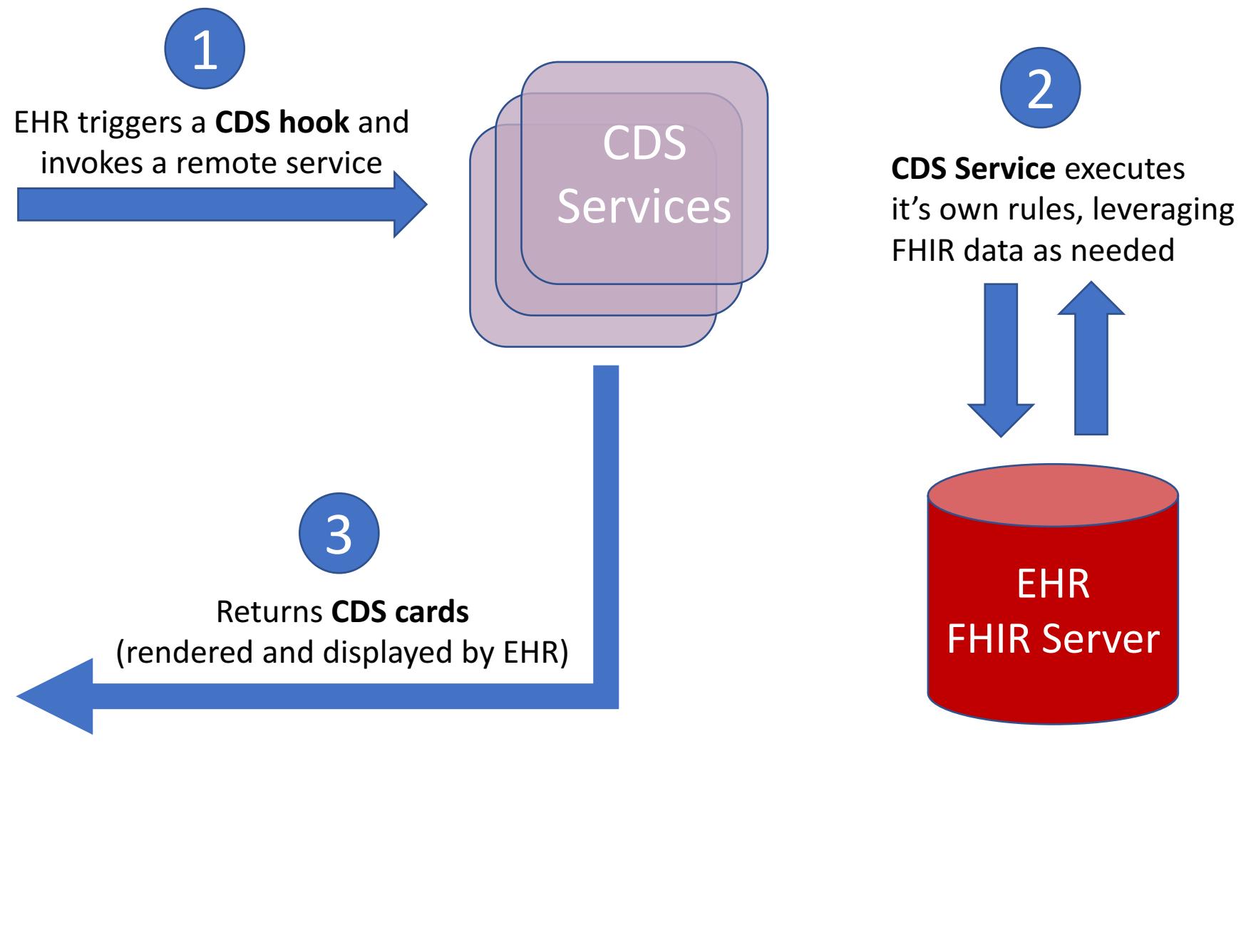
When a patient's chart is opened

medication-prescribe

When a medication is selected for prescription

order-review

Viewing pending orders for signing





EHR



CDS Service

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>





EHR



CDS 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"  
      } } ] }
```

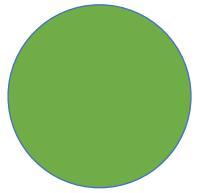
Cards

- 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

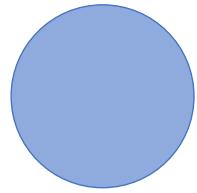
CDS Service Response JSON

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

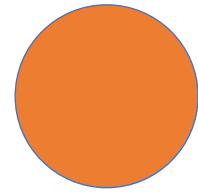
Card Indicator



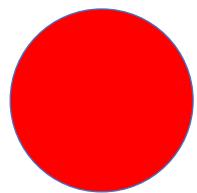
Success



Informational

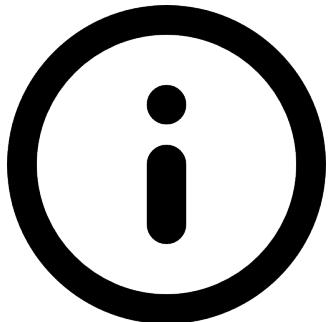


Warning



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 amiloride 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

