

# Evolution of Clinical Decision Support

Dr. David McCallie

# The Evolution of Clinical Decision Support

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Cerner Corp.

# Agenda

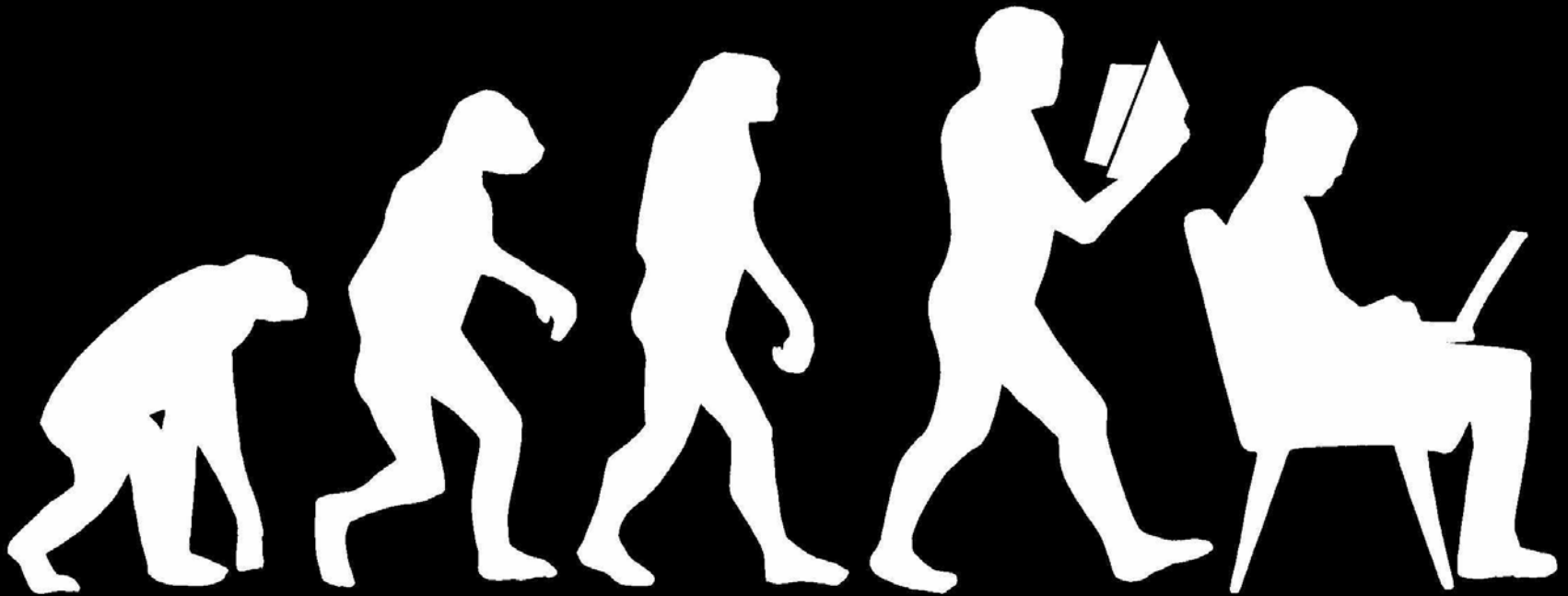
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General Observations

Some Examples

# Evolution of CDS?

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# Broad Spectrum of CDS



**Identify**

**DISCERN ALERT**  
NAME: McKenna, Steve  
DATE: October 2, 2011 10:08:27 CDT  
MRN: 00001694  
BIRTH DATE: January 04, 1973  
AGE: 38  
LOCATION: BASELINE WEST M, 4 North - ICU - 404

The following clinical events suggest that your patient may have sepsis. Please Sepsis Management PowerPlan that has been suggested for this patient.

Early goal directed therapy is essential for the treatment of sepsis. Time dependent intervention may impact patient outcome.

**SIRS Criteria**  
1002/11 1001 Blood Glucose, Capillary = 290 mg/dL (H) [greater than 120]  
1002/11 1001 Temperature Oral = 39.3 C (H) [greater than 38.3]  
1002/11 1001 Affect/Behavior = Agitated, Anxious

**Organ Dysfunction**  
1002/11 1001 Respiratory Rate = 40 mmHg (L) [less than 30]  
1002/11 1001 Mean Arterial Pressure, Cuff = 30 mmHg (L) [less than 65]

**Propose**

**Significant Events**  
Results From: Last Sepsis event  
03/06/2011 08:47

Apical Heart Rate: 132.5 bpm  
Temperature Oral: 39.3 C  
Respiratory Rate: 38 bpm  
Systolic Blood Pressure: 160 mmHg

Event Traced: 03/06/2011 08:47

McKenna, Steve H56 Years DOB: 12/01/1974 Weight: 87.64 / 193.00 Height: 202.86 / 109.78

**Select Suspected Infection Source** | **Select Support Infection Type** | **Select Recommendation**

**Select Suspected Infection Source\***

**Select Support Infection Type\***

**Select Recommendation\***

**Antibiotics**

**Fluid Therapy**

**Additional Studies**

**Optional Therapies**

**Intervene**

**Outcomes**

Outcome	Status	By Phase End
Verbalize Understanding of VTE Education	Activated	4/4/2012 3:33 PM CDT - Phase End
DVT Signs and Symptoms	Activated	4/4/2012 3:33 PM CDT - Phase End
PE Signs and Symptoms	Activated	4/4/2012 3:33 PM CDT - Phase End
VTE Treatment Plan	Activated	4/4/2012 3:33 PM CDT - Phase End
Complications of Anticoagulation	Activated	4/4/2012 3:33 PM CDT - Phase End
VTE Complications of Condition	Activated	4/4/2012 3:33 PM CDT - Phase End
Patient Specific VTE Risk Factors	Activated	4/4/2012 3:33 PM CDT - Phase End

**Interpreting**

- Education VTE Prophylaxis Ordered 04/04/12 15:33:00 CDT, Constant order
- Weight Ordered 04/04/12 15:33:00 CDT, Daily
- \*\*\*MEDICAL PROPHYLAXIS\*\*\*
- Assure Correct Size, Proper Application of Mech Prophylaxis Activated 4/4/2012 3:33 PM CDT - Phase End
- Done
- Monitor Mechanical VTE Prophylaxis at All Times Activated 4/4/2012 3:33 PM CDT - Phase End
- Evaluate ambulation frequency and duration prior to discontinuing mechanical prophylaxis
- If patient unable to ambulate collaborate with physician for OT evaluation for assist device
- \*\*\*PHARMACOLOGIC PROPHYLAXIS\*\*\*
- Consult to Pharmacy Ordered 04/04/12 15:33:00 CDT, Routine, hepar... for heparin dosing and monitoring

**Sign Alerts**

**Sign Alerts (Chart)**

Alert	Type	Description	Location	Severity	Start	End	Status
Alert 1	Warning	Alert 1 Description	ICU 404	Warning	10/02/11 10:08:27	10/02/11 10:08:27	Resolved
Alert 2	Warning	Alert 2 Description	ICU 404	Warning	10/02/11 10:08:27	10/02/11 10:08:27	Resolved

**Quality Measures**

Measure	Target	Actual	Status
Measure 1	95%	90%	Not Met
Measure 2	90%	85%	Not Met
Measure 3	85%	80%	Not Met

**Report 1**

Category	Value
Category 1	100%
Category 2	95%
Category 3	90%

**Manage**

**Analyze**

# User Experience

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Reactive -> interrupt

Interactive -> assist

Ambient -> guide

# Knowledge Representation

---

Scripts

Rules

Algorithms & agents

“Big data” & learning

# Knowledge Source

---

Locally authored

Vendor packages

Cloud-based services

Third-party via imported content

Third-party via interactive plugins



# Workflow Integration

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Foreground (triggers)

Background (event monitors)

Network (multi-agent monitors)

# Data and Access

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Ad hoc codes + “curly braces” (Arden)

Value sets + vMR + ECA rules? (HeD)

Clinical Element Models + FHIR?

