



Clinical Decision Support:

What's next

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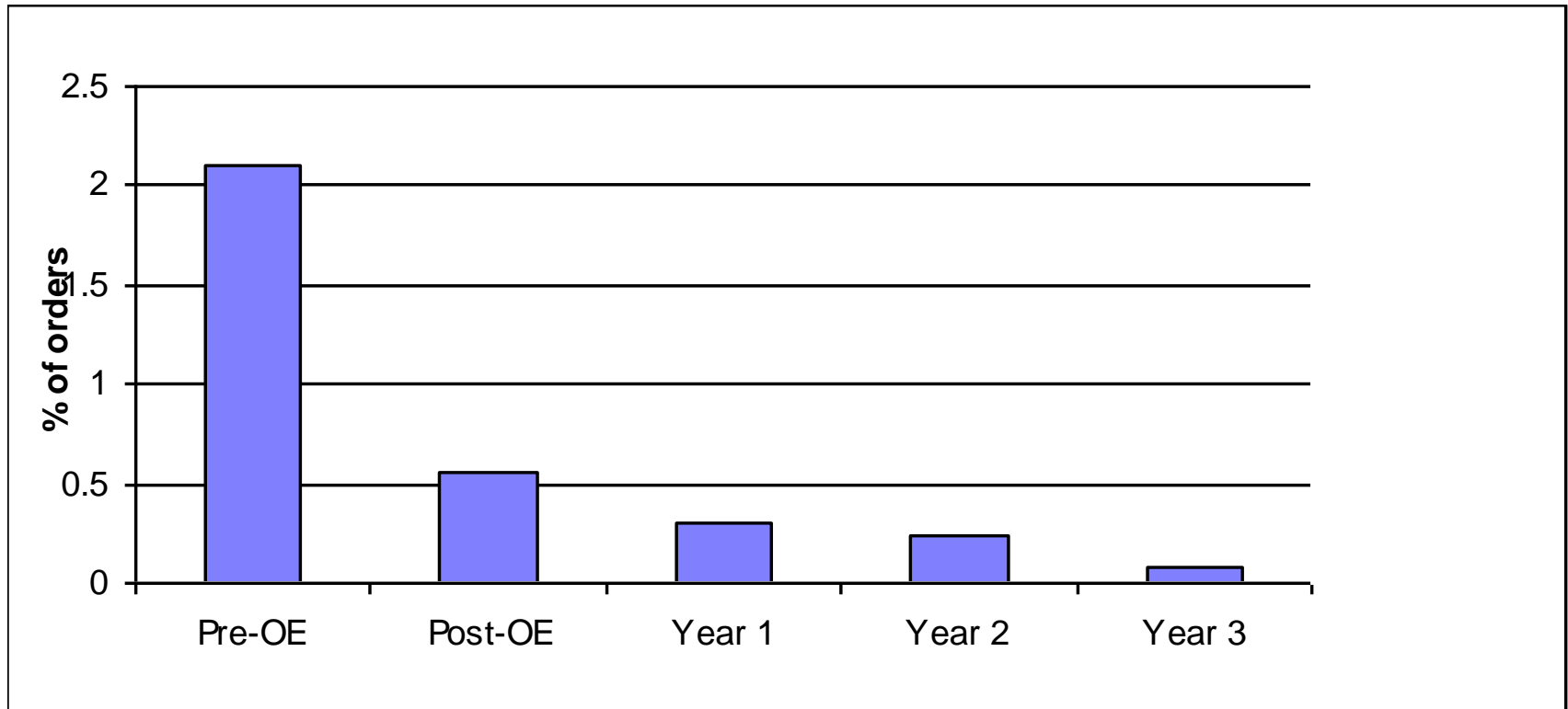
Disclosure



- Elsevier provides management tools and content for order sets, care plans, clinical pathways, drug information, smart reference, analytics, and probably other stuff I don't even know about.
- This talk contains a few examples from Elsevier, some from the Brigham, and a lot from general sources.
- None of the material is intended to be commercial.

Good CDS is good for healthcare

reduced dosing errors after implementing CDS with CPOE



News seems to fluctuate

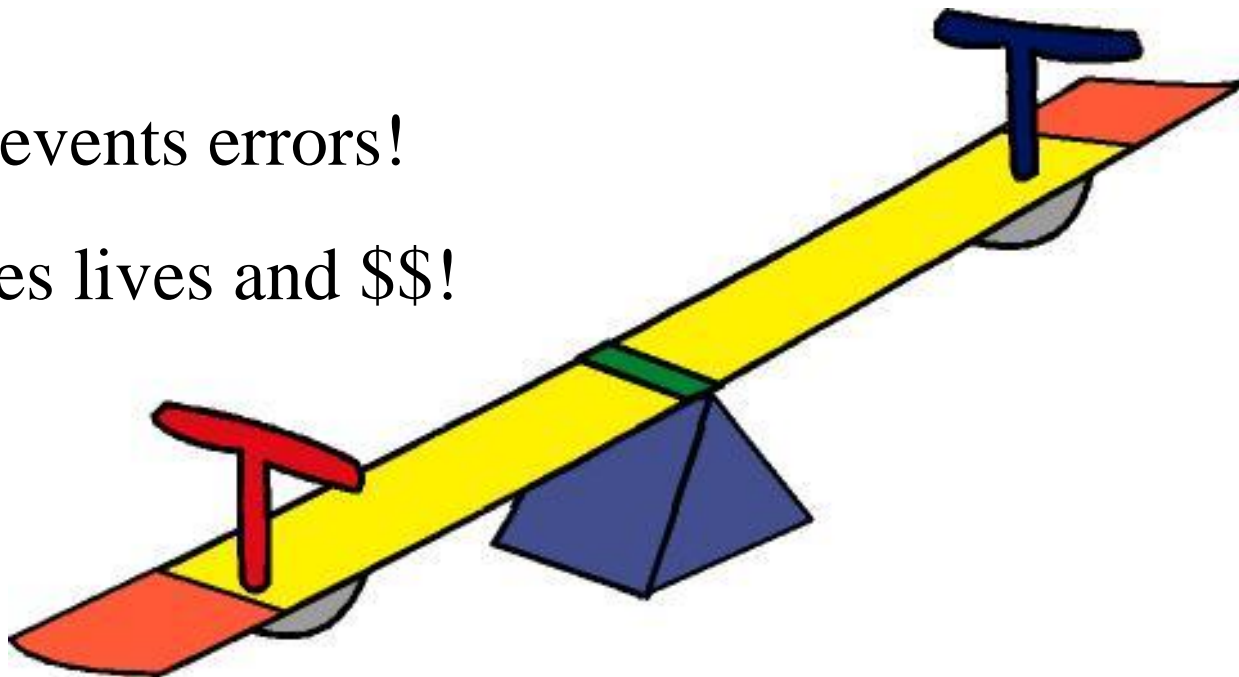


Causes errors!

Hurts patients!

Prevents errors!

Saves lives and \$\$!



Grand Challenges (2008)



Available online at www.sciencedirect.com



Journal of Biomedical Informatics 41 (2008) 387–392

Journal of
Biomedical
Informatics

www.elsevier.com/locate/yjbin

Grand challenges in clinical decision support

Dean F. Sittig ^{a,b,*}, Adam Wright ^{b,h}, Jerome A. Osheroff ^{c,d}, Blackford Middleton ^e,
Jonathan M. Teich ^{f,g}, Joan S. Ash ^b, Emily Campbell ^b, David W. Bates ^h

- Usability
- Share CDS artifacts (executable/readable)
- Provide CDS repositories
- Communicate best practice CDS
- Filter for co-morbidities
- Make use of free text information
- Learn new CDS from big data



