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**EXTENDING THE EHR WITH INTEROPERABLE APPS AND SERVICES:  
THE UNIVERSITY OF UTAH EXPERIENCE**

**CCIC F2F MEETING, SALT LAKE CITY, UTAH, JANUARY 10, 2018**

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# DISCLOSURES

- In the past year, I have been a consultant or sponsored researcher on clinical decision support for ONC\*, Hitachi, and McKesson InterQual

\*via ESAC, A+ Government Solutions, Hausam Consulting

# UNIVERSITY OF UTAH HEALTH

- Clinical context
  - 4 hospitals, 10 community clinic centers
  - 1,100 physicians, 1.7 million annual visits
  - 34,000 annual discharges
- Technical context
  - Epic system-wide since 2014
  - On Epic 2017



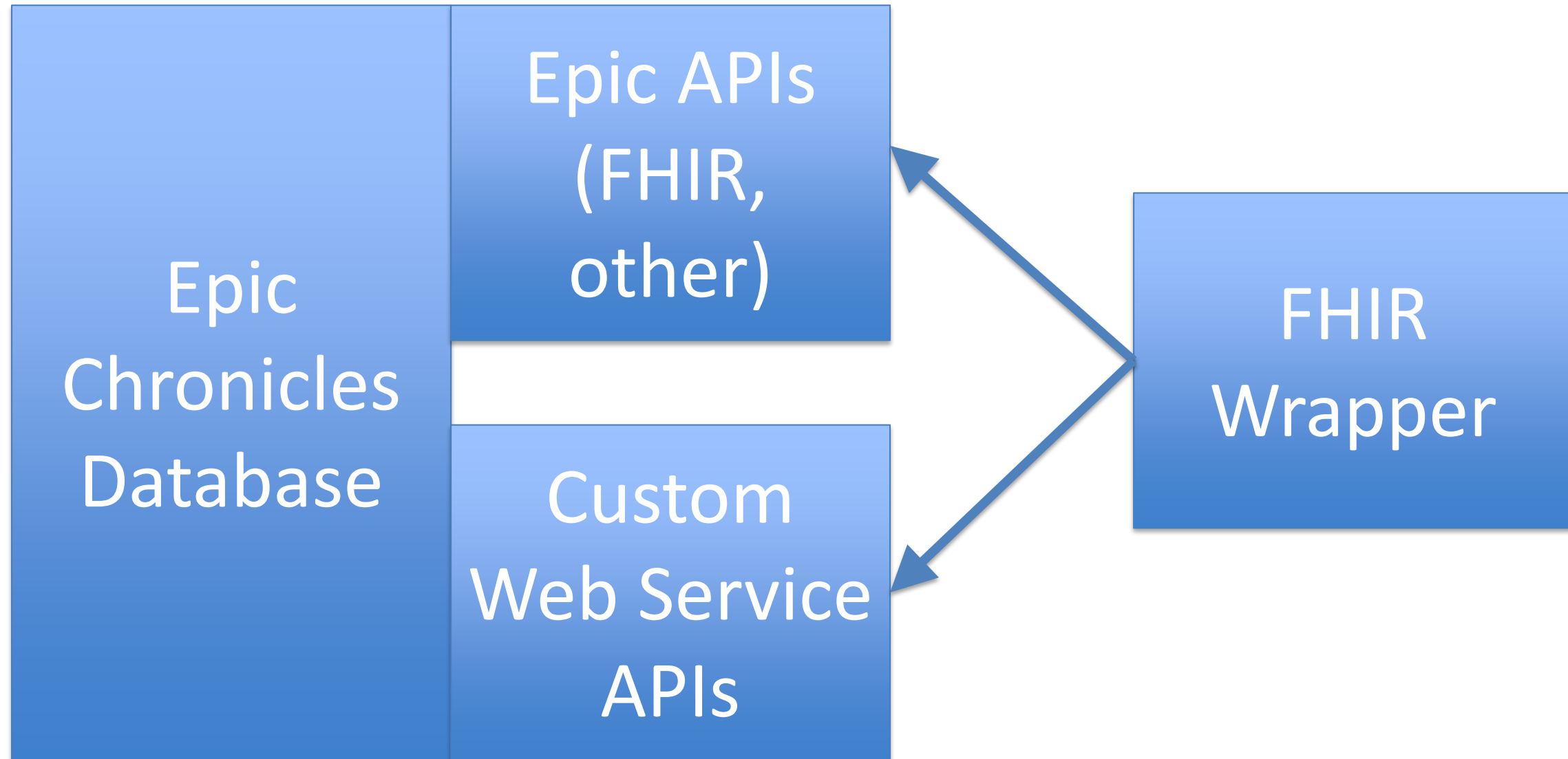