# Decision Support Goals

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Avoid harm

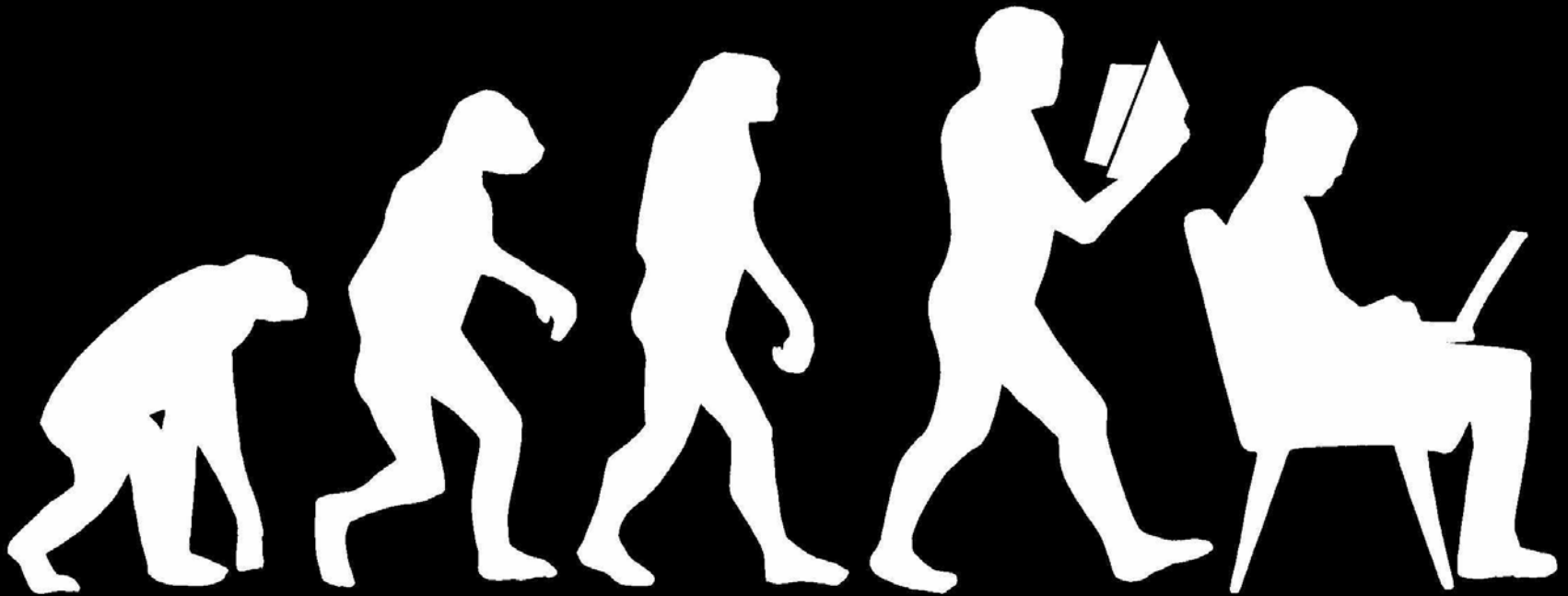
Guide therapy (Tx)

Guide Dx and Tx

Prevent Dx

# Some (random) examples...

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# Traditional ADE Interaction Alert

**Decision Support** Multum, Denver  
00012169

IDENTIFIED ORDER:  
**warfarin**

Show:

Status	Type	Severity	Overrid...	Name
Ordered	<b>D</b>	<b>●</b>		amiodarone 500 mg, Tab, Oral, Daily, Routine, 05/23/11 16:49:00 CDT
Ordered	<b>D</b>	<b>●</b>		ciprofloxacin 250 mg, Tab, Oral, q12hr, Routine, 06/01/11 12:00:00 CDT

Previous Override Reason:

Current Override Reason:   Apply To All

**warfarin - amiodarone (interaction)**

warfarin() amiodarone(): MAJOR

**MONITOR CLOSELY:** Amiodarone may increase the pharmacologic effects of warfarin by inhibiting CYP450 2C9 hepatic metabolism of S-warfarin. Similar effects may also occur with other oral anticoagulants, resulting in significant hypoprothrombinemia and bleeding. When amiodarone is added to an anticoagulant regimen, increased anticoagulant effects may become apparent within one to several weeks and may persist for months after the amiodarone is discontinued. The effects of this interaction are highly variable - while some patients are asymptomatic, serious and life-threatening bleeding complications have been reported in others. Patients who are poor CYP450 2C9 metabolizers may have a higher risk of bleeding and a faster onset of the interaction.

**MANAGEMENT:** An empiric 30% to 50% reduction in anticoagulant dosage has been recommended, in addition to frequent monitoring of the patient and the prothrombin time or International Normalized Ratio (INR). Patients should be advised to notify their physician promptly if they experience any signs of excessive anticoagulation such as unusual or prolonged bleeding, bruising, vomiting, change in stool or urine color, headache, dizziness, or

Drug Reference | Education Leaflet | Reference | BNF

warfarin

## warfarin

[Pharmacology](#), [Warnings](#), [Pregnancy](#), [Lactation](#), [Side Effects](#), [IV Compatibility](#), [Dosage](#), [Additional Dosage](#)

### Pharmacology (Top)

#### Pharmacology

Warfarin, a coumarin derivative, is an oral anticoagulant. Warfarin is administered in racemic form. The S-enantiomer of warfarin appears to be a more potent anticoagulant than the R-enantiomer.

The mechanism of action of warfarin involves interference with the cyclical interconversion of vitamin K and vitamin K epoxide. Vitamin K is reduced to vitamin KH<sub>2</sub>, which is an essential cofactor in the synthesis of clotting factors II, VII, IX, and X, as well as protein C and protein S. Vitamin KH<sub>2</sub> is converted to vitamin K epoxide in the factor synthesis process. The conversion of vitamin K epoxide to vitamin K is interrupted by warfarin, essentially resulting in a vitamin K-deficient state and reduced production of the vitamin K-dependent clotting factors.

Warfarin is approved by the FDA for use in the treatment of deep venous thrombosis and pulmonary embolism, as well as for the prophylaxis of thromboembolism associated with atrial fibrillation and cardiac valve replacement. Warfarin is also approved for use after myocardial infarction (MI) to reduce the risk of death, subsequent MI, and thromboembolic events such as stroke or systemic embolization after myocardial infarction.