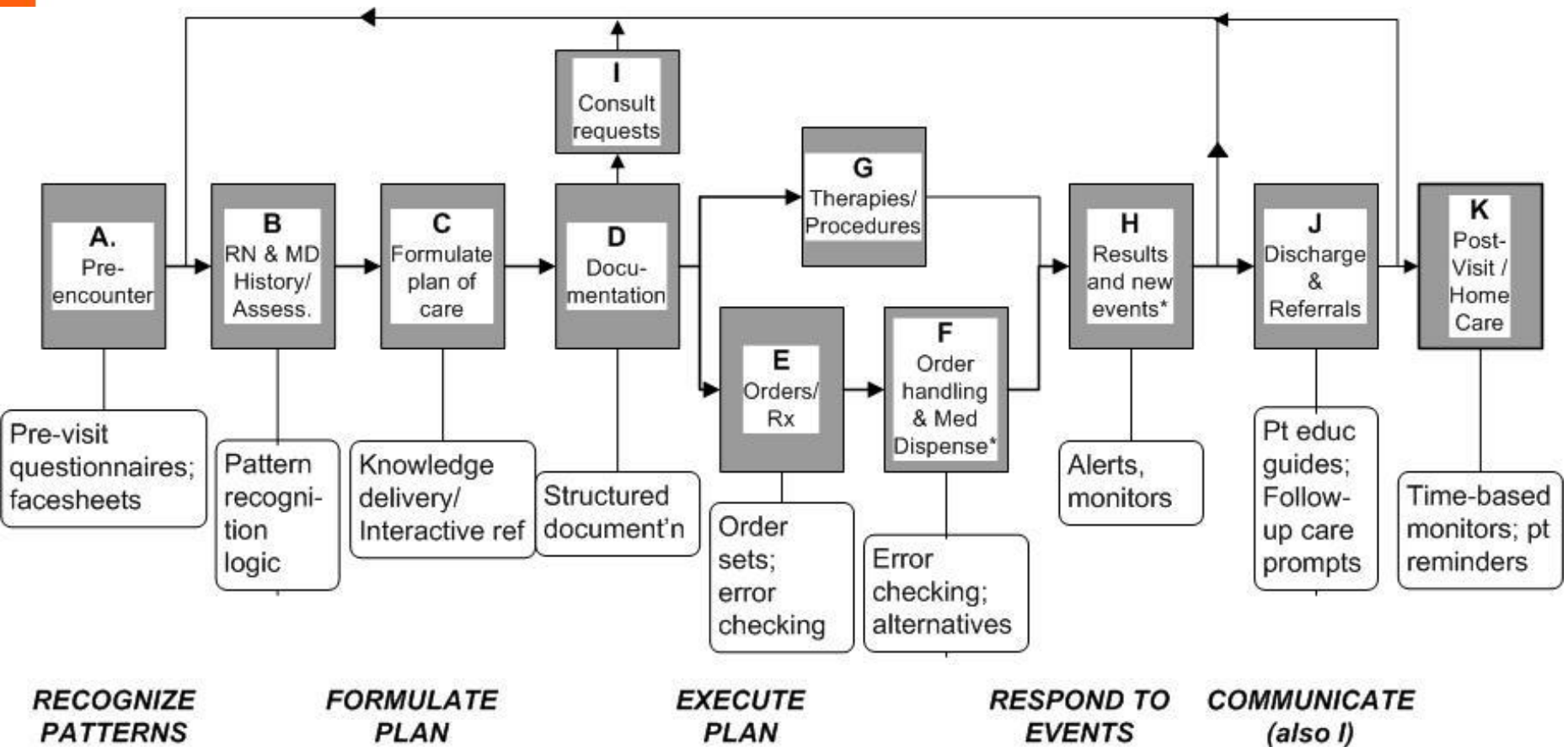
- Knowledge access
- Clinical pathways
- CDS sharing
- Back to the roots



Knowledge Access



Knowledge access





- At *Recognize* and *Formulate* time, it's about Q&A
 - Confirm things I know
 - Tell me about things I didn't know
 - Tell me about new things
- The “smart doc on my shoulder”:

Understanding information needs and queries

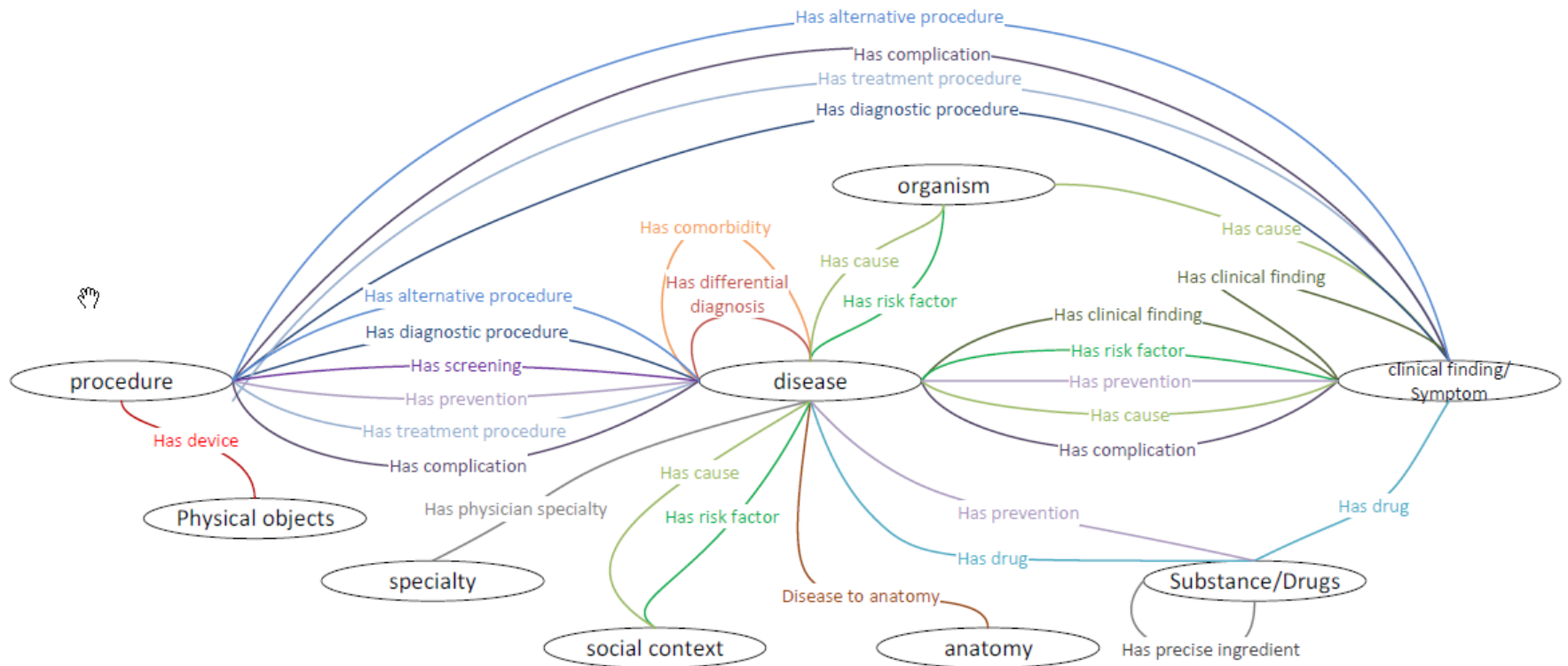
- 300,000 consecutive queries to MDConsult, ClinicalKey
- Synthesized ontology of information needs
- Agrees with and extends work of Ely et. al.

1	Sample search query	NEW: Mapping to standard question template	N
66	treatment of hyperhidrosis	How do I treat CONDX?	
67	atrial fibrillation anticoagulation	How effective is MED in the treatment of CONDX?	
68	(anemia) and diagnosis	How do I work up a patient with CONDX?	
69	(septic shock) and diagnosis	How do I work up a patient with CONDX?	
70	corticosteroids in bronchiolitis	How effective is MED in the treatment of CONDX?	B
71		How do I use MED in the treatment of CONDX?	B
72	"insulin pump therapy in children" and adolescents	How do I use MED in the treatment of CONDX?	D
73		How is OTHERTX used in the treatment of CONDX?	D
74	thrombolysis in myocardial infarction	How effective is MED in the treatment of CONDX?	A
75		How do I use MED in the treatment of CONDX?	A
76	indications for tpm	What are the risks and benefits of using OTHERTX in the treatment of CONDX?	N
77	deep brain stimulation for parkinson's disease	What are the risks and benefits of using OTHERTX in the treatment of CONDX?	P
78		How is OTHERTX used in the treatment of CONDX?	P

Doctors only ask about 80 questions

59	How do I perform STUDY?						
60	What DX could cause lab test finding RESULT?						
61	* Diagnosis: Differential Diagnosis (by Topic 1...2...n)						
62	How do I distinguish CONDX from CONDX2...n?						
63	Compare DX1...DXn as the cause of OBS1...OBSn (differential diagnosis)						
64	What DXs could cause history finding OBS?						
65	What DXs could cause physical finding OBS?						
66	What DXs could be the cause of OBS1+...OBSn?						
67	What DX could cause lab test finding RESULT?						
68	* Diagnosis: Consultation						
69	In what circumstances should I obtain consultation in the workup of CONDX?						
70	* Treatment: Summary Approach						
71	What are the best treatment options for CONDX?						
72	How should I manage condition CONDX (not specifying diagnostic or therapeutic)?						
73	Compare MED1...MEDn (or med class 1...n) for treating CONDX						
74	Compare medical vs. surgical vs. other treatment for CONDX						
75	* Treatment: Medications: (by Drug 1...2...n)						
76	What is the best medication treatment for CONDX?						
77	How effective is MED in the treatment of CONDX?						
78	What is the dosing of MED?						
79	What are the side effects and adverse effects of drug MED, and how do I avoid/manage them?						
80	Are there contraindications to using MED?						

