



---

# EXAMPLES OF FHIR-BASED SOLUTIONS FROM THE UNIVERSITY OF UTAH

2018 UNIVERSITY OF WASHINGTON FHIR WORKSHOP  
SEPTEMBER 24, 2018

*KENSAKU KAWAMOTO, MD, PHD, MHS*

*ASSOCIATE CHIEF MEDICAL INFORMATION OFFICER*

*VICE CHAIR OF CLINICAL INFORMATICS, DEPT. OF BIOMEDICAL INFORMATICS*

# DISCLOSURES

- In the past year, I have been a consultant or sponsored researcher on clinical decision support for ONC\*, Hitachi, McKesson InterQual, and UC San Francisco
- Several of the apps, services, and tools described are being commercialized to enable wider impact

\*via various subcontractors

# NEONATAL BILIRUBIN APP

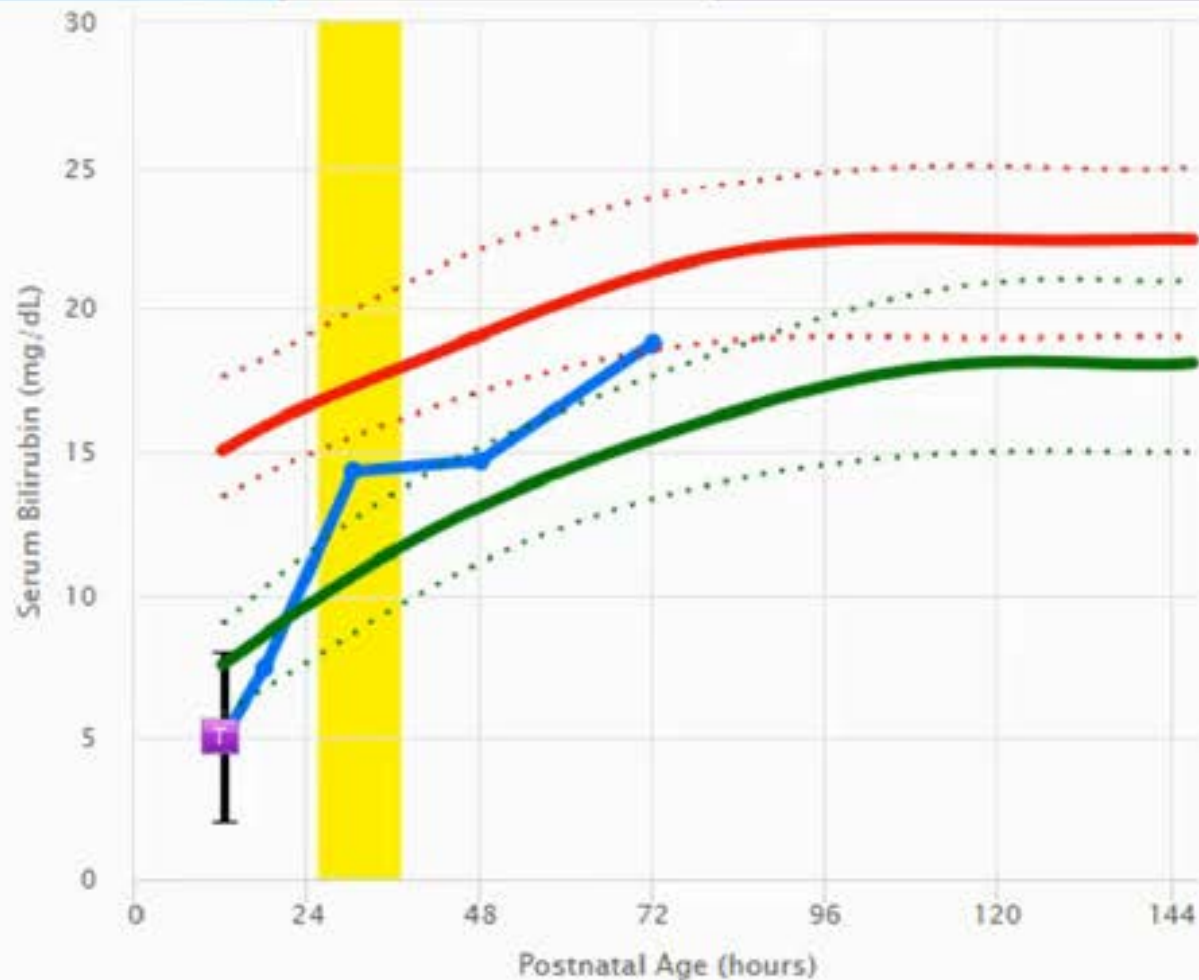
- Goal: improve neonatal bilirubin management and prevent neurotoxicity
- Iteratively enhanced based on user requests
- Estimated to save >300 hrs of MD time/yr
- Awarded HHS Provider User Experience App Challenge Awards ([link](#))

# 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)

© 2017 Epic Systems Corporation. Used with permission.

# PROCEDURE SCHEDULE MANAGEMENT APP

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

Refresh

# July 2017

?
⌵
✕
<<
>>
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

[About ECT Calendar App](#)

© 2017 Epic Systems Corporation. Used with permission.

# SURGICAL REFERRAL DASHBOARD

- Goal: enhance communication between surgeons and referring providers
- 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.

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

**B / I / U**

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

### Care Plan

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

**B / I / U**

#### 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**

#### 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



# MDCALC EHR INTEGRATION

- Goal: enable seamless integration of medical calculations within clinical workflows
- 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.

# DIABETES MANAGEMENT DASHBOARD

- Goal: assist clinicians with diabetes management decision making
- Collaboration with Hitachi, Ltd. Data Science team
- Developed and leveraging predictive models of therapy outcomes with AUC of 0.87

Next Goal

7.0% in 6 mo.

Med. Option

Options Comparison

**Current** MET

62% Success rate

22% (Target)

39% (Current)

**Benefits**  
Low risk of low blood sugar

**Risks**  
Stomach discomfort, diarrhea

✓ \$ \$5 /Mo

AETNA Coverage Information

- MET
- Metformin ER 1000 mg \*\*\*high medication cost
- Metformin ER 500 mg
- Metformin ER 750 mg
- Metformin IR 1000 mg
- Metformin IR 500 mg
- Metformin IR 850 mg

MET GLP-1

34% Success rate

34% (Current)

**Benefits**  
Low risk of low blood sugar

**Risks**  
Stomach discomfort, diarrhea  
Nausea

\$\$\$ \$716 /Mo

AETNA Coverage Information

- GLP-1
- Trulicity 0.75 mg/0.5ml, 1.5 mg/0.5ml (QL)
- Victoza (QL)

MET DPP-4

57% Success rate

57% (Current)

✓ **Benefits**  
Low risk of low blood sugar

**Risks**  
Stomach discomfort, diarrhea  
Allergic reaction (rare)

\$\$ \$373 /Mo

AETNA Coverage Information

- MET,DPP-4
- Janumet (QL)
- Janumet XR 100-1000 mg, 50-1000 mg, 50-500 mg (QL)
- DPP-4
- Januvia (QL)
- Onglyza (QL)
- Tradjenta (QL)

# OPIOID DECISION SUPPORT

- Goal: provide point-of-care support for CDC guideline on opioid use for chronic pain outside of active cancer treatment, palliative care, or end-of-life care



**GUIDELINE FOR PRESCRIBING OPIOIDS FOR CHRONIC PAIN**

IMPROVING PRACTICE THROUGH RECOMMENDATIONS

CDC's *Guideline for Prescribing Opioids for Chronic Pain* is intended to improve communication between providers and patients about the risks and benefits of opioid therapy for chronic pain, improve the safety and effectiveness of pain treatment, and reduce the risks associated with long-term opioid therapy, including opioid use disorder and overdose. The Guideline is not intended for patients who are in active cancer treatment, palliative care, or end-of-life care.

<https://www.cdc.gov/drugoverdose/prescribing/guideline.html>

- CDC-sponsored effort. Partners: ONC, Yale, ESAC.
- <http://build.fhir.org/ig/cqframework/opioid-cds/>

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> <ul style="list-style-type: none"> <li>&gt; Sig: 5 mg Oral Every 4 hours as needed</li> <li>&gt; Daily dose: Oxycodone Oral Tablet 6/d * 5 mg = 30 mg. Morphine equivalence: 1.5x.</li> </ul>	45 mg
<p><b>72 HR Fentanyl 0.1 MG/HR Transdermal System</b></p> <ul style="list-style-type: none"> <li>&gt; Sig: Apply 1 patch to the skin Every 72 hours.</li> <li>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</li> <li>&gt; Dispense: 30 patches. Refills: 0. Expected supply duration: through 2017-12-17.</li> <li>&gt; Daily dose: Fentanyl patch: 1 * 0.1 mg/hr = 0.1 mg/hr. Morphine equivalence: 2400x.</li> </ul>	240 mg
<p><b>Buprenorphine 2 MG Sublingual Tablet</b></p> <ul style="list-style-type: none"> <li>&gt; Sig: Place 2 mg under the tongue 2 times a day.</li> <li>&gt; Prescriber: HISTORICAL, MEDS.</li> <li>! &gt; Daily dose: Buprenorphine Sublingual Tablet 2/d * 2 mg = 4 mg. Morphine equivalence: 30x.</li> </ul>	120 mg
<p><b>Methadone Hydrochloride 10 MG Oral Tablet</b></p> <ul style="list-style-type: none"> <li>&gt; Sig: Take 0.5 tablets by mouth Every 6 hours as needed for pain for up to 180 days.</li> <li>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</li> <li>&gt; Dispense: 360 tablets. Refills: 0. Expected supply duration: through 2017-12-30.</li> <li>&gt; Daily dose: Methadone Oral Tablet 4/d * 5 mg = 20 mg. Morphine equivalence: 4x.</li> </ul>	80 mg
<p><b>Oxycodone Hydrochloride 5 MG Oral Capsule</b></p> <ul style="list-style-type: none"> <li>&gt; Sig: Take 2 capsules by mouth Every 6 hours as needed.</li> <li>&gt; Prescriber: Michael Flynn, MD. Rx date: 2017-09-19.</li> <li>&gt; Dispense: 180 capsules. Refills: 0. Expected supply duration: through 2017-06-23.</li> <li>&gt; Daily dose: Oxycodone Oral Capsule 4/d * 10 mg = 40 mg. Morphine equivalence: 1.5x.</li> </ul>	60 mg
<b>Total</b>	<b>545 mg</b>

CDC opioid recommendation #5  
MME conversion table

Patient's average oral morphine equivalence (OME) is **192.33** mg/day.

**Daily Average OME (mg/day)**



For adults, CDC recommends reassessing evidence of individual benefits and risks when increasing dosage to  $\geq 50$  OME/day, and avoid increasing dosage to  $\geq 90$  OME/day or carefully justifying such a decision.

Active Opioid Rx	Avg OME/day*
ⓘ <b>New Oxycodone Hydrochloride 15 MG Oral Tablet</b> ⌵	<b>135 mg</b>
<b>FENTANYL CITRATE 200 MCG BU LPOP</b> ⌵ ⚠ Verify taking; Rx may have expired	<b>17.33 mg</b>
<b>HYDROCODONE-ACETAMINOPHEN 10-325 MG PO TABLET</b> ⌵ ⚠ Verify taking; Rx may have expired ⚠ Not adding OME for presumed redundant Rx's with start dates of 02/07/18 and 03/07/18.	<b>40 mg</b>
<b>Total Average OME/Day</b>	<b>192.33 mg</b>

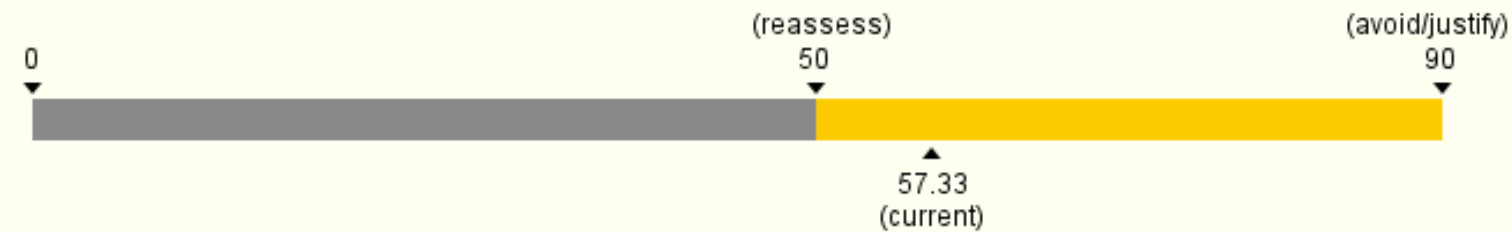
\*Avg OME = (qty dispensed)/(days supply). 30d supply assumed unless otherwise noted in Sig or note to pharmacy.  
 \*Max OME (see details) = max amount patient may take on a given day according to Sig, even if patient runs out of med early.

[OME conversion table](#)  
[CPG opioid Rx guideline](#)  
 Source: [CDC opioid Rx guideline -- recommendation #5](#)

## Outpatient Opioid Oral Morphine Equivalence (OME) Calculator

Patient's average oral morphine equivalence (OME) is **57.33** mg/day.

### Daily Average OME (mg/day)



For adults, CDC recommends reassessing evidence of individual benefits and risks when increasing dosage to  $\geq$  50 OME/day.

Active Opioid Rx	Avg OME/day*
<b>FENTANYL CITRATE 200 MCG BU LPOP</b> ☹	<b>17.33 mg</b>
⚠ Verify taking; Rx may have expired	
<b>HYDROCODONE-ACETAMINOPHEN 10-325 MG PO TABLET</b> ☹	<b>40 mg</b>
⚠ Verify taking; Rx may have expired	
⚠ Not adding OME for presumed redundant Rxs with start dates of 02/07/18 and 03/07/18.	
<b>Total Average OME/Day</b>	<b>57.33 mg</b>

\*Avg OME = (qty dispensed)/(days supply). 30d supply assumed unless otherwise noted in Sig or note to pharmacy.

\*Max OME (see details) = max amount patient may take on a given day according to Sig, even if patient runs out of med early.

[OME conversion table](#)

[CPG opioid Rx guideline](#)

Source: [CDC opioid Rx guideline -- recommendation #5](#)

©2018 Epic Systems Corporation. Used with permission.



# LESSONS LEARNED AND FUTURE DIRECTIONS

- FHIR-based solutions hold great potential for improving patient care and provider experience
  - Important complement to traditional EHR optimization
- Areas of current and planned focus:
  - Evaluation
  - Widespread dissemination and deployment
  - Many more apps and services
  - Disease Management Dashboard
    - Decision support, 1-click documentation and ordering

# ACKNOWLEDGMENTS (PARTIAL LIST)

- Amy Ballard, MBA
- Benjamin Brooke, MD
- Brent Hill, PhD
- Bryn Rhodes
- Carole Stipelman, MD, MPH
- Charlene Weir, PhD, RN
- David Anisman, MD
- David Shields
- Damian Borbolla, MD, MS
- Farrant Sakaguchi, MD, MS
- Graham Walker, MD
- Greg Bayles, MEAE
- Guilherme Del Fiol, MD, PhD
- Heidi Kramer, PhD
- Hideyuki Ban, PhD
- Howard Weeks, MD
- Isaac Vetter
- Jan Losby, PhD
- Jill Sindt, MD
- Jim Turnbull, DHA
- Joe Habboushe, MD, MBA
- Julie Shakib, DO, MPH
- Junichi Kuwata
- Kevin Shekleton
- Kyle Turner, PharmD
- Matt Varghese, MS
- Michael Flynn, MD
- Mike Donnelly
- Mike Strong, MD
- Nitu Kashyap, MD
- Phillip Warner, MS
- Richard Bradshaw, PhD
- Rick Freeman
- Rick Shiffman, MD
- Roger Altizer, PhD
- Ryan Cornia
- Salvador Rodriguez, PhD
- Scott Junkins, MD
- Scott Narus, PhD
- Shinji Tarumi
- Travis Cummings
- Travis Gregory
- Wataru Takeuchi
- Wesley Sargent, EdD
- Yi Lu

# THANK YOU!

Kensaku Kawamoto, MD, PhD, MHS

Associate Chief Medical Information Officer

Associate Professor and Vice Chair for Clinical Informatics, Dept. of  
Biomedical Informatics

University of Utah

[kensaku.kawamoto@utah.edu](mailto:kensaku.kawamoto@utah.edu)