While not FDA approved indications, warfarin may be useful for the treatment of heart failure and it may reduce the risk of ischemic events in patients with giant cell arteritis. In general, routine anticoagulation for patients with heart failure is controversial. Most experts believe that heart failure in patients with (1) a history of pulmonary or systemic thromboemboli, (2) atrial fibrillation, or (3) left ventricular thrombi should definitely be treated with warfarin therapy unless strong contraindications exist.

#### Pharmacokinetics

The bioavailability of warfarin is 100%. The onset of warfarin is dependent upon the half-lives of factors II.

# eRx – Guidance + Pre-screened choices

Testpatient, Anna 15 Y F ALLERGIES: Recorded

PCP: Bascomb, Daphne DOB: 9/23/1990 MRN: MEMBER NUMBER: 13757790

eRx

## Treatment Map

New Rx:

### Other Arrhythmias

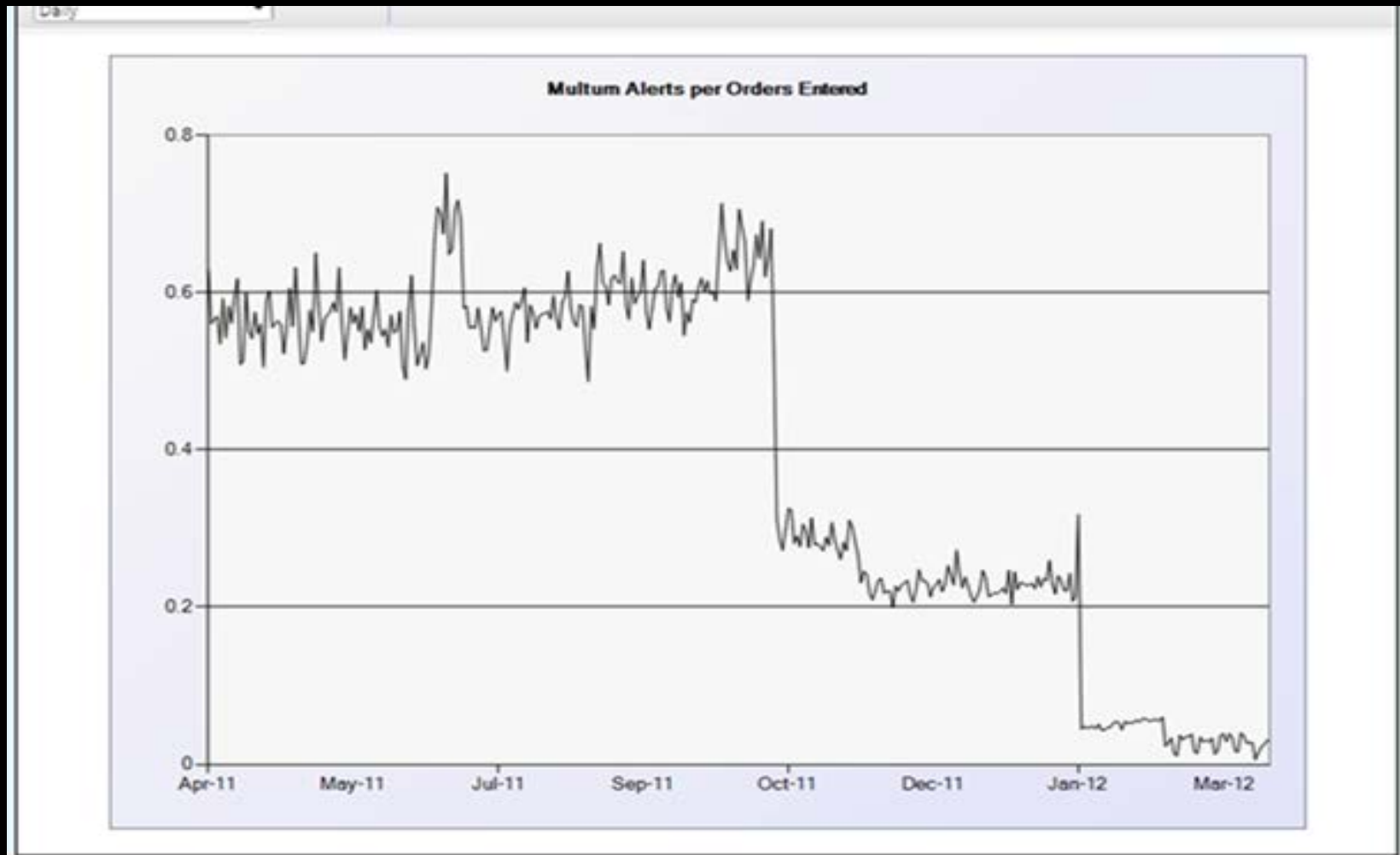
#### All Medications

- adenosine
- antiplatelet agents
- beta blockers for arrhythmia**
- cardiac glycosides
- class 1A antiarrhythmics
- class 1B antiarrhythmics
- class 1C antiarrhythmics
- class III antiarrhythmics
- heparin
- non-dihydropyridine CCB's
- sympathomimetic agents
- vagolytic agents
- warfarin, oral

#### beta blockers for arrhythmia

Pref	atenolol (Tenormin)
Pref	bisoprolol (Zebeta)
PA* !!!	carvedilol (Coreg)
Pref	metoprolol (Lopressor, Toprol-XL)
Pref !!!	nadolol (Corgard)
Pref !!!	propranolol (Inderal)

# Reduction in “nuisance” ADE alerts



# Interactive CDS

## Multi-step VTE Advisor

Sheffield, David M 59 Years DOB: 10/31/1951 BMI: 31 Weight: 94.8 kg FIN: 000331661 Location: 1122

Discern Advisor@ VTE Prophylaxis

\* Selection Required

This page is not a complete source of visit information.

Evaluate Patient Risk > Identify Contraindications > Select Recommendation > Document and Sign

### Evaluate Patient Risk

#### Current State

Relevant Allergies

None found

Relevant Lab Results

None found

Active Anticoagulation Orders

None found

Cancel

Patient Type\* **Medical**

Risk Factors\* **Padua Score 4 or greater**

Padua Risk Score: 4 [Padua Score table](#)

Category	Documented	Category	Documented
<input type="checkbox"/> Acute infection and/or rheumatologic disorder		<input type="checkbox"/> Previous VTE	
<input type="checkbox"/> Acute myocardial infarction/ischemic stroke		<input type="checkbox"/> Reduced mobility	
<input type="checkbox"/> Active cancer		<input type="checkbox"/> Trauma and/or surgery less than one month	
<input checked="" type="checkbox"/> Already known thrombophilic condition	01/11/2002	<input type="checkbox"/> Ongoing hormonal treatment	
<input type="checkbox"/> Heart and/or respiratory failure		<input checked="" type="checkbox"/> Obesity (BMI greater than 30)	Body Mass Index Measured: 31 08/17/11 16:22:00