Convert evidence → Knowledge graphs, triples

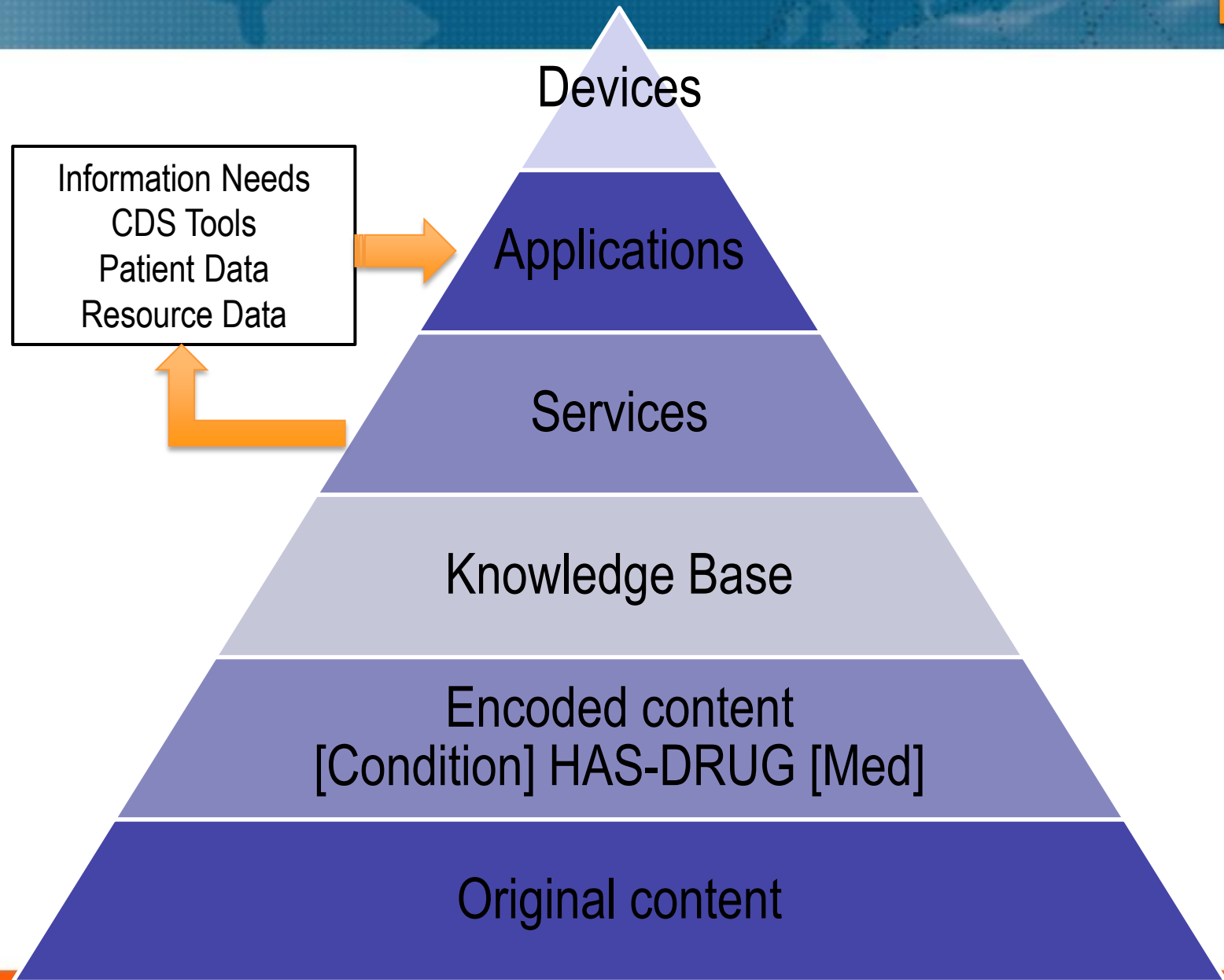


Strep pharyngitis

has drug
SOE: 10 SOR: 9

penicillin

Knowledge as a service tuned to need



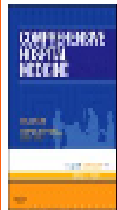
Precision Information to answer queries



Find an answer to:

Go

ASSESSMENT Differential Diagnosis Syncope versus Seizures



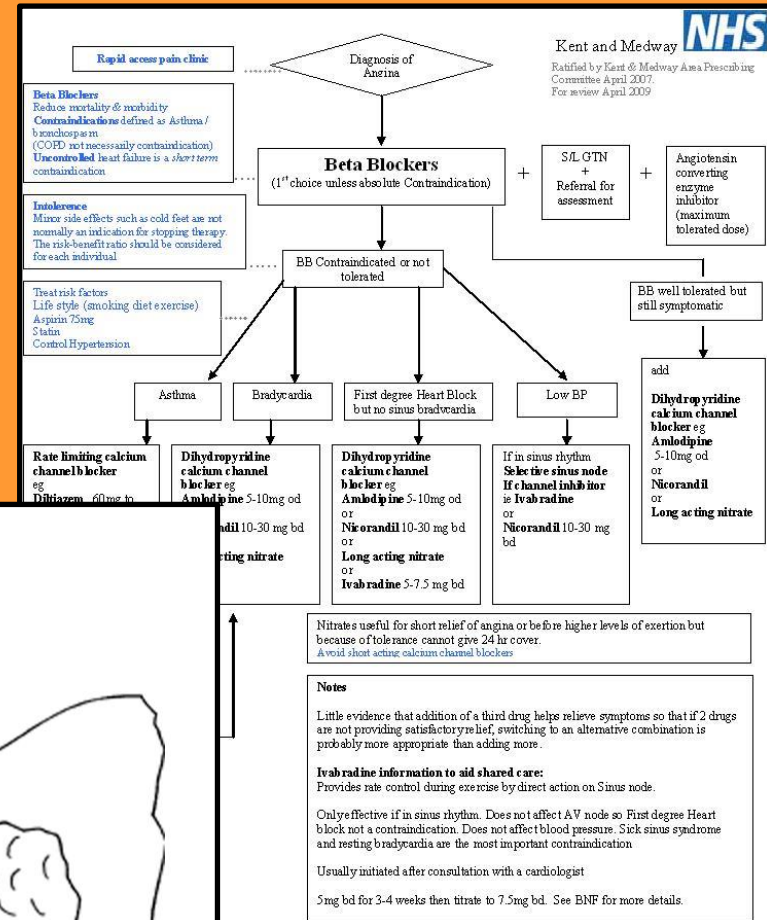
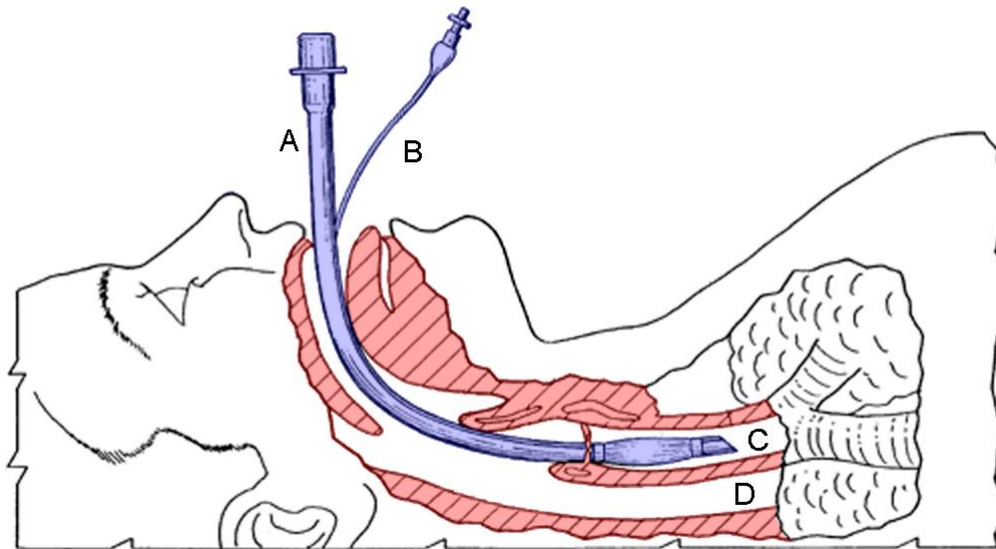
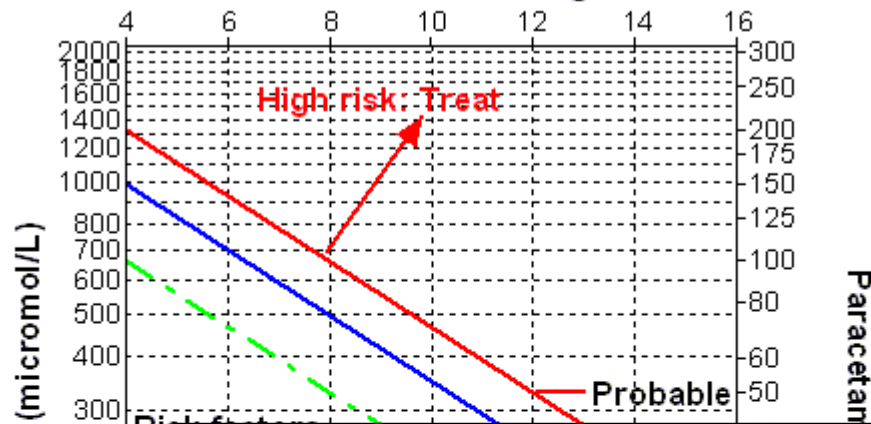
From Syncope

Source: [Comprehensive Hospital Medicine](#) (YEAR)