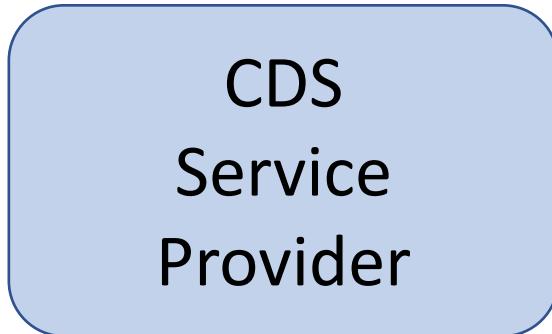
 Medication Review

Capturing user behavior for analytics

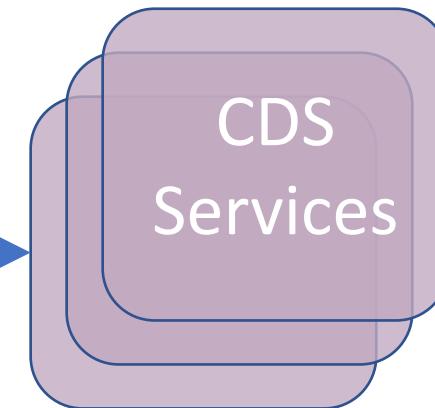
- Since CDS Services return purely JSON, they don't know how users interact with their suggestion
- Each suggestion *may* contain a **UUID**
- The UUID allows the EHR to notify the CDS Service that the user interacted with their suggestion

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

Base `https://example.com`



Discovery `/cds-services`



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>

Rx View

Patient: Daniel X. Adams ID: 1288992

Treating:

Alzheimer's disease

Medication:

Search for a drug...

Acetaminophen 300 MG / Codeine Phosphate 30 MG Oral Tablet

Take 1 pill by mouth daily

Start date

2017-03-30

End date

2017-04-30

Cost: \$12

Source: CMS Public Use Files