Continue

### Identify Contraindications

Pharmacologic Contraindications\*

NONE

Absolute	Evidence	Absolute	Relative	Evidence
<input type="checkbox"/> Coagulopathy (non therapeutic)		<input type="radio"/>	<input type="radio"/>	Thrombocytopenia
<input type="checkbox"/> Active bleeding		<input type="radio"/>	<input type="radio"/>	Uncontrolled hypertension
<input type="checkbox"/> History of Heparin Induced Thrombocytopenia (HIT)		<input type="radio"/>	<input type="radio"/>	Infective endocarditis
<input type="checkbox"/> Thrombolytics given within past 24 Hr		<input type="radio"/>	<input type="radio"/>	Active hepatitis or Hepatic insufficiency
<input type="checkbox"/> Severe trauma		<input type="radio"/>	<input type="radio"/>	Other
<input type="checkbox"/> Spinal tap or epidural catheter within next 24 Hr				

Mechanical Contraindications\*

- No Mechanical Contraindications
- Bilateral lower extremity amputation

- Bilateral lower extremity trauma
- Other



# Contextual, ambient, actionable guidance

[Links](#) [Notifications \(Loading\)](#) [Options](#) [Current](#) [Add](#) [Help](#)  
[New Note](#) [View Sticky Notes](#) [Tear Off](#) [Attach](#) [Charges](#) [Charge Entry](#) [Exit](#) [Calculator](#) [Message Sender](#) [AdHoc](#) [Communicate](#)

DOB: 12/21/1967    Age: 45 years    Sex: Male    Allergies: Penicillin  
 Weight: 187 lbs.    MRN: 200365448    FIN: 1005-63251

Search This Chart    Print    1 minute ago

### Vitals

	Most Recent	Previous	Previous	Previous
Temperature (96-100 DegF)	98.3 30 minutes	98.2 6 days	98.6 7 days	98.0 3 months
Heart Rate (60-90 bpm)	86 30 minutes	82 6 days	↑92 7 days	82 3 months
Respiratory Rate (12-24 breaths per minute)	20 30 minutes	17 6 days	22 7 days	18 3 months
Blood Pressure (100-120/60-80 mm/Hg)	↑142/↑88 30 minutes	118/80 6 days	↑124/↑83 7 days	↑122/↑83 3 months
O2 Saturation (>92%)	97 30 minutes	98 6 days	98 7 days	97 3 months
Height (inches)	5'11" 30 minutes	5'11" 6 days	5'11" 7 days	5'11" 1 year
Weight (lbs)	200 30 minutes	203 6 days	204 7 days	210 3 months
BMI (kg/m2)	27.9 30 minutes	28.3 6 days	28.4 7 days	29.3 3 months

#### Temperature

96-100 DegF

Results Actions    Add Comment

Date	Temperature	Time	Setting
2013 Today	98.3	8:29	Oral Outpatient
2013 Sep 30	98.2		Axillary Inpatient
2013 Sep 29	98.6		Axillary Inpatient
2013 Jul 6	98.0		Oral Outpatient
2012 Oct 20	↑ 100.2		Oral Outpatient

#### Patient Entered

Discuss recent hospitalization for chest pain and abnormal LDL

[Diet and Exercise Log](#)  
[Patient entered ROS](#)

#### Differential Checklist

- Ischemic Heart Disease
- Hyperlipidemia
- Insulin Resistance
- Neuroacanthocytosis

Powered by: [Isabel](#)

#### Smoking Cessation

Problem: Tobacco Abuse  
Order: Chantix  
Patient Education: Smoking Cessation (Cha..)

[Add All](#)    [Dismiss](#)

### Recommendations

Present - September 2014    Group by: Program

Incomplete    Completed

Expectation	Priority	Frequency	Due
<b>Quality Indicator</b>			
🔴 Tobacco Cessation Screening and Counseling	High	--	This Visit
<b>Health Maintenance</b>			
🟡 Influenza Immunization	High	Q 1year(s)	Nov 14, 2013
Colorectal Screening	High	Q 10year(s)	Apr 01, 2014

#### Tobacco Cessation Screening and Counseling

This Visit (Oct 05, 2013)

Contraindicate    Actions

Due

#### Patient Entered ROS

Positives:  
Chest Tightness  
Difficulty Swallowing  
[...more](#)

[Import](#)    [Dismiss](#)

#### Patient Education

Chest Pain

[Add](#)    [Dismiss](#)

# Contextual, ambient, actionable guidance

MedCalc 3000

[AaPO2 Correction](#)

Anion Gap

Appar Score

[View all](#) [Patient calculat](#)

---

**AaPO2 Correction for FIO2**

AaPO2  torr

FIO2  %

**RESULTS**

AaPO2 Corrected  torr

Decimal Precision: 2

[Cancel](#) [Post to EHR](#)

Isabel isabel

Show Clinical Features

- Pulmonary Edema
- Rocky Mountain Spotte...
- Hypotensive Disorders
- ✓ Renal Failure
- Pulmonary Thromboemb...
- ✓ Waterhouse-Frideriche...

[Dismiss](#) [View Details](#)

Study Reminder

Recruiting for a study on patients with a **family history of breast cancer**. If appropriate, may we contact this patient for this study?

[Yes](#) [No](#) [Dismiss](#)

CareDecisions Cardiology

**Diabetes:** Risk 31%

**CHF Re-Admission:** Risk 22%

[Dismiss](#)

Significant Events !

Filter By: [Sepsis](#) [Criteria](#)

Last Sepsis Event: 3/8/2011 6:47:00 PM

Apical Heart Rate: **125**

Temperature Oral: **38.4**

Respiratory Rate: **34**

03/08/2011 Sepsis Management Init...

03/06/2011 Central venous pres 8 m..

03/06/2011 ScvO2 70%

[Launch Sepsis Empiric Therapy Advisor](#)

[Dismiss](#)

Chart Alert !

This patient has been flagged with the following chart alert(s):

**Clinical alerts:** Potential drug abuser

**Administrative alerts:** Financial Concepts

Charted Date: November 06, 2012

MyClinicalInfo.com

[Modify](#) [Ignore](#) [Cancel](#) [OK](#)