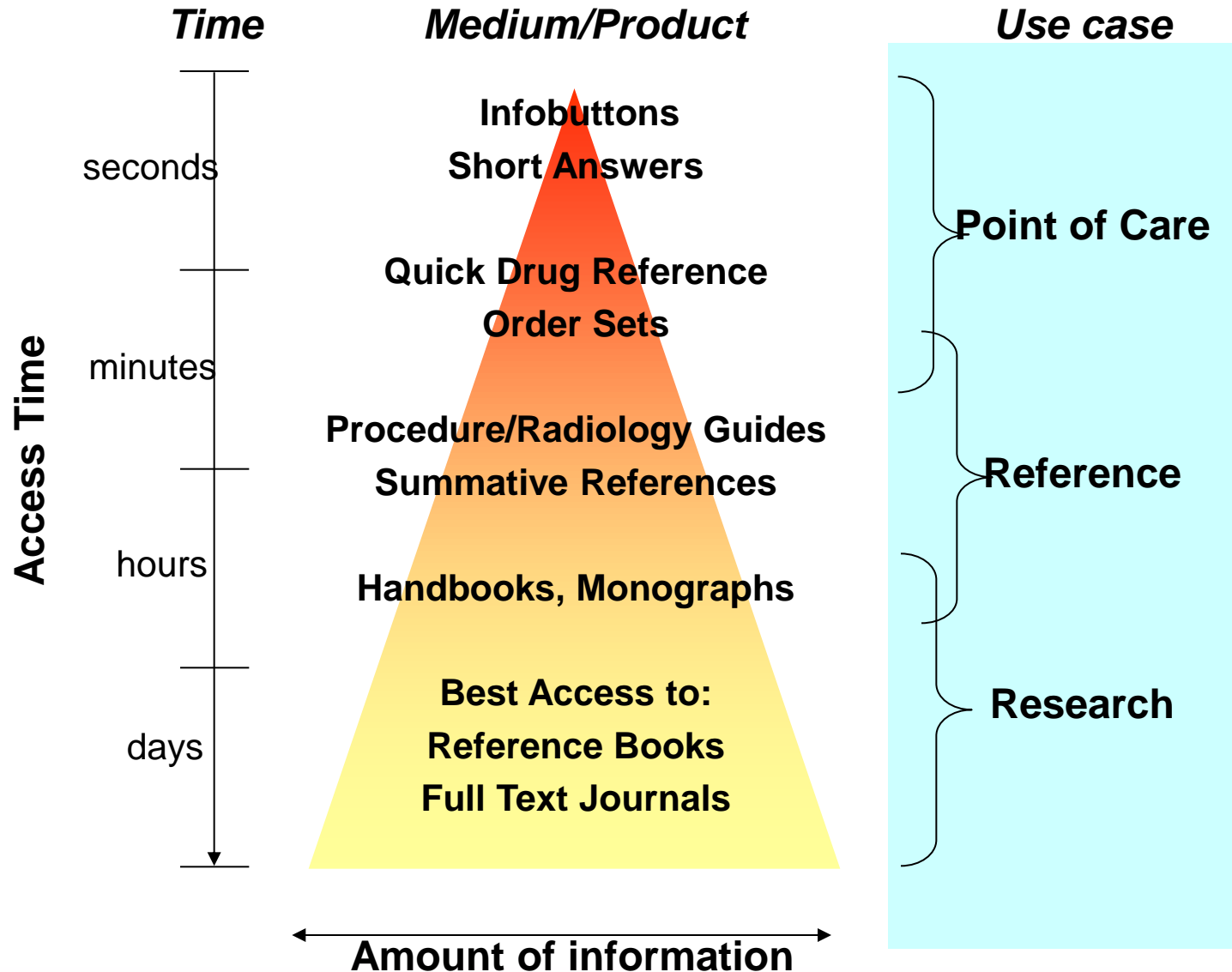
The differentiation between syncope and seizures is important, and it is not always obvious. Tongue biting or oral trauma, incontinence (especially fecal), lack of pallor or cyanosis, persistent tonic-clonic movements, slow return to consciousness, post event headache or confusion, or myalgias indicate seizures. Symptoms of nausea or diaphoresis prior to the event suggest syncope, whereas an aura (an auditory phenomenon, an upset stomach, complex visual experiences, or unpleasant olfactory sensations) is associated with seizures. Patients with syncope do not remember actually hitting the ground. Post event confusion has been described with syncope, but the confusion should not last more than 30 seconds. Seizure-like activity can occur with syncope (convulsive syncope) if the patient is held in an upright posture. However, convulsive syncope is not sustained and also rarely lasts longer than 30 seconds. Seizures generally last for at least 1-2 minutes. Seizures are associated with stertorous breathing and tachycardia, whereas syncope is usually associated with pallor and a slow, thready pulse.

Knowledge in the right form

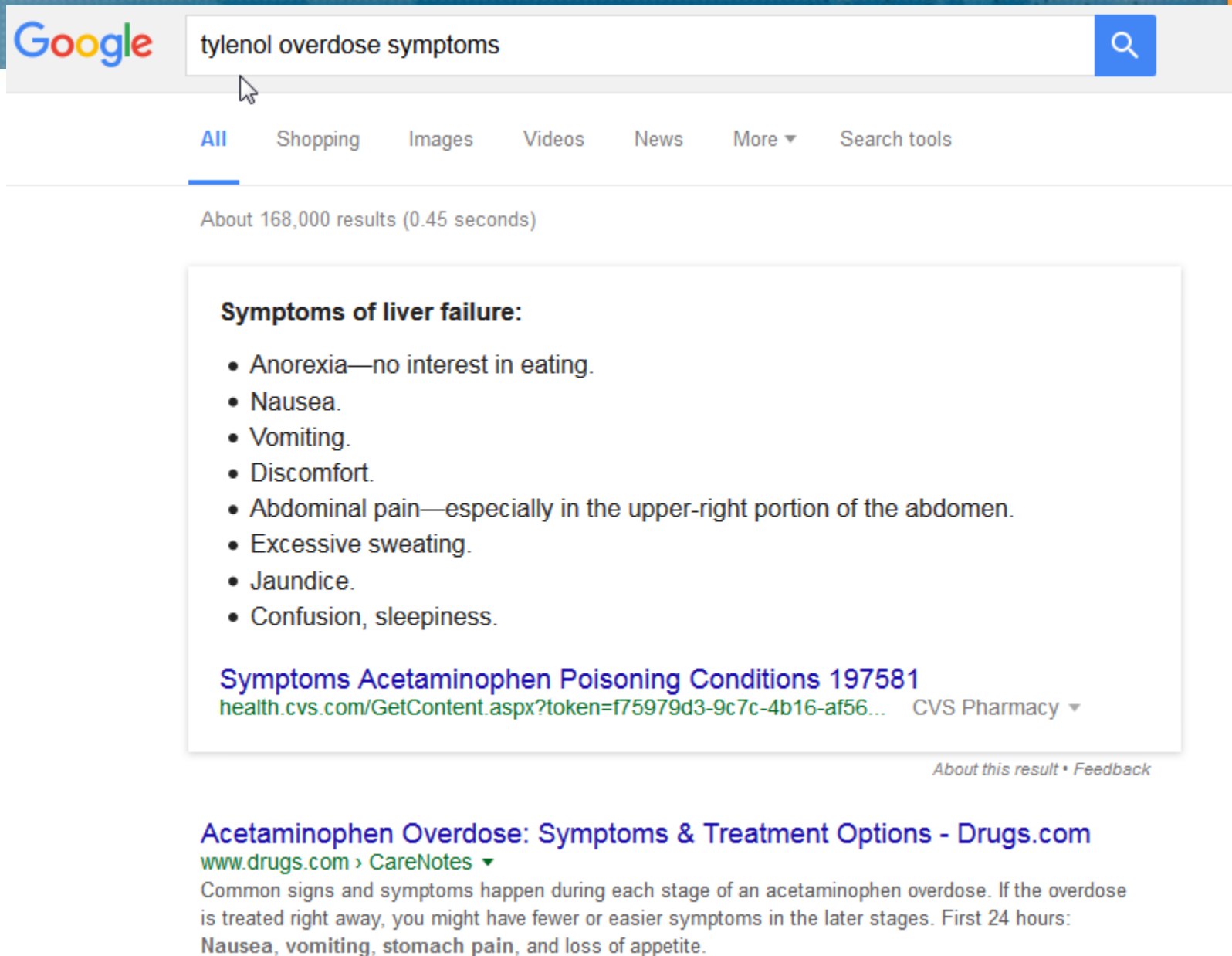
Paracetamol nomogram



Knowledge at the right depth



There is precedent for converting knowledge to Q&A



Google

tylenol overdose symptoms

All Shopping Images Videos News More ▾ Search tools

About 168,000 results (0.45 seconds)

Symptoms of liver failure:

- Anorexia—no interest in eating.
- Nausea.
- Vomiting.
- Discomfort.
- Abdominal pain—especially in the upper-right portion of the abdomen.
- Excessive sweating.
- Jaundice.
- Confusion, sleepiness.

[Symptoms Acetaminophen Poisoning Conditions 197581](#)
health.cvs.com/GetContent.aspx?token=f75979d3-9c7c-4b16-af56... CVS Pharmacy ▾

About this result • Feedback

Acetaminophen Overdose: Symptoms & Treatment Options - Drugs.com
www.drugs.com ▸ [CareNotes](#) ▾

Common signs and symptoms happen during each stage of an acetaminophen overdose. If the overdose is treated right away, you might have fewer or easier symptoms in the later stages. First 24 hours:
Nausea, vomiting, stomach pain, and loss of appetite.