# OPPORTUNITY

- Demand for new features is always greater than available local and central EHR resources
- Epic, along with other major EHR vendors, is encouraging a new paradigm where a large community of contributors can add functionality
- Beyond local and central EHR resources, we could harness the innovation of other local stakeholders, other institutions, and vendors

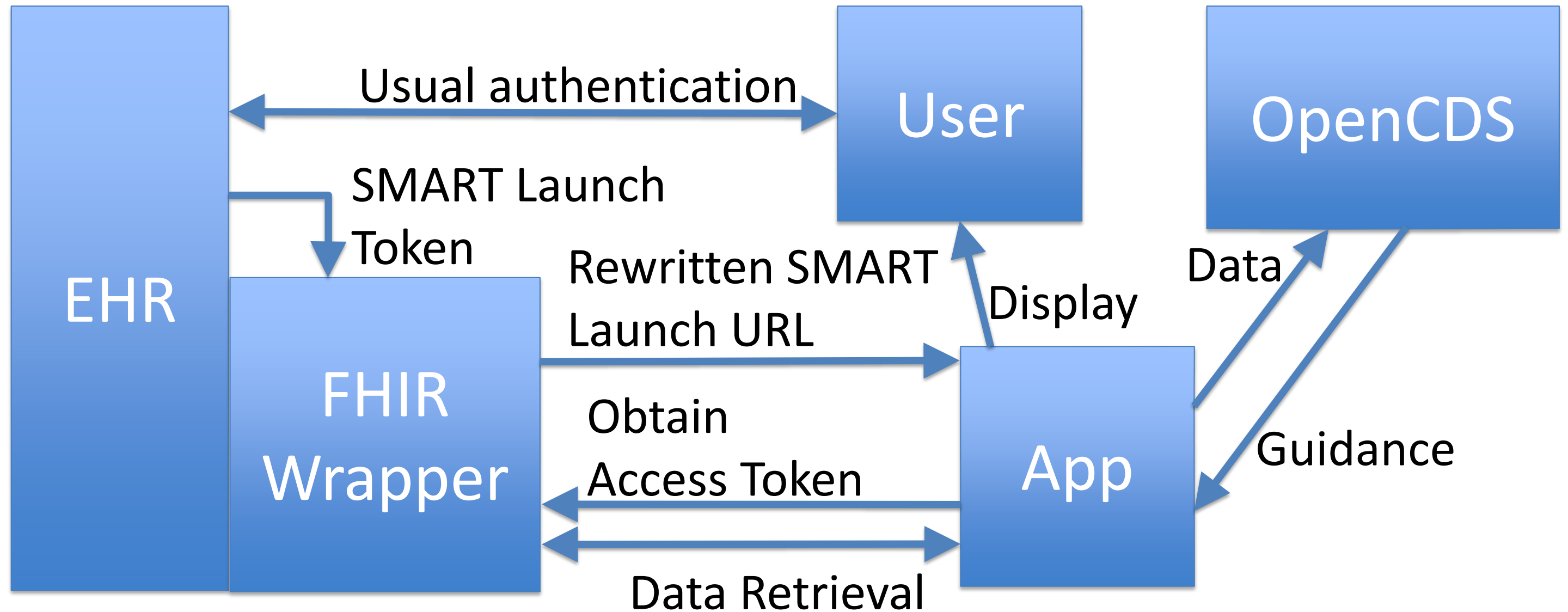
# UNIVERSITY OF UTAH IAPPS INITIATIVE

- Acronym for Interoperable Apps and Services
- Goal: improve patient care and the provider experience through innovative, interoperable extensions of native Epic functionality
- Multi-stakeholder initiative started by University of Utah in 2016
- Focus: SMART on FHIR Apps and CDS Hooks Services
- Synergy between research, operations, and clinical services