Outside Information

**Population Record** 2/22

**HIE View(s)**

LACIE 12/5/2011

DHIN --

**Document Exchange** [Reconcile New](#)

Baseline West Medical 2/6

North Kansas City Hosp 0/3

Childrens Mercy Hospit 0/3

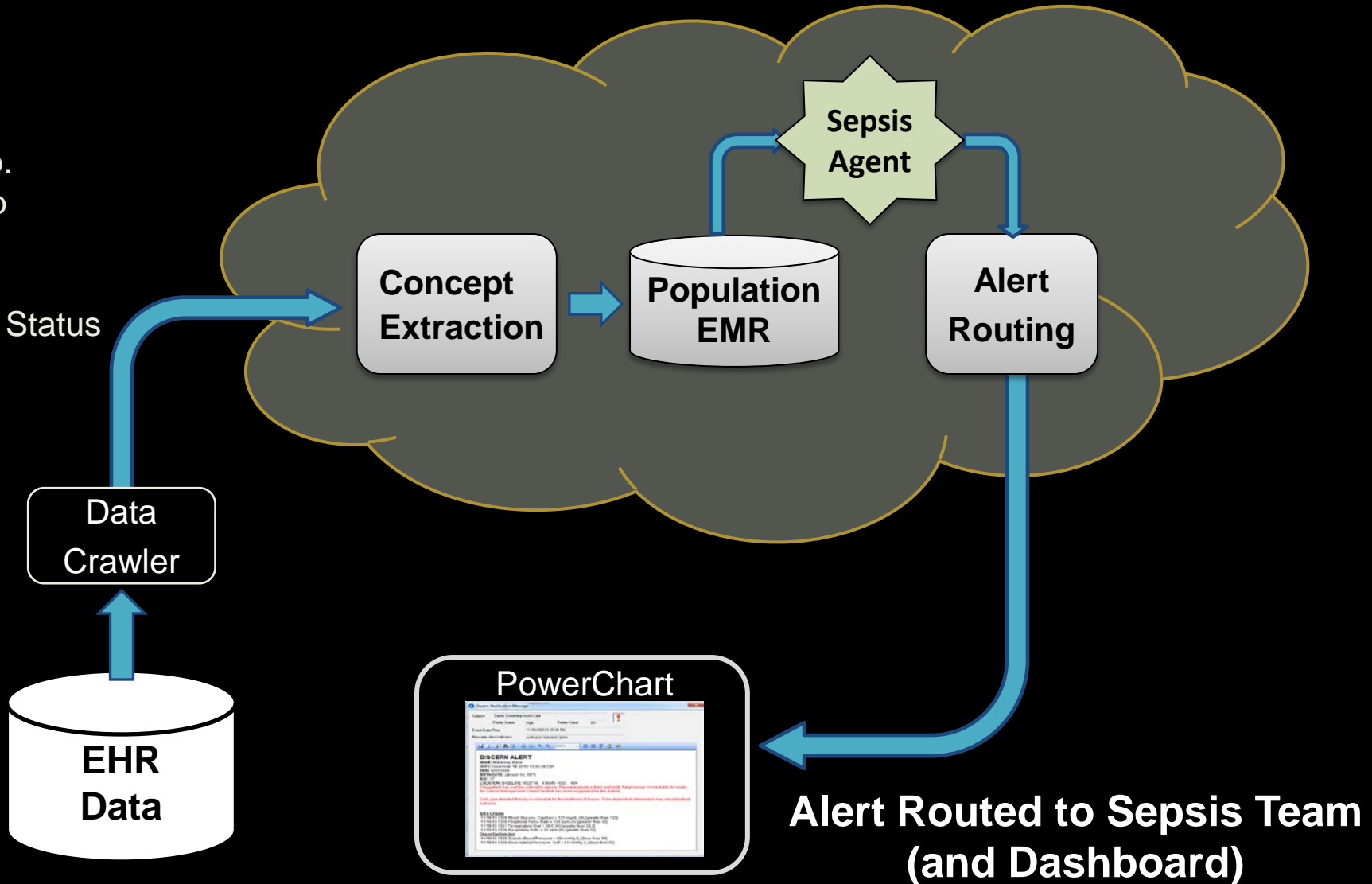
Last Query: 10/02/12

**Surescripts Rx Histo** 12/5/2011

[Dismiss](#)

# Cloud-based CDS Continuous Sepsis Agent

HR  
Resp.  
Temp  
BP  
Labs  
CNS Status  
Etc.



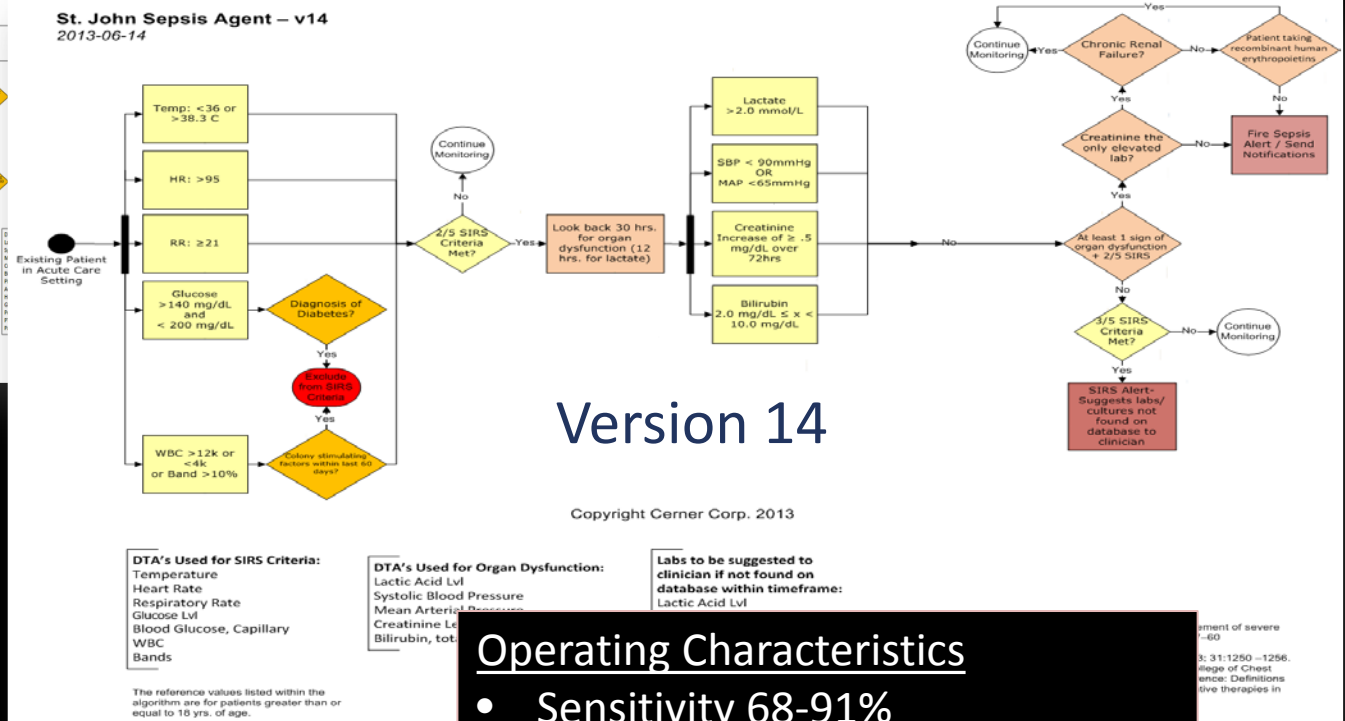
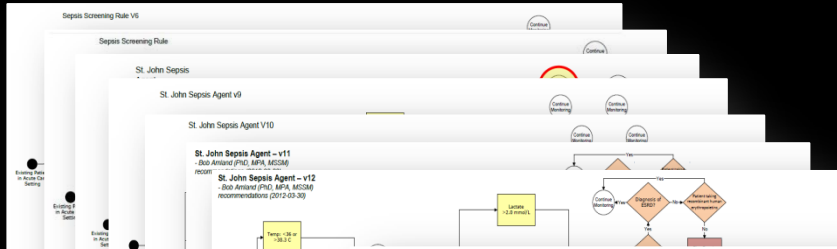
**Alert Routed to Sepsis Team  
(and Dashboard)**