“ How do I treat a
pulmonary embolism ”

OK, here you go:

Input interpretation

pulmonary
embolism
and infarction

drugs
prescribed at visit

Result

	male	female	all
coumarins and indandio- nes	34%	40%	38%
phenylpi-	0%	27%	22%



Applications: Knowledge as surveillance

Schedule **Hope, Robert** ✕ Actionable Updates

Hope, Robert

DOB: 11-25-1974

Age/Gender: 35/M

Allergies: Penicillin G

Language: English

Snapshot

Results Review

Synopsis

Intake/Output

Problem List

History

Notes

Medications

Flowsheet

Order Review

Order Entry

Admission

Pre-transfer

Discharge

Rounding

Consult

Procedures

Discharge

Actionable Updates

[Heart failure patients taking losartan \(Cozaar\) 50 mg/day should be switched to 150 mg/day](#)

[Very low energy diet may improve ob](#)

Demographics

Mr. Robert A. Hope
104 East 32nd Street
Cincinnati, OH 45044

Male - Age
Tel 1: (513)
Tel 2: (513)

Problem List

Heart Failure [new dose](#)
Hypertension, uncontrolled
Rheumatoid Arthritis
Sleep Apnea [new study](#)

Reminders and Results

- none -

Heart failure patients taking losartan (Cozaar) 50 mg/day should be switched to 150 mg/day ✕

Read Summary - Source: *BMJ* (3 Dec 2009)

Mr. Hope fits this criteria:

- ICD9 = 428.*
- Med = losartan (Cozaar)
- Dosage = 50mg PO qd

FirstConsult topic: Heart failure


methotrexate 15mg/week [new med](#)

nitrofurantoin (macrocrystal-monohydrate)
(MACROBID) capsule 100 mg

Immunizations / Injections

- none -





Knowledge on rounds




Dr. Julius Hibert
Settings

Rounds

Search





Mike Roberts

Headache

Venue

Age, Sex 42 Male Height 5'9" Weight 240lbs

Notable Conditions Type 1 Diabetes

Allergies Penicillin

General

Migraine-type HA >72 hrs, give 250-500 cc D51/2 NS prior to neuroleptic administration and observed for potential orthostatic hypotension and acute extrapyramidal side effects. (ICSI 2009)

Radiology

CT head no contrast (1) pt with HA and new abnl findings on neuro exam and/or suspicion of serious intracranial process (Level 2 ACEP 2008, ICSI 2009) OR (2) acute head trauma with sz (ICSI 2009)

CT head with contrast (1) any new sudden-onset severe HA (Level 2 ACEP 2008) OR (2) consider in HIV+ pt with new type of HA (Level 2 ACEP 2008)

Medication

New Related Information

In pellentesque faucibus vestibulum. Nulla at nulla justo, eget luctus tortor. Nulla facilisi. Duis aliquet egestas purus in blandit. Curabitur vulputate, ligula lacinia scelerisque tempor, lacus lacus ornare ante, ac egestas est urna sit amet arcu.

In pellentesque faucibus vestibulum. Nulla at nulla justo, eget luctus tortor. Nulla facilisi. Duis aliquet egestas purus in blandit. Curabitur vulputate, ligula lacinia scelerisque tempor, lacus lacus ornare ante, ac egestas est urna sit amet arcu.

ELSEVIER FIRST CONSULT | [READ MORE](#)

Patient-specific workup options:
diagnostic and therapeutic choices



Clinical Pathways

Definition of a Clinical Pathway (Cochrane)

1. **Structured, multidisciplinary** plan of care
2. **Standardizes** care for a specific clinical problem or procedure
3. **Translates** guidelines or evidence into local action
4. **Shows all the care steps** in some structured form
5. **Advance to next step** at certain times or after certain events happen

Found in 80% of US hospitals



Role in modern healthcare

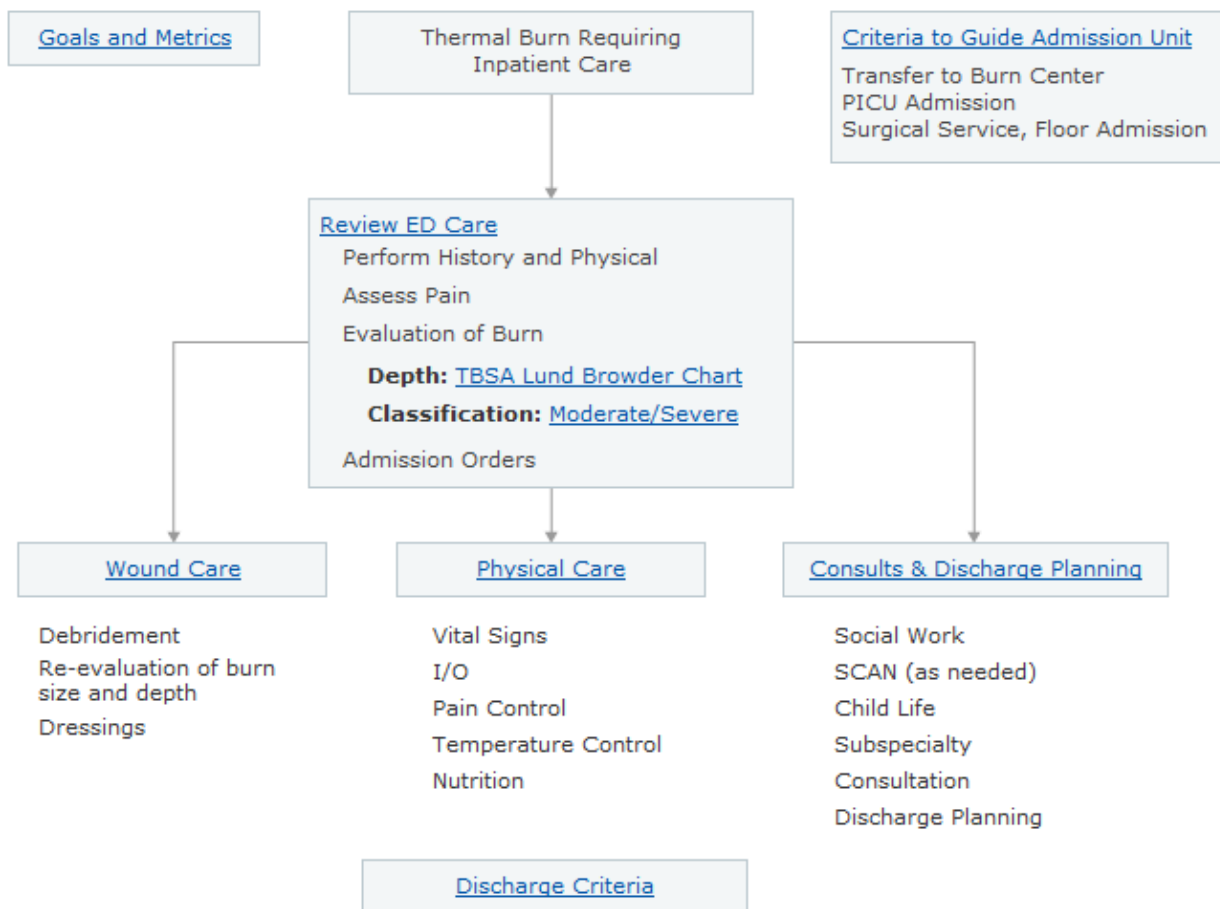
- Complex, chronic care
- Accountable care model – multi-site, multi-clinician, synchronized
- Standard care models, e.g., prenatal
- Acute inpatient protocols
- Under-resourced, developing countries



Pathways can be multi-threaded

Related Pathway:
[ED Burn Pathway](#)

Inpatient Pathway for the Care of Children with Thermal Burns



Learn More

[American Burn Association](#)


Videos

[Trunk Burns Dressing](#)

[Hand Burns Dressing](#)

Source: CHOP

Criteria to Assist in Determining Admission Unit

Admit to Floor	<ul style="list-style-type: none">NO inhalation injuryNO airway edemaNO significant oral burns< 15% TBSA partial thickness burn (minor and moderate burns)NO hyperbaric oxygen treatment
Transfer to Burn Center	<ul style="list-style-type: none">> 15% TBSA partial thickness or > 5% TBSA full thickness thermal burn (major burns)Severe electrical or chemical burnPotential need for graftingConsult with trauma  and call Transport Communication Center at 4-2160Chester-Crozer Burn Unit: 610-447-2800St. Christopher Burn Center: 215-427-6900
Admit to PICU	<ul style="list-style-type: none">Intubated, potential airway edema, potential inhalation injury, severe oral burns> 15% TBSA burns with delayed transfer to Burn Center due to instability or bed availabilityOther injuries requiring ICU careHyperbaric oxygen treatment for elevated carboxyhemoglobinSevere pain requiring aggressive pain management