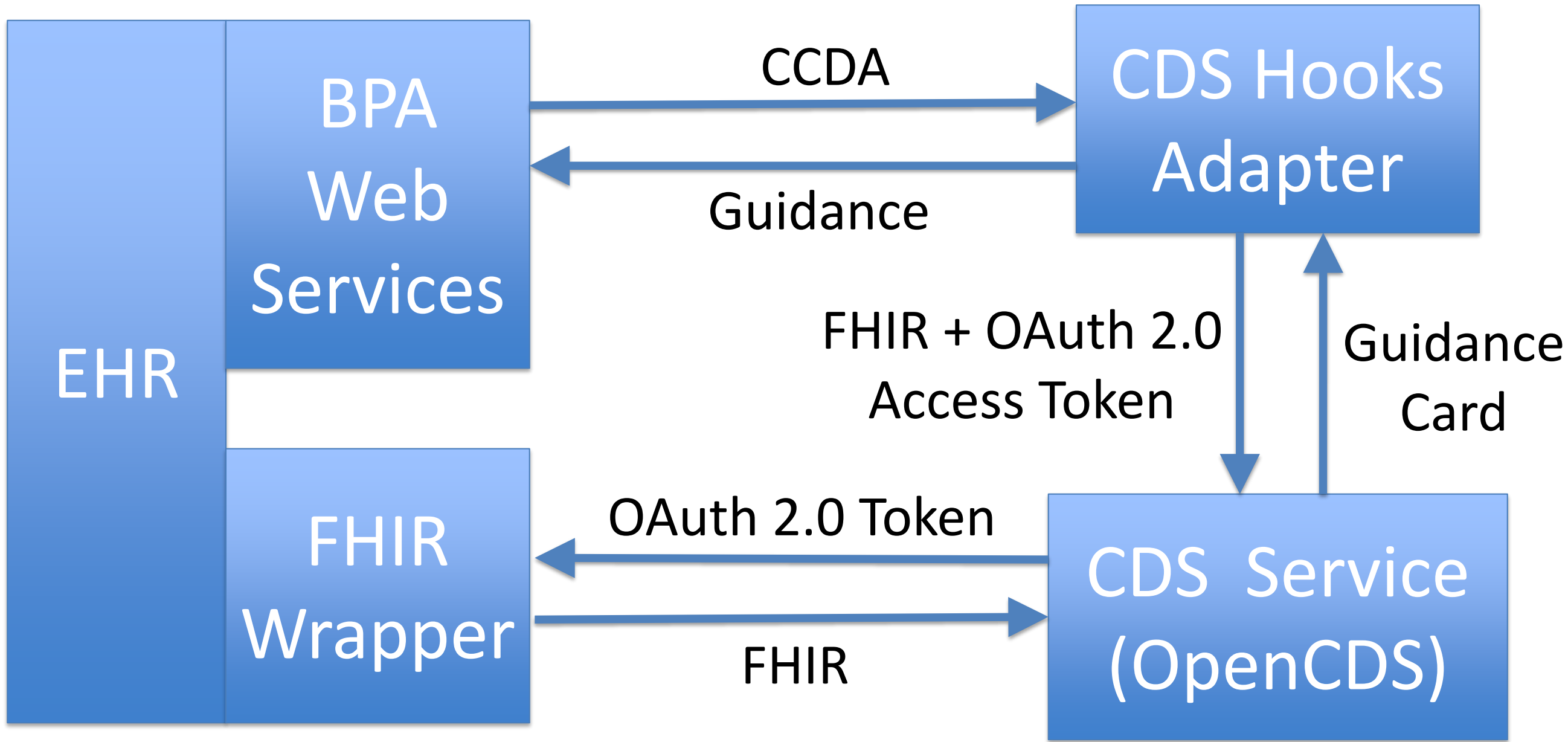
# APPROACH TO DATA: NATIVE + CUSTOM FHIR



# APP FRAMEWORK: SMART



# CDS SERVICE FRAMEWORK: CDS HOOKS





# NEONATAL BILIRUBIN APP

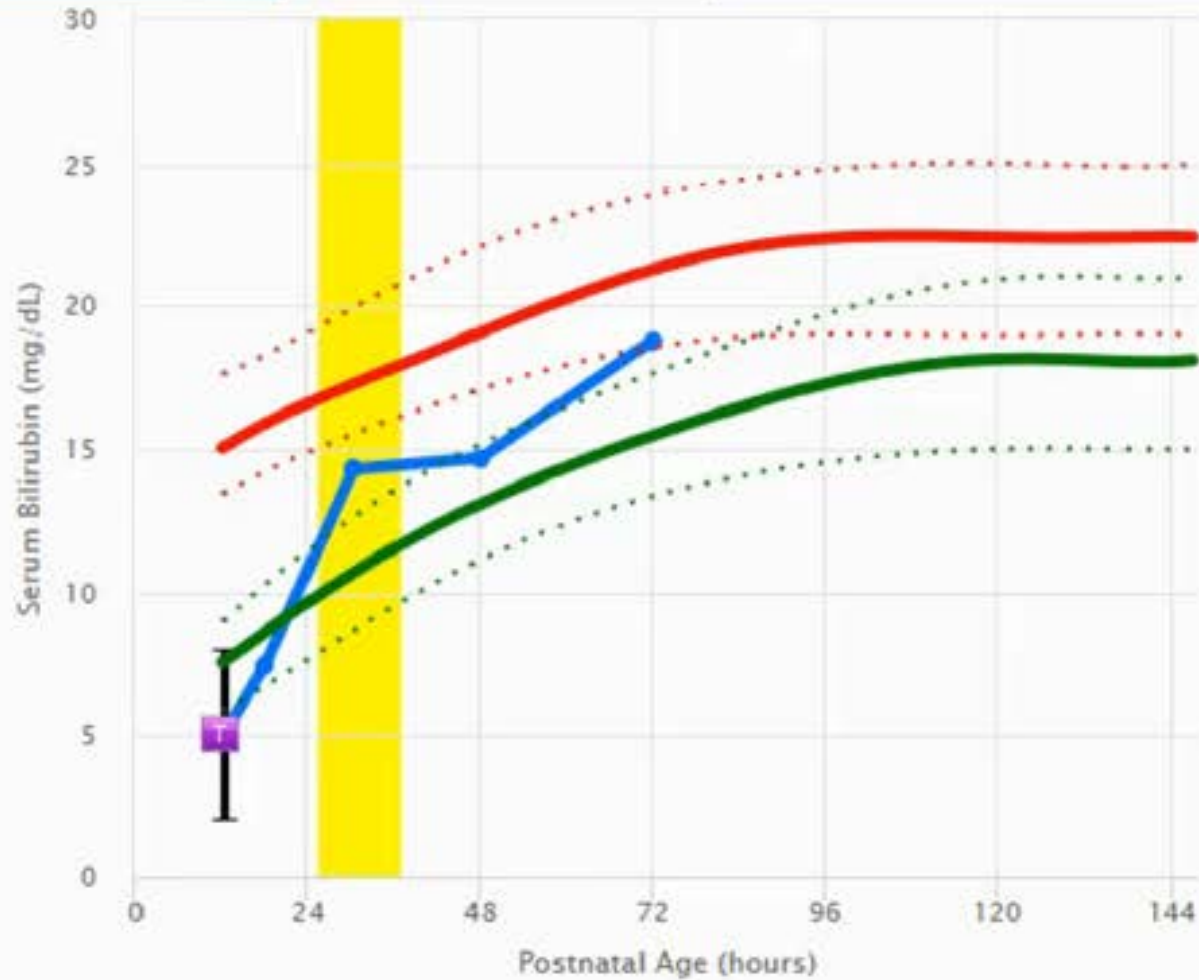
- Goal: improve neonatal bilirubin management and prevent neurotoxicity
- Physician champions:
  - Carole Stipelman, MD, MPH
  - Julie Shakib, DO, MPH
- Iteratively enhanced based on user requests
- Estimated to save >300 hrs of MD time/yr
- Awarded HHS Provider User Experience App Challenge Awards ([link](#))

# Bilirubin App



Neurotoxicity Risk

Hyperbilirubinemia Risk



- Bilirubin
- ◆ Exchange Transfusion Thresholds\*
- ▼ Phototherapy Thresholds\*
- InPt Phototherapy
- OutPt Phototherapy Order
- Transcutaneous Bilirubin
- Current Age

\*Bold = patient-specific threshold.

Source: AAP Hyperbilirubinemia Management Guidelines. Pediatrics. 2004;114:297-316.

## Gest. Age

< 35 wks  35-37 wks  38 wks+

## Direct Coombs (risk factor)

Pos. (01/01/16)  Neg.  
 Unknown

## Other neurotoxicity risk factors?

- Acidosis
- Asphyxia
- G6PD deficiency
- Isoimmune hemolytic disease
- Sepsis
- Sig. lethargy
- Temp. instability

Present  Not Present

## Albumin < 3.0 g/dL (risk factor for phototherapy only)

Yes  No  None on record

	Blood Type	Indirect Coombs
Baby	B Pos (01/01/16)	Positive (01/01/16)
Mother	O Neg (04/09/15)	Positive (04/09/15)

## Phototherapy recommended.

Rationale: Patient's latest total serum bilirubin level of 18.8 mg/dL at 72 hrs is above treatment threshold for phototherapy (15.48) given gestational age  $\geq$  38 wks with risk factors for phototherapy.

## Clinical Prediction Rule for Rebound Hyperbilirubinemia

- Risk Score: 55.84 (above threshold of 20)
- Predicted risk of rebound hyperbilirubinemia after phototherapy: **ELEVATED (> 4%)**
- Based on paper on probability of return of total serum bilirubin (TSB) to phototherapy threshold within 72 hours of phototherapy termination (Chang et al. A Clinical Prediction Rule for Rebound Hyperbilirubinemia Following Inpatient Phototherapy)

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# PROCEDURE SCHEDULE MANAGEMENT APP

- Goal: enable efficient procedure scheduling based on available capacity
- Physician champion: Howard Weeks, MD
- Initial focus: electroconvulsive therapy (ECT)
- Support for custom capacity rules and manual over-rides

Refresh

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Today

Sun	Mon	Tue	Wed	Thu	Fri	Sat
25 ● 28 / 34	26 ● 12 / 17	27 ● 25 / 34	28 ● 10 / 17	29 ● 26 / 34	30 ● 18 / 17	01
02 ● 30 / 34	03	04 ● 23 / 34	05 ● 7 / 17	06 ● 23 / 34	07 ● 15 / 17	08
09 ● 26 / 34	10 ● 8 / 17	11 ● 20 / 34	12 ● 15 / 17	13 ● 20 / 34	14 ● 16 / 17	15
16 ● 26 / 34	17 ● 5 / 17	18 ● 25 / 34	19 ● 11 / 17	20 ● 19 / 34	21 ● 14 / 17	22
23	24 ● 18 / 17	25 ● 26 / 34	26 ● 15 / 17	27 ● 12 / 34	28 ● 15 / 17	29
30 ● 25 / 34	31 ● 6 / 17	01 ● 21 / 34	02 ● 15 / 17	03 ● 18 / 34	04 ● 16 / 17	05

# SURGICAL REFERRAL DASHBOARD

- Goal: enhance communication between surgeons and referring providers
- Physician champion: Ben Brooke, MD, PhD
- Builds on prior research on information needs and issues with traditional approach
- ONC High Impact Pilot (PIs: Brooke, Del Fiol)
- Covers PCP → surgeon and surgeon → PCP communication



### Encounter

#### Procedure(s)

Date	Name
Jun 29, 2017	AAA repair. <a href="#">✎</a>

#### Outcome of procedure / surgeon concerns to be conveyed to PCP

**B / I / U** [List icons]

Surgery successful, no issues. Post-op course uneventful.

### Care Plan

#### Surgery team (what we will do)

**B / I / U** [List icons]

#### Follow-up plan:

F/u in vascular surgery clinic in 1 week. Will remove sutures. F/u thereafter at 1 and 3 months.

#### PCP (what we would like you to do)

**B / I / U** [List icons]

#### Follow-up plan:

Please call the vascular surgery clinic if there is any sign of infection.

#### Prognosis / recovery expectations:

Full recovery expected in 2-4 weeks.

### Surgery Team

#### Surgeon

- Benjamin Sands Brooke
- VASCULAR SURGERY

VIEW SURGERY TEAM

#### Surgery Team Contact

Vascular Surgery

801-581-8301 (Vasc. Surg. providers 8am - 4pm)  
 801-585-7676 (Vasc. Surg. scheduling, 8am - 4pm)  
 801-339-7100 (Vasc. Surg. on-call pager for emergencies, 4pm - 8am)

### Primary Care Team

#### Primary Care Provider

- Michael Flynn
- Location Not Available

VIEW PCP TEAM

SAVE SEND TO REFERRING PROVIDER

# OPIOID DECISION SUPPORT

- Goal: provide point-of-care decision support for opioid use and pain management
- Physician champions:
  - Jill Sindt, MD
  - Scott Junkins, MD
  - David Anisman, MD
- CDC support
- External partners: Yale, Houston Methodist

Maximum morphine equivalent daily dose (MEDD) is **545 mg/day** (PRN meds assumed to be taken at maximum allowed frequency). Taper to < 50.

Active Opioid Rx	Max MEDD
<p><b>[ New ] Oxycodone Hydrochloride 5 MG Oral Tablet</b></p> <p>&gt; Sig: 5 mg Oral Every 4 hours as needed</p> <p>&gt; Daily dose: Oxycodone Oral Tablet 6/d * 5 mg = 30 mg. Morphine equivalence: 1.5x.</p>	45 mg
<p><b>72 HR Fentanyl 0.1 MG/HR Transdermal System</b></p> <p>&gt; Sig: Apply 1 patch to the skin Every 72 hours.</p> <p>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</p> <p>&gt; Dispense: 30 patches. Refills: 0. Expected supply duration: through 2017-12-17.</p> <p>&gt; Daily dose: Fentanyl patch: 1 * 0.1 mg/hr = 0.1 mg/hr. Morphine equivalence: 2400x.</p>	240 mg
<p><b>Buprenorphine 2 MG Sublingual Tablet</b></p> <p>&gt; Sig: Place 2 mg under the tongue 2 times a day.</p> <p>&gt; Prescriber: HISTORICAL, MEDS.</p> <p>ⓘ &gt; Daily dose: Buprenorphine Sublingual Tablet 2/d * 2 mg = 4 mg. Morphine equivalence: 30x.</p>	120 mg
<p><b>Methadone Hydrochloride 10 MG Oral Tablet</b></p> <p>&gt; Sig: Take 0.5 tablets by mouth Every 6 hours as needed for pain for up to 180 days.</p> <p>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</p> <p>&gt; Dispense: 360 tablets. Refills: 0. Expected supply duration: through 2017-12-30.</p> <p>&gt; Daily dose: Methadone Oral Tablet 4/d * 5 mg = 20 mg. Morphine equivalence: 4x.</p>	80 mg
<p><b>Oxycodone Hydrochloride 5 MG Oral Capsule</b></p> <p>&gt; Sig: Take 2 capsules by mouth Every 6 hours as needed.</p> <p>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</p> <p>&gt; Dispense: 180 capsules. Refills: 0. Expected supply duration: through 2017-06-23.</p> <p>&gt; Daily dose: Oxycodone Oral Capsule 4/d * 10 mg = 40 mg. Morphine equivalence: 1.5x.</p>	60 mg
<b>Total</b>	<b>545 mg</b>

CDC opioid recommendation #5  
MME conversion table

Source: CDC



# MDCALC EHR INTEGRATION

- Goal: enable seamless integration of medical calculations within clinical workflows
- Physician champions: Mike Strong, MD + many others
- MDCalc: leading medical calculation tool
  - > 1 million monthly users from 196 countries
  - 35+ specialties, 200+ conditions

## CURB-65 Score for Pneumonia Severity

Estimates mortality of community-acquired pneumonia to help determine inpatient vs. outpatient treatment.

### Confusion

Glasgow Coma Score Total: **12**; 3hr 0min ago, 8/14/17 12:00 PM (latest from past 48hrs)  
( $\leq 14$  considered to be confused)

No 0

Yes +1

### BUN > 19 mg/dL (> 7 mmol/L)

BUN: **15 mg/dl**; 2hr 50min ago, 8/14/17 12:10 PM (latest from past 72hrs)

No 0

Yes +1

### Respiratory Rate $\geq 30$

Respiratory Rate: **20 /min**; 2hr 17min ago, 8/14/17 12:43 PM (latest from past 24hrs)

No 0

Yes +1

### Systolic BP < 90 mmHg or Diastolic BP $\leq 60$ mmHg

Systolic BP: **120 mm[Hg]**; 2hr 17min ago, 8/14/17 12:43 PM (latest from past 24hrs)

Diastolic BP: **60 mm[Hg]**; 2hr 17min ago, 8/14/17 12:43 PM (latest from past 24hrs)

No 0

Yes +1

### Age $\geq 65$

Age: **84.16 yrs**

No 0

Yes +1

**3** points

Severe risk group: 14.0% 30-day mortality.

Consider inpatient treatment with possible intensive care admission.

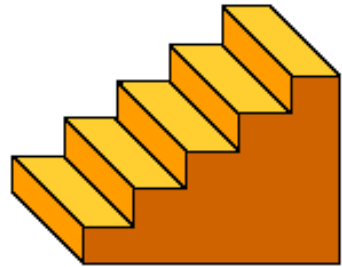


# CHECKLIST



- Important problem
- Feasible to implement solution
- Engaged clinical champions
- Benefits > Costs of implementation
- EHR vendor does not support
- EHR vendor will not support in near future
- Cannot meet need via EHR configuration
- Security acceptable (local hosting or remote hosting with local client execution)

# STEPS



- Analyze and understand source data
- Analyze available APIs, extend as needed
  - Preference for FHIR STU2 APIs
  - Custom extensions where needed
  - Planned migration to CIMI
- Iterate design with end users
- Testing, code review, and security review
- Release into production and iterate based on feedback

# CHALLENGES WITH THE DATA AND APIS

- Real-life data is messy
  - Manually entered lab data missing units
  - Problem list that isn't maintained
  - Rx SIGs that are free-texted
- Many potential ways to say the same thing
  - EHR vendor A's implementation of an API may or may not be the same as EHR vendor B's implementation
    - E.g., Show home meds when inpatient? Code set for med route?
  - Custom APIs we develop suffer from the same problem
    - E.g., Should administered phototherapy be a Procedure or an Observation?

# CHALLENGES WITH THE DATA AND APIS (CONT.)

- No established mechanism for sharing custom API implementations
  - Yet existing API implementations often fall short of clinical needs
  - Trade-off between easy-to-share and less-functional vs. more-functional and harder-to-share solutions

# POTENTIAL SOLUTION

- Drive data modeling and API implementation based on high-value use cases
  - i.e., where we are building a solution for production use
- Use CIMI as the core data model underlying implementations
- Collaborate among institutions when building new APIs
  - EHR engagement critical



# MORE LESSONS LEARNED AND KEY QUESTION

- Lessons learned
  - Interoperability of FHIR interfaces across EHR vendors still in early stages
  - Custom FHIR interfaces needed in many cases; need to figure out how to best share across institutions and EHR vendor platforms
- Key question
  - How can we best collaborate on interoperable apps and services to improve patient care and the provider experience?
  - Interactive discussion on this key question at Healthcare Services Platform Consortium Implementers Forum, 2/15-16, Salt Lake City, Utah (<https://www.hspconsortium.org/>)