```
{  
  "resourceType": "MedicationOrder",  
  "dateWritten": "2017-03-30",  
  "status": "draft",  
  "patient": {  
    "reference": "Patient/1288992"  
  },  
  "dosageInstruction": [  
    {  
      "doseQuantity": {  
        "value": 1,  
        "system": "http://unitsofmeasure.org",  
        "code": "{pill}"  
      },  
      "timing": {  
        "repeat": {  
          "frequency": 1,  
          "period": 1,  
          "periodUnits": "d",  
          "boundsPeriod": {  
            "start": "2017-03-30",  
            "end": "2017-04-30"  
          }  
        }  
      }  
    }  
  ],  
  "medicationCodeableConcept": {  
    "text": "Acetaminophen 300 MG / Codeine Phosphate 30 MG Oral Tablet",  
    "coding": [  
      {  
        "display": "Acetaminophen 300 MG / Codeine Phosphate 30 MG Oral Tablet",  
        "system": "http://www.nlm.nih.gov/research/umls/rxnorm"  
      }  
    ]  
  }  
}
```

Separation of Concerns

Concern	Owner
Workflow & hooks (triggers)	EHR
CDS logic	CDS Service Provider
Initial context data	EHR
Additional data	CDS Service Provider (via FHIR or other sources)
CDS presentation	EHR



fdb
First Databank

HSPC
the healthcare
services platform
consortium™

MAYO
CLINIC

MCKESSON

 **PREMIER**

 **NANTHEALTH**

 **visualDx**

QvΣRA

 **Cerner**

Epic

 **healthwise®**
for every health decision®

 **Intermountain**SM
Healthcare

 **Allscripts**TM

 **athenahealth**

 **IMO**
Intelligent Medical Objects

 **mcg**

 **surescripts**

RxREVU



Wolters Kluwer
Health

MITRE

 **syapse**

stanson**health**

“polyglot”[®]
Health Through Understanding™

PHILIPS
Healthcare

 **medical-objects**
CLINICAL APPLICATIONS, MESSAGING AND INTEGRATION

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)

Wait, doesn't FHIR already define an approach for CDS?

Level 5 Providing the ability to reason about the healthcare process



Clinical Reasoning

[Library](#), [ServiceDefinition](#) & [GuidanceResponse](#), [Measure](#)/[MeasureReport](#), etc

Let's compare!

	Clinical Reasoning	CDS Hooks
Management		
Rule definition	✓	
Local execution	✓	
Remote execution	✓	✓

What the?!

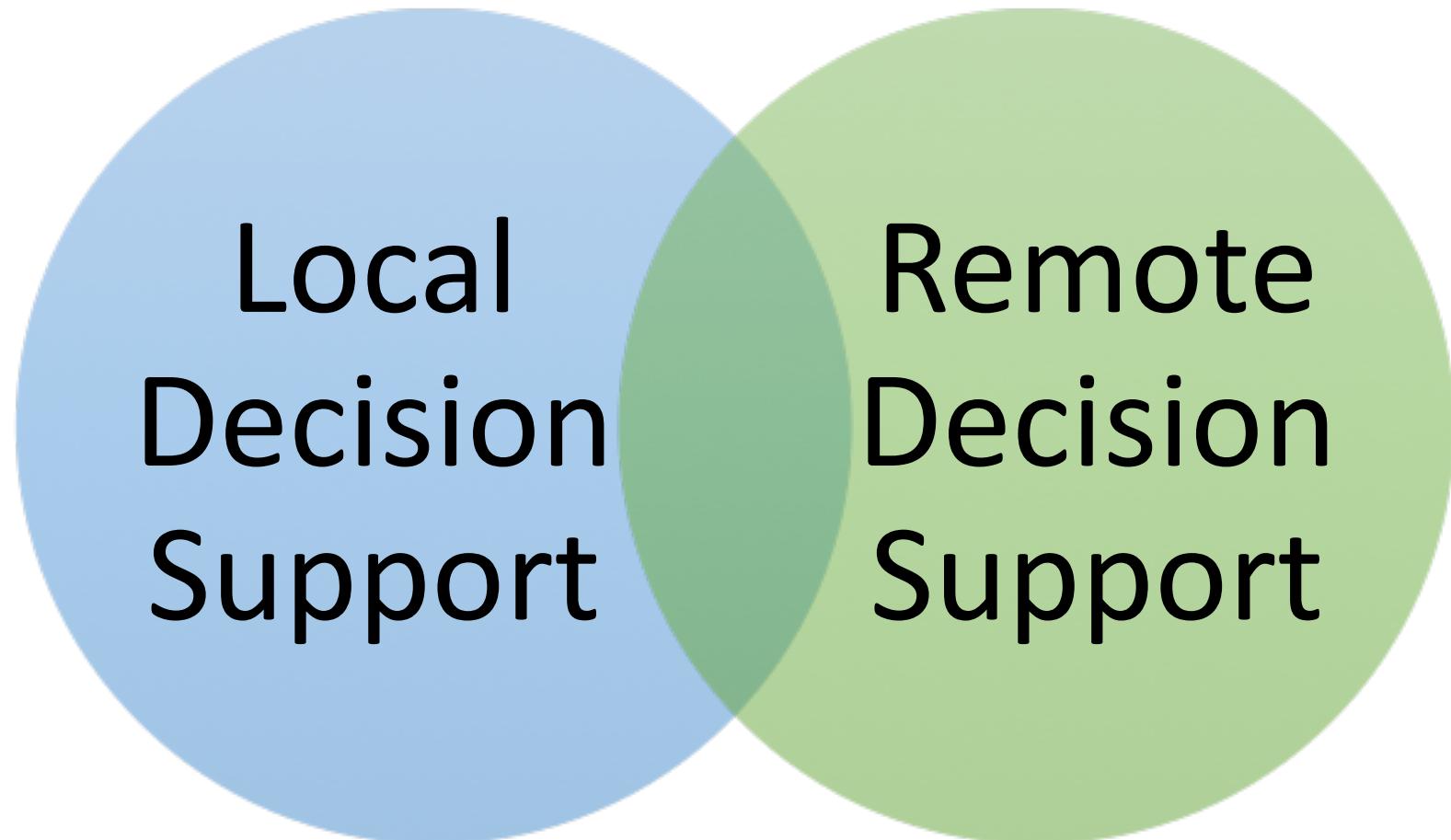
More ✓ wins, right?

broad vs narrow



Clinical Reasoning

CDS HOOKS



Let me predict your questions...

Q: Is CDS Hooks in production?

A: Not yet :-(

Q: Will CDS Hooks support <insert feature>?

A: Log a Github issue or let's discuss over our Google Group or Zulip chat!



Let me predict your questions...

Q: What is the planned support for
<insert your favorite EHR, hospital, etc>?

A: ¯_(ツ)_/¯

Q: What is the business model for
CDS Hooks?

A: ¯_(ツ)_/¯



References



Specification & documentation
<http://cds-hooks.org>



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



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

Thanks!

Addendum

Sample content from CDS vendors
developing on 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.

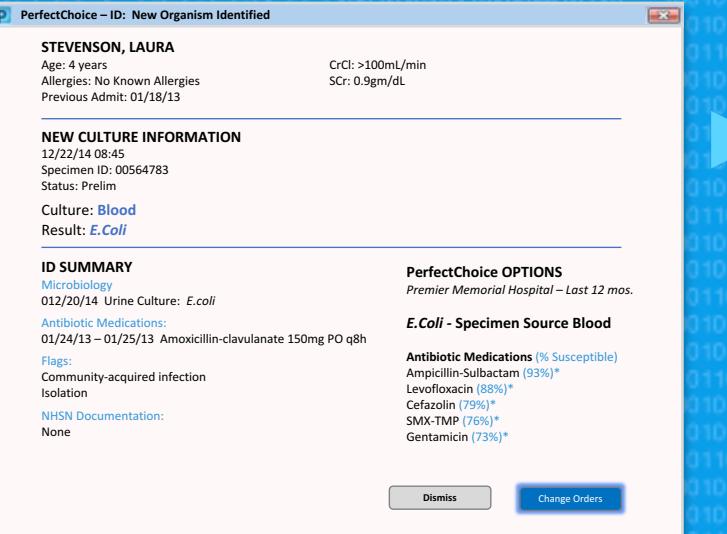
IDENTIFY.

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

Source:
 Launch Premier TheraDoc for more details.

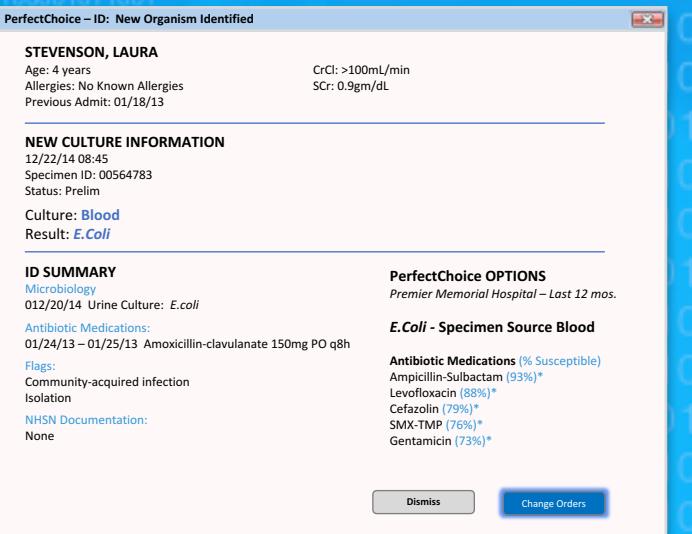
Know the priority patients with new microbiology results with automated surveillance that notifies clinicians in their workflow.

DECIDE.



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

ACT.



Access the EMR to make the appropriate medication order decisions.



A Premier Solution

surescripts® 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	9/25/2016	30 days
NDC: 68382075810		

✓ 85% Cholesterol 10/25/2016

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

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

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

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

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
Age: 5
Height: 25.00 inches
Weight: 13.63 kgs
Gender: Female

mommy.girl@hotmail.com
855-293-0593
309-637-4622
42 Richmond Terrace,
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/m²] 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: Dosage (5 mg/kg) x Patient Weight (13.63 kgs)	68 mg
Rounded Dosage Amount: Not to Exceed:	72.0 mg 160.00 mg
Variance Amount Low: Low variance (0.9 mg) x Calculated Dosage Amount (68 mg)	61.34 mg
Variance Amount High: High variance (1.1 mg) x Calculated Dosage Amount (68 mg)	74.96 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® (CDS Hooks)

Meducation Personalized Medication Information

meducation®

Meducation® 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®

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

 Interact with MeducationRS

UNIVERSITY MEDICAL CENTER
University Medical Center
123 Main Street, Anytown, NC 12345
212-555-2121
ID: FHRH7WKJ

EVERY DAY: Medicine you need to use every day.

	Morning	Noon	Evening	Bedtime
Aspirin Enteric Coated Tablet 81 mg	1			
Accupril Tablet 10mg	1			
Humalog Insulin Solution 100 IU/mL	12 units	14 units	16 units	
Biaxin Oral Suspension 125mg/5 mL	10 mL		10 mL	
Lipitor Tablet 40 mg				1

Take by MOUTH. For heart.
Take by MOUTH. For high blood pressure.
INJECTION medicine. For diabetes.
Take by MOUTH. For infection. Use for 10 days.
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

meducation®

UNIVERSITY MEDICAL CENTER
University Medical Center
123 Main Street
Anytown, NC 12345
Phone: 212-555-2121

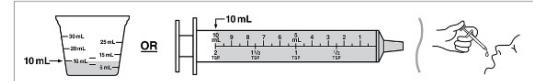
Biaxin Oral Suspension 125 mg/5 mL

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.

Ref#: FHRH7WKJ-389785

English
Biaxin Oral Suspension 125 mg/5 mL



Disease Guideline

RxCheck

Hypertension

Medication Options

Medication Alert

RxCheck

lisinopril 5 mg tablet

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

Switch to amiloride 5 mg-hydrochlorothiazide 50 mg tablet

Optimize pharmacy spend using **actionable recommendations**.

Hypertension + acebutolol 200 mg capsule <small>CMS Triple Weighted</small>	Est. Cost <small>i</small> \$55	Actual Adherence <small>i</small> 98%
Seasonal Affective Disorder + Wellbutrin XL (bupropion HCl) 150 mg tablet extended release 24 hr	Est. Cost <small>i</small> \$1,081	Actual Adherence <small>i</small> 73%

Improve outcomes through **consistent prescribing**.

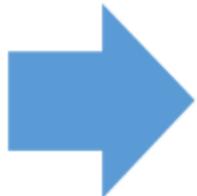
Name	Patients	GDR <small>?</small>	Prescribing Compliance	Prescriptions	High-risk Meds	Total Spend	Potential Savings	Actions
Jamil Miller	52	94%	87%	310	22	\$2,467	\$713	
Darron Durgan	24	98%	76%	279	14	\$3,322	\$616	

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.