Consults and Discharge Planning

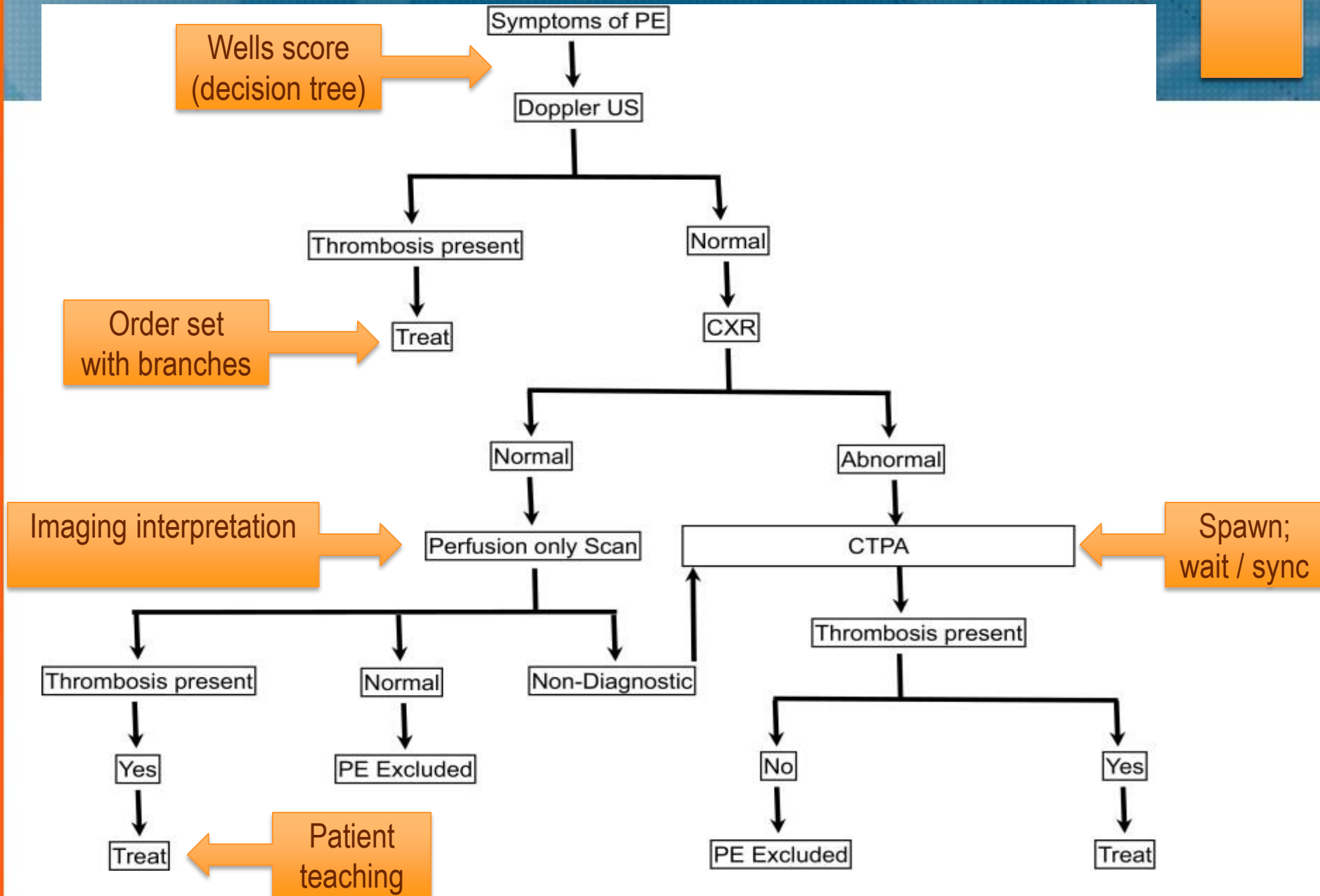
Consults

Social Work	PRN for altered coping Lack of insurance Rule-out abuse
SCAN Team if concern for abuse	Patterned contact burns with insufficient history Cigarette burn Stocking, glove pattern to burn Mirror image burns of the extremities Symmetric burns on buttocks Immersion burn Multiple burn sites

Subspecialty Consults

Ophthalmology	Burns in or near eyes
Plastic Surgery	Ear burns Full thickness burns that might need skin grafts
Speech Therapy	Oral burns
Occupational and/or Physical Therapy	Burns over joints Limited range of motion Possible splinting to prevent scar contractures
Pain Team	Opioid PCA

Multi-step pathway with occasional CDS outputs





CDS Sharing



Episode IV

A NEW HOPE

*Roadmap for National Action on
CDS*

CDS Consortium

*American Health Information
Community*

ONC CDS Expert Panel

Advancing CDS standards project

Health e-Decisions

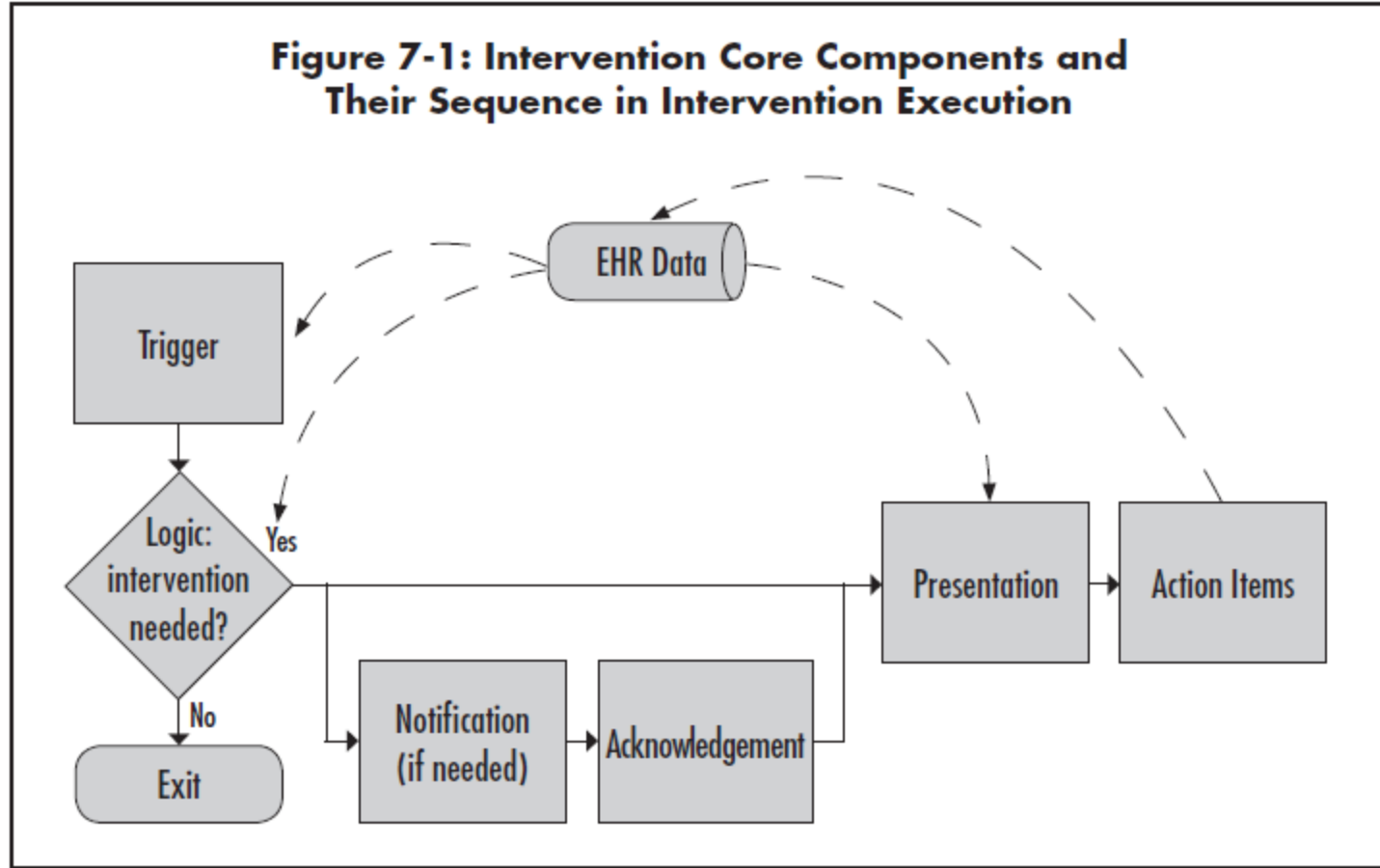
CDS on FHIR

What I Want: The CDS Pyxis machine



- Disseminate
 - Standard format
- Select
 - By target, intervention type, setting
- Download
- Measure
- Collect Feedback

Getting there: Standard CDS main components



Standard CDS elements



Trigger points

- Register
- ADT
- Observation
- Order start
- Med select
- Test result

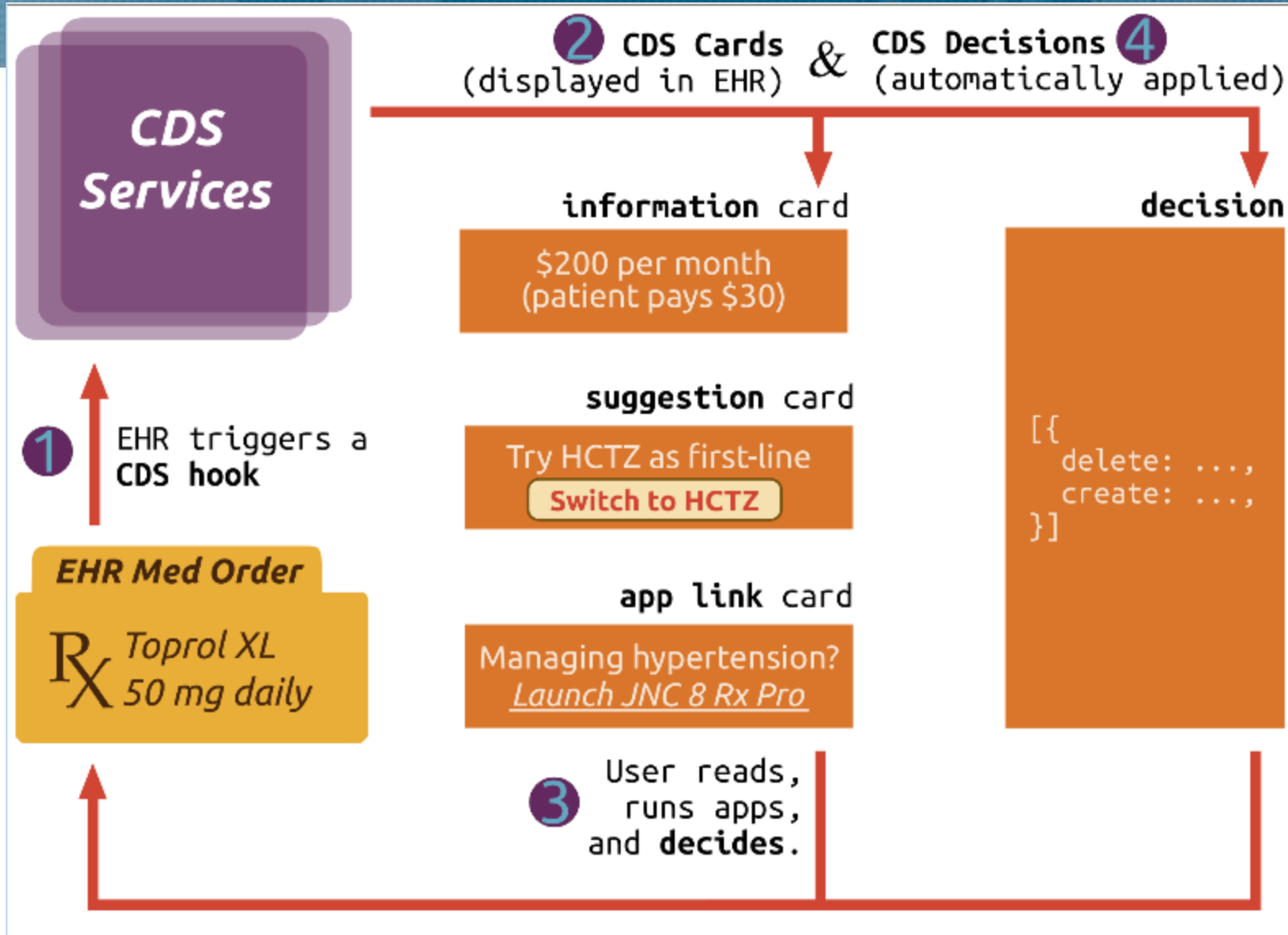
Present'ns

- Alert
- Order set
- Smart Docu
- Advisory
(infobutton)

