Remote Decision Support with @JoshCMandel, MD (Verily, Harvard DBMI)
David McCallie (Cerner)

Slides credit: Kevin Shekleton (Cerner)
We have entered the “API Era”

Surprisingly rapid emergence of standards-based APIs for Health IT

- **JASON Report (Apr 2014)**: “EHRs should expose ‘public’ APIs”
- **JASON Task Force (Oct 2014)**: Provide standards-based API for “core data services & core data profiles”
- **Argonaut Project (Dec 2014)**: Coalition to agree on API “core data services and profiles”
- **EHR Certification Rule (2015)**: Requires API for access to MU data elements
- **21st Century Cures (2016)**: Comprehensive APIs TEFCA / DaVinci / “all data”

bit.ly/amia18
Quick Review: Emerging Standards for Open Platforms

- **FHIR** = “Fast Health Interoperability Resources”
- A standard for accessing health care data (“Resources”)
- ReSTful API design leverages Internet standards (HTTP, etc.)
- Created by Health Level 7 International (HL7)
- Emerging support by most major HIT providers (e.g., Argonaut)
- Meets 2015 EHR Certification

- **SMART** = “Substitutable Medical Applications and Reusable Technology”
- A SMART App is a Web App
  - HTML5 + JavaScript
  - Typically embedded in EHR
- EHR Data Access is via FHIR
- OAuth2 for security and context passing
- Also supports smart-phone and patient-controlled apps
Multi-vendor SMART on FHIR App demos at HIMSS

SMART® Mobile Apps

Web Apps

OAuth 2.0

HL7® FHIR®

FHIR Data Profiles

ARGONAUT PROJECT

Supporting Health IT Systems

Cerner

Athenahealth

Department of Veterans Affairs

HSPC Healthcare Services Platform Consortium

Epic
Example SMART App - Neonatal bilirubin – Intermountain

- Developed at Intermountain
- Guides duration of phototherapy to prevent neonatal brain damage
- Windows app that was rapidly ported to use SMART on FHIR
- But it requires a MENU CLICK!
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

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

bit.ly/cds-himss18
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 Med Order

 RX 50 mg daily

**Toprol XL**

1. EHR triggers a CDS hook and invokes a remote service

2. CDS Service executes its own rules, leveraging FHIR data as needed

3. Returns CDS cards (rendered and displayed by EHR)

- **Information card**
  - $200 per month (patient pays $30)

- **Suggestion card**
  - Try HCTZ as first-line
  - Switch to HCTZ

- **Smart app link card**
  - Managing hypertension?
  - Launch JNC 8 Rx Pro

[bit.ly/cds-himss18]
```json
{
  "hook": "patient-view",
  "fhirServer": "https://fhir.example.com",
  "user": "Practitioner/789",
  "context": {
    "patientId": "123",
    "encounterId": "456",
  }
}
```
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 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/{{context.patientId}}"
      }
   },
   {...}
   ]
}
CDS Service Invocation

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

            "prefetch": {
                "patientToGreet": "Patient/{{Patient.id}}"
            }
        }
    ]
}

POST https://example.com/cds-services/example-service
```
Security

EHR trusts the CDS Service via its TLS endpoint

CDS Service trusts the EHR via signed JWT

EHR provides FHIR access token to CDS Service
Security > JWT

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJpc3MiOiJodHRwczovL2ZoaXItZWh0LmV4YW1wbGUtY29tLyIsImF1ZCI6imh0dHBzOi8vY2FzLmV4YW1wbGUub3JnL2Nkcy1zZXJ2aWNlcy9zb21ibXRpY2UtLCJleHAiOiJEMjI1Njg4NjAsImIiLCJcIjoiZWUyMmIwMjEtZTFiNy00NjExLWJhNWUtOGVlYzZhMzNhYzIlIn0.Gwl3s301OMWpdEVAVj_T3JZV8bs7N5-V7QNNG7TQ33o

{  
  "iss": "https://ehr.example.com/",  
  "aud": "https://example.org/cds-services/my-service",  
  "exp": 1422568860,  
  "iat": 1311280970,  
  "jti": "ee22b021-e1b7-4611-ba5b-8eec6a33ac1e"
}
<table>
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<tr>
<th>Field</th>
<th>Value</th>
<th>Example</th>
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</thead>
<tbody>
<tr>
<td>iss</td>
<td>The URL of the issuer of the JWT</td>
<td><a href="https://ehr.example.com">https://ehr.example.com</a></td>
</tr>
<tr>
<td>aud</td>
<td>The CDS Service endpoint being called</td>
<td><a href="https://example.org/cds-services/my-service">https://example.org/cds-services/my-service</a></td>
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<tr>
<td>exp</td>
<td>Time this JWT expires</td>
<td>1422568860</td>
</tr>
<tr>
<td>iat</td>
<td>Time at which this JWT was issued</td>
<td>1311280970</td>
</tr>
<tr>
<td>jti</td>
<td>Nonce to protect against replay attacks</td>
<td>ee22b021-e1b7-4611-ba5b-8eec6a33ac1e</td>
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</tbody>
</table>
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

CDS Service Exchange
Select a Service:
http://hooks.fhir.me:8082/cds-services/patient-hello-world

Request

Response

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

<table>
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<td>EHR</td>
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</table>
Argonauts ❤️ □ CDS Hooks

Pushing SMART apps via a CDS Service upon opening the patient’s chart

Validate and implement the CDS Hooks security model
2018 Roadmap

Release a 1.0 specification

Launch production pilots
What’s after 1.0?

Performance: trigger guards, SLAs

Event & time based hooks

Specific use cases
(ACR ordering guidelines, CDC opioid guidelines, etc)
<table>
<thead>
<tr>
<th>Level 5</th>
<th>Providing the ability to reason about the healthcare process</th>
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</thead>
<tbody>
<tr>
<td>Clinical Reasoning</td>
<td>Library, ServiceDefinition &amp; GuidanceResponse, Measure/MeasureReport, etc</td>
</tr>
</tbody>
</table>
Let’s compare!

<table>
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<tr>
<th>Management</th>
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<tr>
<td></td>
<td><img src="https://via.placeholder.com/150" alt="HIML International" /></td>
<td><img src="https://via.placeholder.com/150" alt="GitHub" /></td>
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<td><img src="HZ.png" alt="HZ International" /></td>
<td><img src="https://cdn.jsdelivr.net/npm-Novus@0.1.0/icons/logo.png" alt="GitHub" /></td>
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<td>Rule definition</td>
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<td></td>
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</tr>
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<td>✔</td>
<td></td>
</tr>
<tr>
<td>Remote execution</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>
What the?!  
More ✔ wins, right?
broad vs narrow
Clinical Reasoning

Local Decision Support

Remote Decision Support
References

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

Sandbox
http://sandbox.cds-hooks.org

Source code
https://github.com/cds-hooks
Let’s code!

Complete the tutorial and write your own CDS Service!

github.com/cerner/cds-services-tutorial
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 antinfectives have the highest likelihood (% susceptible) of effectively treating the infection.

Source: Launch Premier TheraDoc for more details.

DECIDE.

Access the EMR to make the appropriate medication order decisions.

ACT.

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

View the best antibiotic options based on facility antibiogram in context of the patient's relevant clinical data to reach the right decision.
Medication Management for Adherence (CDS Hooks)

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

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

Patient View

Daniel X. Adams
Birthdate: 1975-10-23

Hello Daniel!
Source: Patient greeting service

Medication Management for Adherence
Source: Pharmacy

Medication Adherence Profile

Diabetes
- METFORMIN HCL - 30.0 MG
  - Dose: 68382075810
  - Filled: 9/25/2016
  - Supply: 30 days

Cholesterol
- LOVASTATIN - 90.0 MG
  - Dose: 68180046803
  - Filled: 9/25/2016
  - Supply: 90 days

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

Real time, workflow integrated, patient specific, evidence based

Reduces low-value and unnecessary care
Build custom differentials from patient information

Differential Diagnosis of a 80+ year old Male

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, pricking and stinging sensations, or pain may occur with urticaria. Usually resolve within 24 hours without skin sequelae.

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
- Autonomic encephalopathy
- Cerebral-sided disease

Update record with new diagnoses and findings

Find patient handouts

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

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

- 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

Leverages FDB Cloud Connector web services
Calculations happen in real-time using current knowledge base
Mедукашн® (CDS Hooks)

Mедукашн® Personalized Medication Information

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

Interact with Meducaion PMI Viewer

Mедукашн® Regimen Summary

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

Interact with MeducaionRS
Optimize pharmacy spend using actionable recommendations.

Improve outcomes through consistent prescribing.

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 70-75% of target dose (e.g., 1.15 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.