# Cloud-based Sepsis

## Iterative, “crowd-sourced” Refinement

### Real-time Monitoring

- Over 160 facilities
- ~40K persons per hour
- ~800K lives per day



### Operating Characteristics

- Sensitivity 68-91%
- Specificity 91-97.6%
- PPV up to 68%

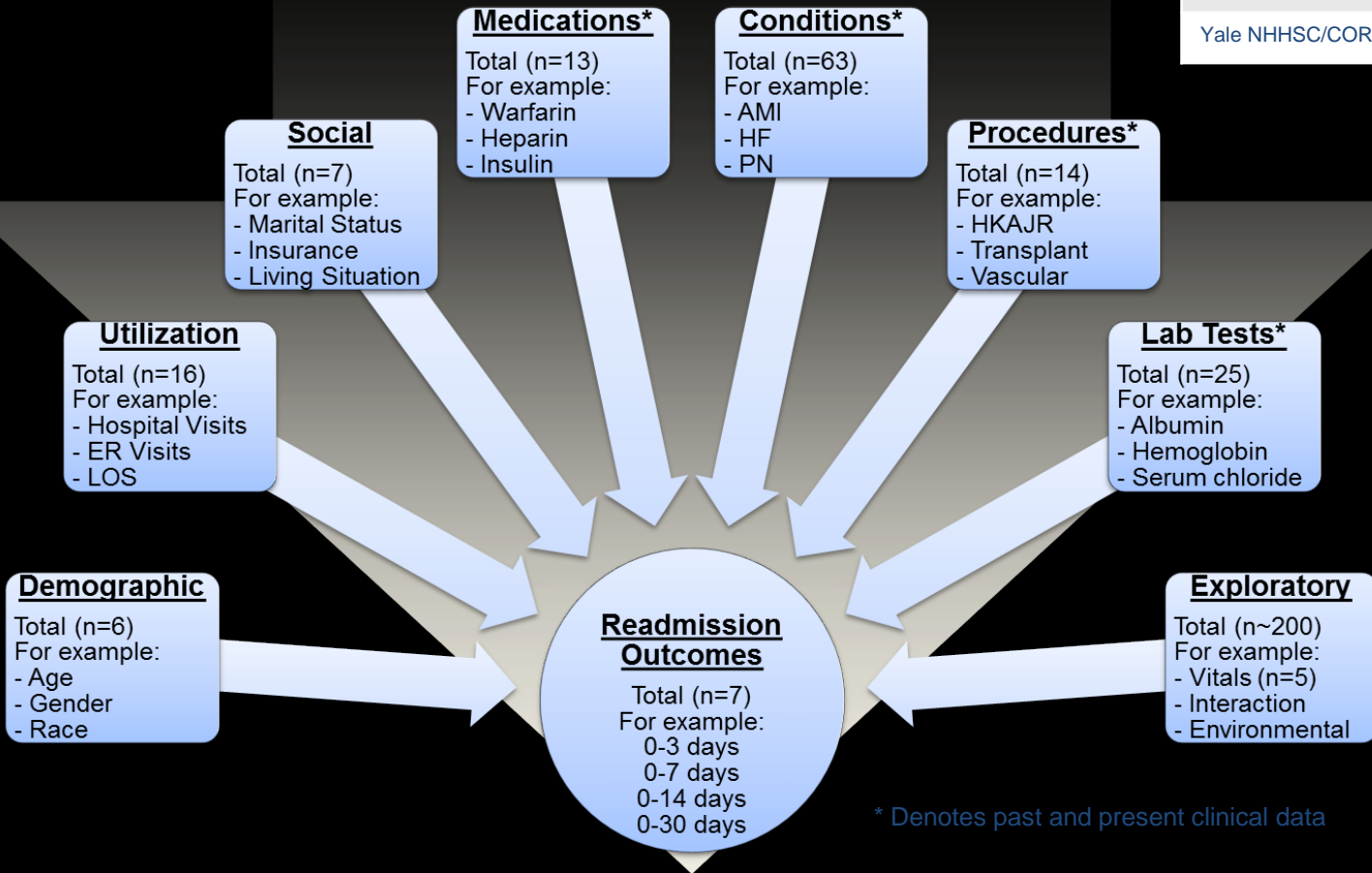
ment of severe  
 -60  
 3: 31:1250 -1256.  
 ilage of Chest  
 ence: Definitions  
 tive therapies in

# All Cause Readmission Prediction Model



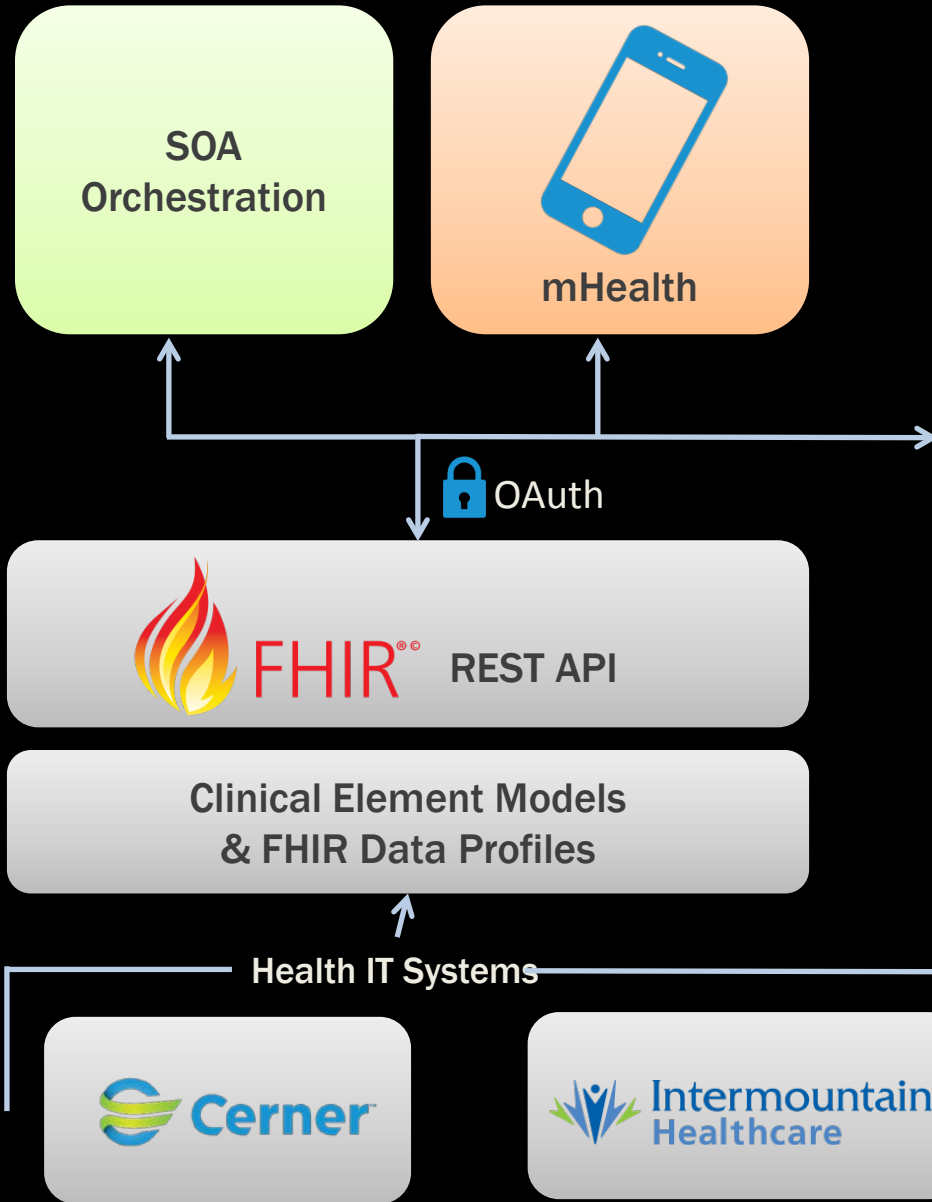
## Hospital Readmission Risk Factors (N~700)

Models	C-Stat
<i>ACC Model</i>	<i>0.78</i>
Previous Model	0.69
Average models reviewed in JAMA <sup>1</sup>	0.66
Yale NHHSC/CORE for CMS <sup>2</sup>	0.66



\* Denotes past and present clinical data

# SMART on FHIR® – Open Platform Architecture



**SMART™**  
Web Apps

Children's Hospital Boston  
Intermountain Healthcare  
visualdx  
"polyglot"  
Health Through Understanding  
HARVARD MEDICAL SCHOOL

Trusted App Registry

PT-FIVE XTESTHIMSS Male dob: 06 Apr 2002 age: 11y 10m 15d

Hour Specific Bilirubin Risk Chart for Term & Near-Term Infants with NO Additional Risk Factors

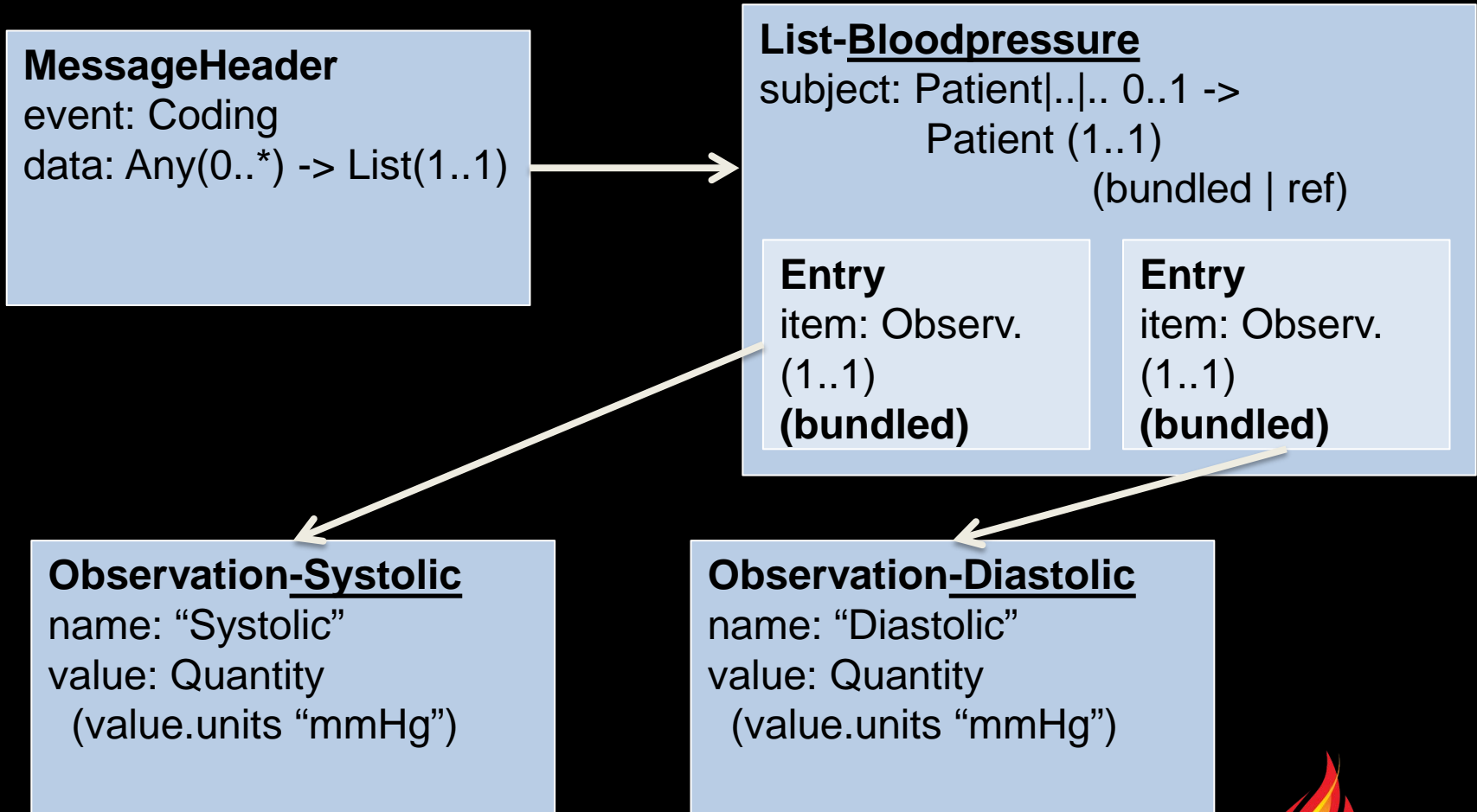
Date/Time	Result
04/06/2002 06:00	4.5
04/07/2002 06:00	12.5
04/07/2002 12:00	12.6
04/07/2002 12:00	12.8
04/08/2002 11:20:00	11
04/10/2002 20:00	9.8

<http://smartplatforms.org/smart-on-fhir/>

# FHIR Resource “Observation”

```
<Observation xmlns="http://hl7.org/fhir">
  <name><!-- 1..1 CodeableConcept Type of observation (code / type) --></name>
  <value[x]><!-- 0..1 Quantity|CodeableConcept|Attachment|Ratio|Period|
    SampledData|string Actual result --></value[x]>
  <interpretation><!-- 0..1 CodeableConcept High, low, normal, etc. --></interpretation>
  <comments value="[string]"/><!-- 0..1 Comments about result -->
  <applies[x]><!-- 0..1 dateTime|Period
    Physiologically Relevant time/time-period for observation --></applies[x]>
  <issued value="[instant]"/><!-- 0..1 Date/Time this was made available -->
  <status value="[code]"/><!-- 1..1 registered | preliminary | final | amended + -->
  <reliability value="[code]"/><!-- 1..1 ok | ongoing | early | calibrating | error
  <bodySite><!-- 0..1 CodeableConcept Observed body part --></bodySite>
  <method><!-- 0..1 CodeableConcept How it was done --></method>
  <identifier><!-- 0..1 Identifier Unique Id for this particular observation --
></identifier>
  <subject><!-- 0..1 Resource(Patient|Group|Device|Location) Who and/or what --></subject>
  <specimen><!-- 0..1 Resource(Specimen) Specimen used for this observation --></specimen>
  <performer><!-- 0..* Resource(Practitioner|Device|Organization) Who did it --></performer>
  <referenceRange> <!-- 0..* Provides guide for interpretation -->
    <low><!-- ?? 0..1 Quantity Low Range, if relevant --></low>
    <high><!-- ?? 0..1 Quantity High Range, if relevant --></high>
    <meaning><!-- 0..1 CodeableConcept Indicates the meaning/use of this range --></meaning>
    <age><!-- 0..1 Range Applicable age range, if relevant --></age>
  </referenceRange>
</Observation>
```

# FHIR Profile for “Blood pressure”





# SMART on FHIR – Pluggable CDS (Intermountain Healthcare)

**DEMORA, CARRIE**    DOB:11/21/2005    Dose Wt:    Sex:Female    MRN:00001008    Attending:STRINGFIELD, STEVE  
 Allergies: Allergies Not Recorded    Age:8 years    My Health: No    Isolation:    Loc:BN 1N    Fin#:000001510

**SMART Bilirubin Tool**    Print 0 minutes ago

**CARRIE DEMORA**    sex Female    dob 21 Nov 2005    age 8y 3m 6d    Intermountain Healthcare

**Hour Specific Bilirubin Risk Chart for Term & Near-Term Infants with NO Additional Risk Factors**

Date/Time	Result	Age (Hrs)	Value:Test	Risk Zone
11/21/2005 06:00	4.5	6.00	Bili Meter	High Intermediate Risk Zone (75-95%)
11/22/2005 06:00	12.5	30.00	Bili Meter	High Risk Zone (>95%)
11/22/2005 12:00	12.6	36.00	Bili Meter	High Risk Zone (>95%)
11/22/2005 20:00	12.8	44.00	Bili Meter	High Intermediate Risk Zone (75-95%)
11/23/2005 20:00	11	68.00	Bili Meter	Low Intermediate Risk Zone (40-74%)
11/25/2005 20:00	9.8	116.00	Bili Meter	Low Risk Zone (<40%)

# SMART on FHIR – Pluggable CDS (VisualDx)

The screenshot displays a SMART on FHIR interface for patient VISTARO, BRUCE. The patient's information is shown in a yellow header bar: DOB: 03/19/1948, Age: 65 years, Sex: Male, MRN: 00001022, and Attending: STRINGFIELD, STEVE. The interface is titled "SMART Visual Dx" and includes a search bar for diagnoses, medications, or findings. The left sidebar contains a table of contents with "SMART Visual Dx" highlighted. The main content area shows search results for "Drug Eruption Search" and "Diagnosis Search".

**Patient Information:**

- VISTARO, BRUCE
- DOB: 03/19/1948
- Age: 65 years
- Sex: Male
- MRN: 00001022
- Attending: STRINGFIELD, STEVE

**Search Results:**

**Rx Drug Eruption Search: 7 of 7 Medications found in VisualDx**

- NIFEdipine 10 mg oral capsule
- Tylenol Extra Strength 500 mg oral tablet
- lisinopril 20 mg oral tablet
- naproxen 500 mg oral tablet
- Cipro 500 mg oral tablet
- Coumadin 4 mg oral tablet
- methotrexate 2.5 mg oral tablet

**Dx Diagnosis Search: 7 of 8 Conditions found in VisualDx**

- Wegener's granulomatosis
- Legionellosis

# SMART on FHIR – Pluggable CDS (VisualDx)

**VISTARO, BRUCE**    DOB:03/19/1948    Dose Wt:    Sex:Male    MRN:00001022    Attending:STRINGFIELD, STEVE  
Allergies: Allergies Not Recorded    Age:65 years    My Health: No    Isolation:    Loc:Cottonwood FP Fin#:000001635

SMART Visual Dx    Print    11 minutes ago

visualdx®    Differential Builder    Get VisualDx Mobile    share    help    Sign Out

## Legionellosis    Acute Pulmonary Infection

Print    [Grid Icon]    [Mobile Icon]

### Contents

- [ICD Codes](#)
- [Synopsis](#)
- [Look For](#)
- [Diagnostic Pearls](#)
- [Differential Diagnosis & Pitfalls](#)
- [Best Tests](#)
- [Management Pearls](#)
- [Therapy](#)
- [References](#)
- [Associated Medications](#)
- [Associated Findings](#)

### Clinical Scenario

**Acute Pulmonary Infection**  
[Chem-Bio-Rad Suspicion](#)

**POTENTIALLY LIFE-THREATENING EMERGENCY**

### ICD Codes

ICD-9-CM:  
482.84 – Pneumonia due to legionnaires' disease

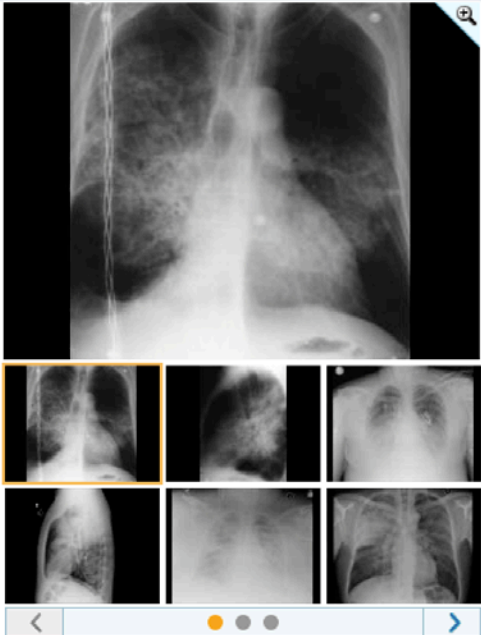
ICD-10-CM:  
A48.1 – Legionnaires' disease

### Synopsis

Legionellosis is caused by *Legionella pneumophila*, a small gram-negative bacillus found in aqueous environments in a wide variety of habitats at temperatures ranging from 5-50 degrees Celsius.

Almost all cases of legionellosis are a result of inhalation of aerosolized bacteria residing in warm, man-made water bodies such as water heaters, air-conditioning equipment, cooling towers, warm-water baths, warm-water plumbing systems, and recirculating water systems. Contamination of such water systems in hospitals has led to nosocomial outbreaks of disease.

The occurrence of disease is dependent on the simultaneous existence of a virulent strain, environmental conditions permitting survival and aerosolization of bacteria, and a susceptible host. Legionellosis (also known as Legionnaires' disease) is believed to occur throughout the world, with 8,000-18,000 cases occurring each year in the United States. About a quarter of these originate in a hospital environment and are associated with a higher proportion of fatalities. Most cases are sporadic. Less than one fifth of all cases are associated with an outbreak.



View all 14 images

# Futures for CDS

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Ambient > interruptive

Guidance > interdiction

Cloud-based > local

Big learning > Big data

Community/population data > EHR local data

Algorithmic, multi-agent > scripts & rules

Multi-disease > single-disease

Pluggable “apps” > imported rules

SMART + FHIR + Element Models > DSS + vMR ?

# Thank You!

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