Actions

- New Order
- Del/Chg Order
- View info
- Post assertion
- Exception
- [Track]

CDS on FHIR



Latest efforts



- NAM Workgroup on CDS
 - Authoring
 - Distribution
 - Integration (EHR and workflow)
 - Technology
- A few companies springing up to connect CDS to any EHR
- The CDS Construction Kit
 - Type of health episode (well visit, chronic condition...)
 - Type of process (admit, communicate, discharge, order, print, administer)
 - Type of intervention, key parameters



Other stuff

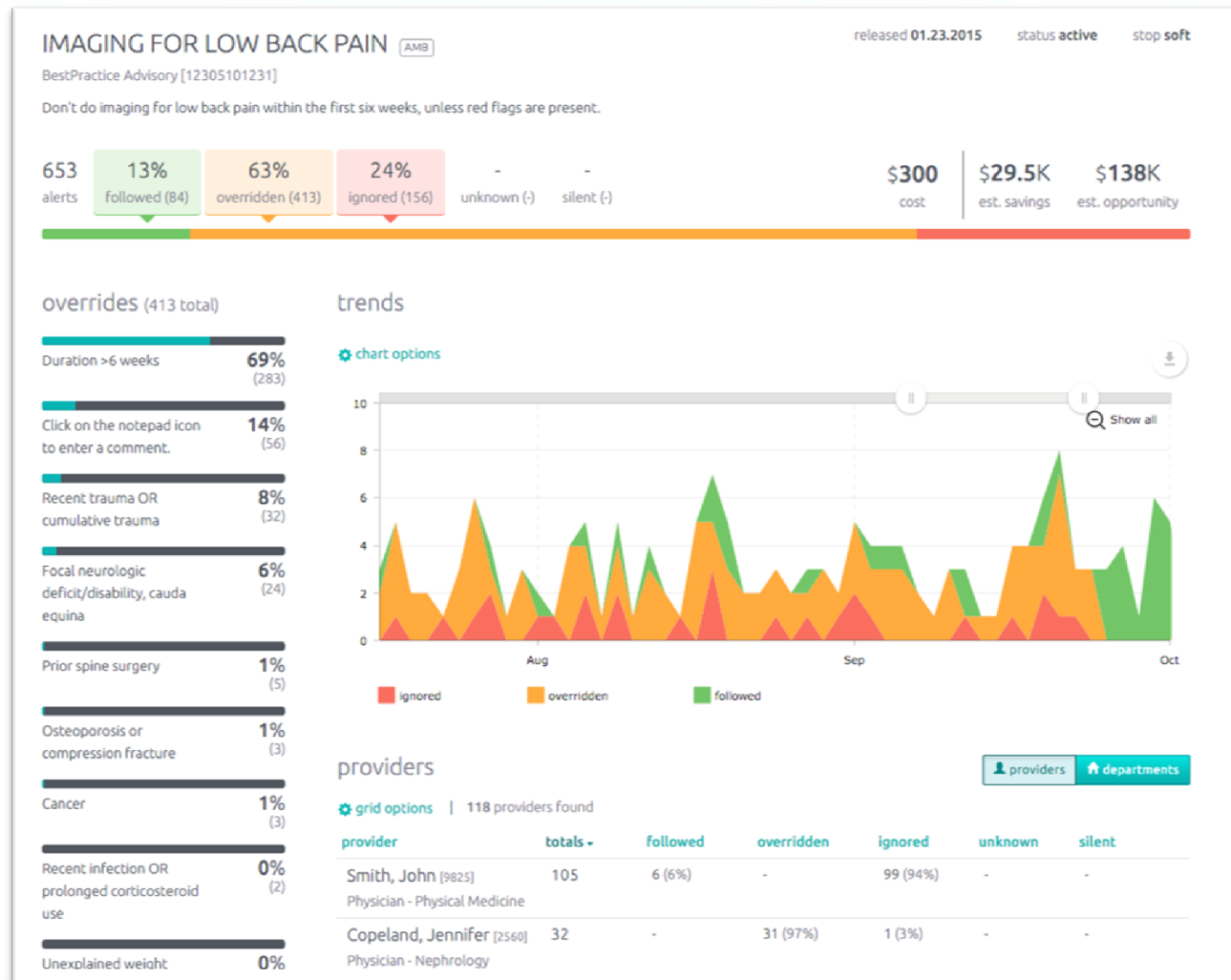
Simple-to-build CDS

The screenshot displays the Herald CDS interface. On the left is a dark sidebar with the Herald logo, a user profile for Dr. Smith, and navigation links: 'Your Protocols', 'Create Protocol', and 'Share & Discover'. The main area is titled 'Your Protocols' and includes a search bar. Below this is a section for 'Active Protocols' with a table of three protocols. Each protocol row includes its name, creation date, input type, condition, output, patient information, status, and a set of action buttons (View, Edit, Pause, Delete).

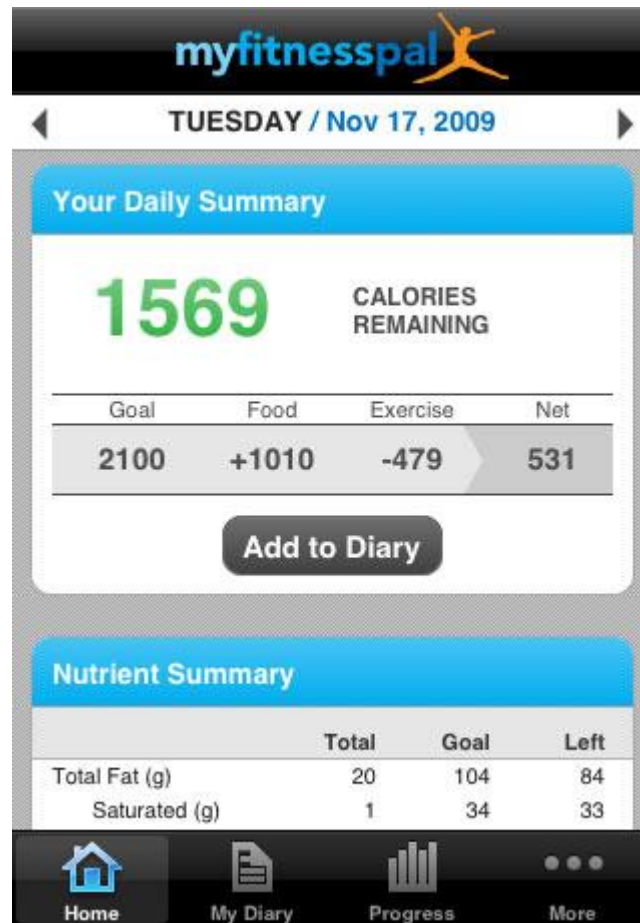
Protocol Name	Input	Condition	Output	Patient(s)	Status	Actions
Troponin elevation Created 11.08.2015	Troponin	More than 0.01	Page	BWH Cards B1	Active	View Edit Pause Delete
Hematocrit drop Created 11.7.2015	HCT	Less than prior by 3.0	SMS	MRN: 53135305	Active	View Edit Pause Delete
Radiology report finalized Created 11.7.2015	Rads	Has finalized	Email	MRN: 13478245	Disabled	View Edit Pause Delete

How is your CDS doing?

Source:
Stanson
Health



Patient-facing CDS

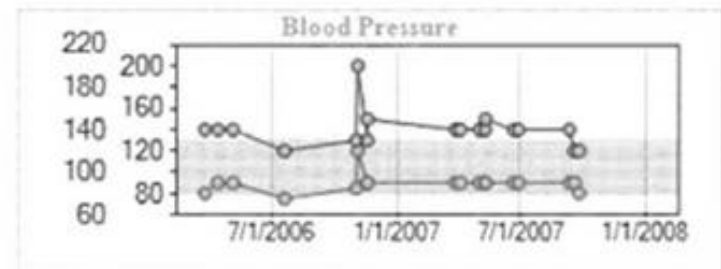


Aspirin

Because you have diabetes or heart disease, you might benefit from aspirin or another similar medication to prevent heart attacks and strokes, but there may be a good reason why your doctor has not prescribed it. Talk with your healthcare provider to find out if you should take aspirin regularly. Tip: Enteric-coated aspirin is effective and often safer than non-coated aspirin.

Blood Pressure

On average, your blood pressure has been running high recently (average of 120/85 from your last two visits). The recommended blood pressure goal is 130/80. If your blood pressure medicine has not been recently adjusted or you are not on blood pressure medicine, you should talk with your provider about steps you can take to help lower your blood pressure.



Urine Protein

People with diabetes have a higher risk of kidney

Health surveillance

google.org

Flu Trends

Language: English (United States)

[Google.org home](#)

Flu Trends

Select country/region

[Home](#)

[How does this work?](#)

[FAQ](#)

Flu activity

Intense

High

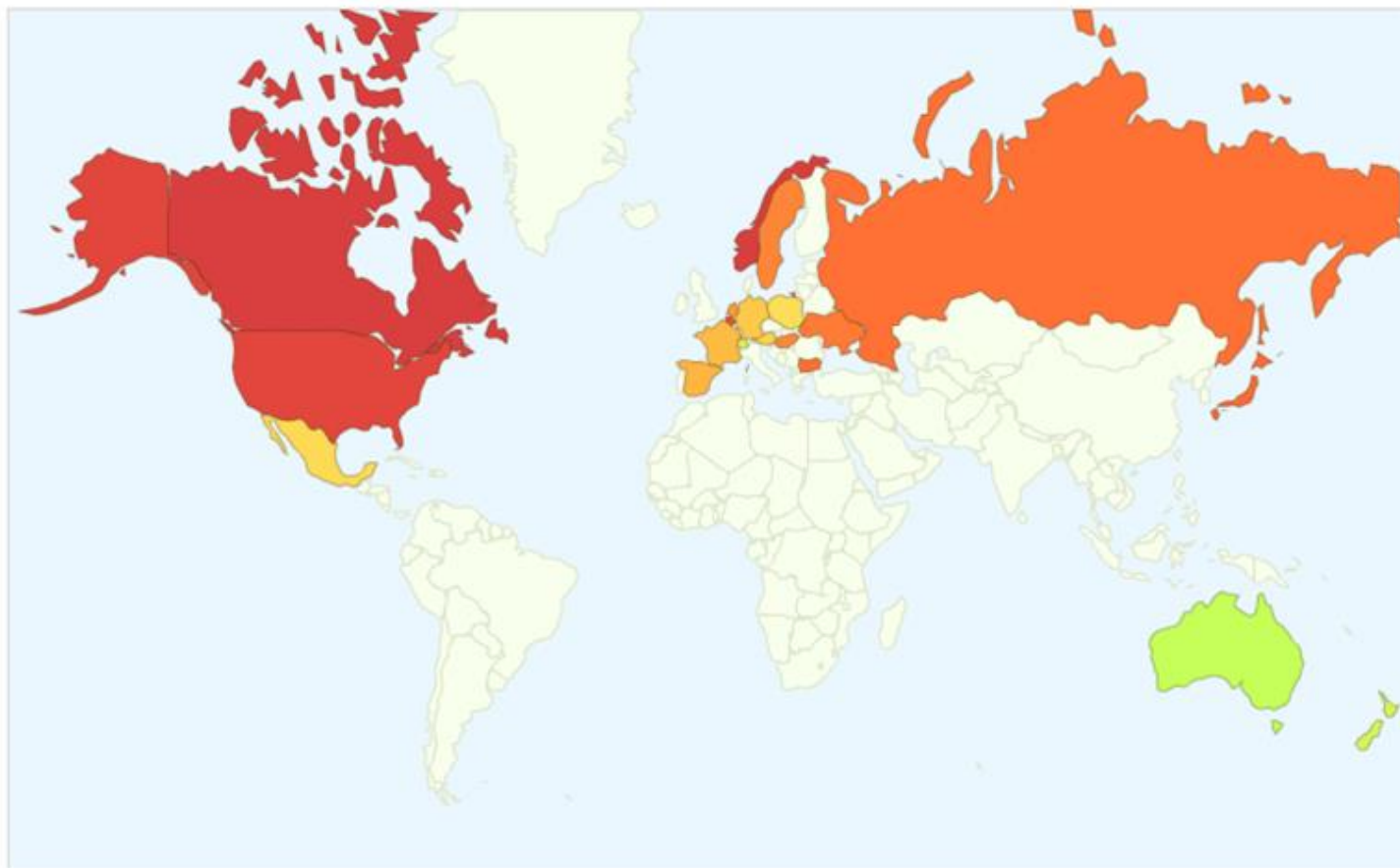
Moderate

Low

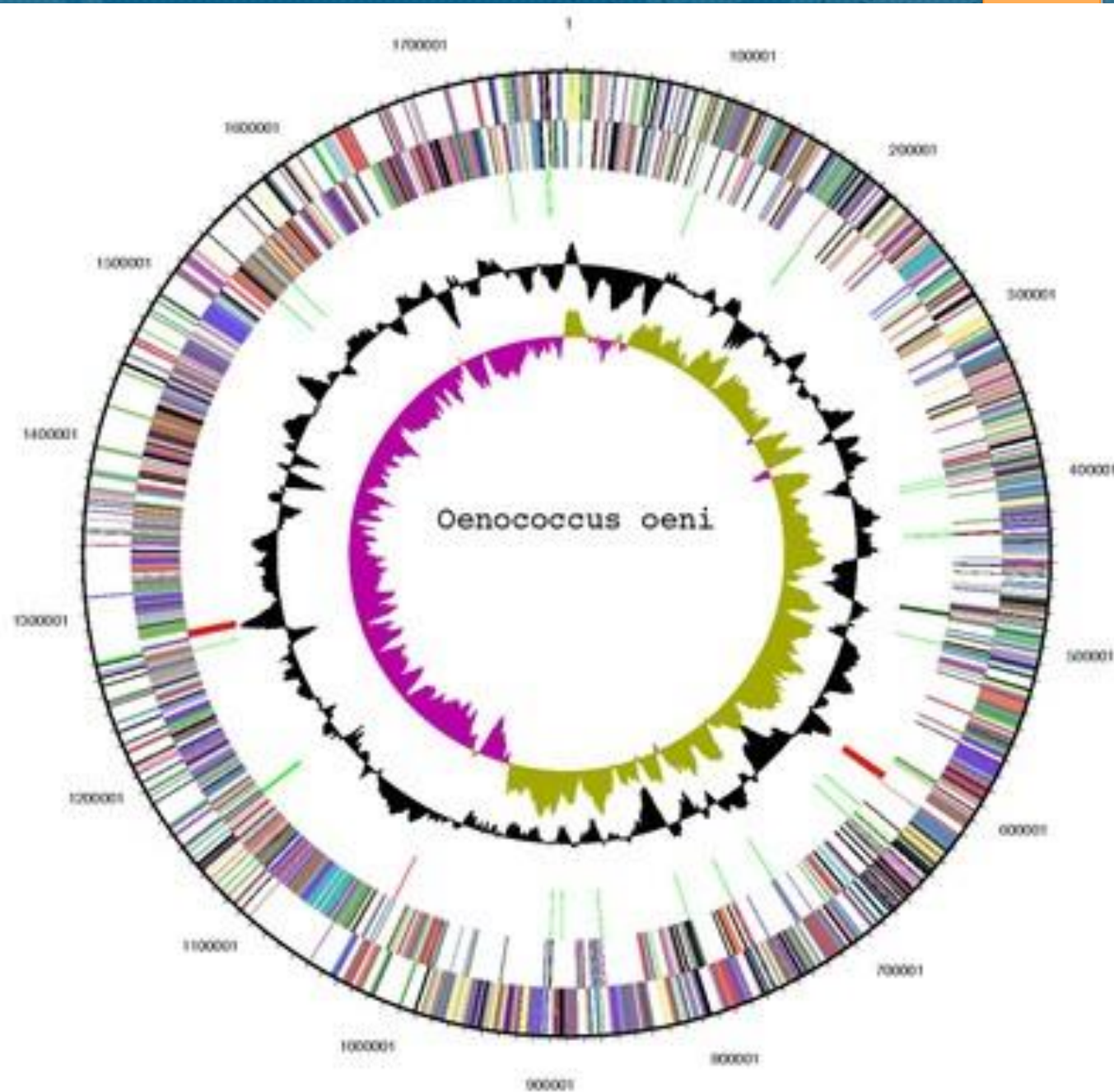
Minimal

Explore flu trends around the world

We've found that certain search terms are good indicators of flu activity. Google Flu Trends uses aggregated Google search data to estimate flu activity. [Learn more »](#)



Clinical genomics





Back to our roots

Smart documentation:



- “Hi doc, I have a problem”
 - “Have you ever had it before?”
 - “Do you also have this other relevant condition?”
 - “Do you have risk factors?”
 - “You might have X or Y”
 - “Here, this is the best treatment for your symptoms and for your problem”
 - I’ll give you this, You do that
 - “Let’s schedule something to find out more”

CDS-driven smart documentation can make noting much better

What are the current grand challenges?



Quick knowledge (Smart Doc)	Deliver the most relevant info in a small, actionable package (mostly acute)
Facilitate complex processes	Simplify, optimize, keep track (pathways)
Share CDS	The CDS Pyxis machine – choose ‘n’ use logic and operation.
Simple CDS building	Lego blocks for the key components – for any CDS type. Teaching file of good examples
Big data	Focus: provide filtered, highest priority recommendations
Monitor itself	reduce fatigue by focusing on the important stuff
Easy EHR	Documentation and optimization bundles for conditions instead of E&M codes

CDS is still the promise of HIT

As Chuck Friedman said:

