CDSS – Part II
Clinical Decision Support

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Star Trek & Diagnostic Device

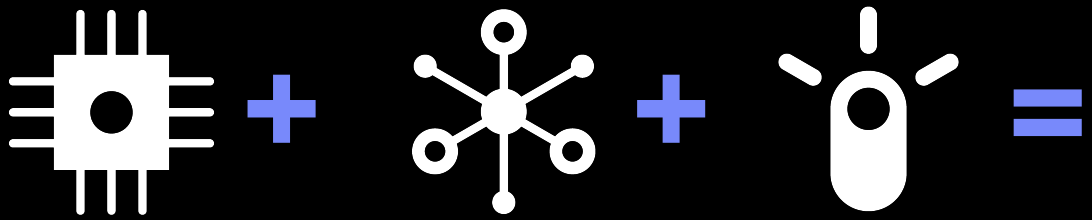
Futuristic ….

* In *Star Trek*- point diagnostic device to patients and device determine
  * What is the problem ?
  * How serious damage is?
* In Star Trek- Diagnostic device is the “Clinical Decision Support”
* Societal Concerns
  * Can computers replace doctors in making decisions?
  * What kinds of decisions can computers make?
  * How good will computers be?
  * What will the effects be on the practice of medicine, on medical education and on relationship among colleagues or between physicians and patients?

On February 14, 2011, IBM Watson changed history introducing a system that rivaled a human's ability to answer questions posed in natural language with speed, accuracy and confidence.

- Watson Wins!
- Largest Jeopardy! in 5 years
  - 34.5M Jeopardy! Viewers
  - 1.3B+ Impressions
- Over 10,000 Media Stories
- 11,000 attend watch events
- 2.5M+ Videos Views (top 10 only)
- 10,897 Twitter
- 23,647 Facebook Fans

The World is Getting Smarter



An opportunity to think and act in new ways—
economically, socially and technically.

Healthcare Industry is beset with some of the most complex information challenges we collectively face

- Medical information is doubling every 5 years, much of which is unstructured
- 81% of physicians report spending 5 hours or less per month reading medical journals

1 in 5

diagnosis that are estimated to be inaccurate or

1.5 million

errors in the way medications are prescribed, delivered and taken in the U.S. every year

44,000 -98,000

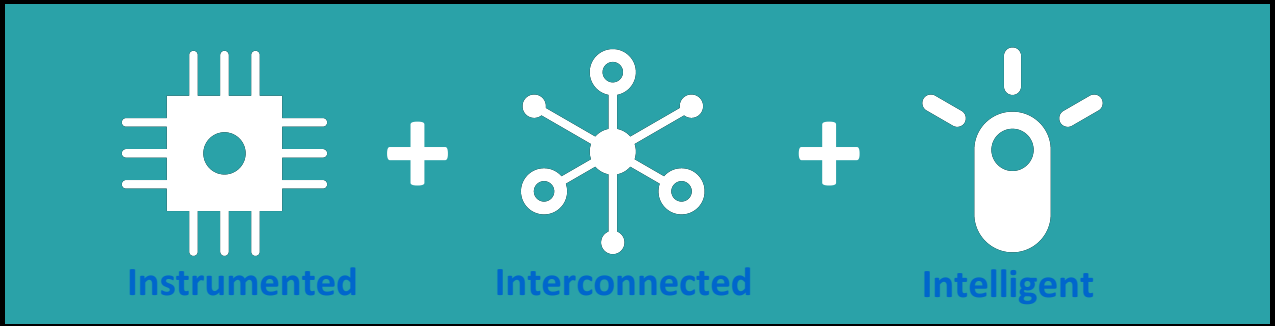
# of Americans who die each year from preventable medical errors in hospitals alone

"Medicine has become too complex (and only) about 20 percent of the knowledge clinicians use today is evidence-based."

Steven Shapiro, Chief Medical and Scientific Officer, UPMC

IBM Smarter Healthcare

A smarter health system improves visibility and collaboration across all health system participants making best use of resources to prevent and treat diseases, reduce overall healthcare costs, and keep people healthy.



Capture accurate, real-time information from devices & systems

Enable seamless information sharing across groups

Use advanced analytics to improve research, diagnosis and treatment

Why is Watson Technology ideal for Healthcare?

Understands natural language questions →

What condition has red eye, pain, inflammation, blurred vision, floating spots and sensitivity to light?

Analyzes large volumes of unstructured data →

Physician Notes, Medical Journals, Clinical Trials, Pathology Results, Blogs, Wikipedia

Generates and evaluates hypothesis →

Possible Diagnosis	Confidence
Uveitis	91%
Iritis	48%
Keratitis	29%

Presents responses with confidence →

Supports iterative dialogue to refine results →

Family History, Patient Interview, Physical Exam, Current Medications

Learns from results over time →

What actions were taken? What treatments were prescribed? What was the outcome?

IBM and WellPoint are working together to put Watson to work in healthcare

WellPoint
Serving 1 in 9 insured Americans

+

IBM Watson

=

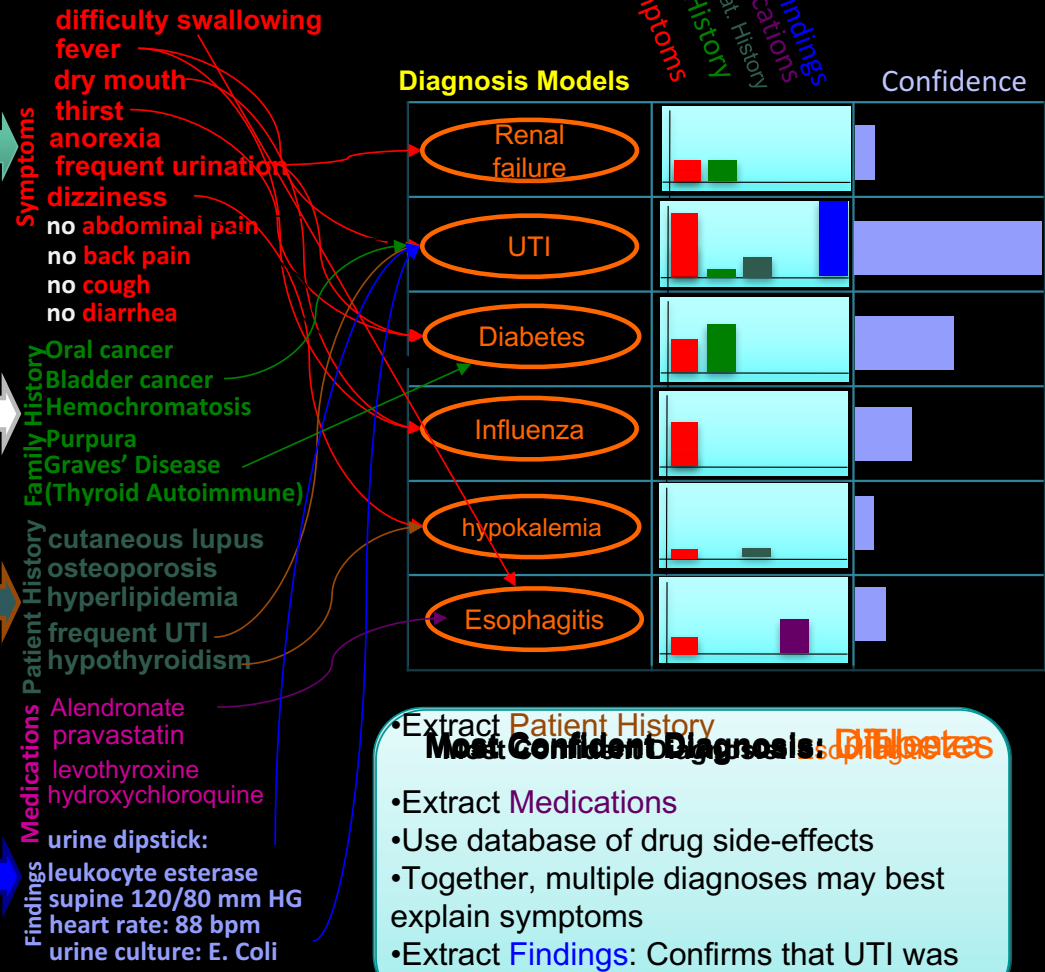
Leverage medical records
TO
diagnose and identify treatment options
TO
enhance the quality of medical care delivered

"Imagine having the ability within three seconds to look through all of that (medical) information….at the moment you're caring for that patient."

Dr. Sam Nussbaum, WellPoint's Chief Medical Officer, WellPoint

Putting the pieces together at point of impact can be life changing

A 58-year-old woman presented to her primary care physician after several days of dizziness, anorexia, dry mouth, increased thirst, and frequent urination. She had also had a fever and reported that food would "get stuck" when she was swallowing. She reported no pain in her abdomen, back, or flank and no cough, shortness of breath, diarrhea, or dysuria. Her family history included oral and bladder cancer in her mother, Graves' disease in two sisters, hemochromatosis in one sister, and idiopathic thrombocytopenic purpura in one sister. Her history was notable for cutaneous lupus, hyperlipidemia, osteoporosis, frequent urinary tract infections, three uncomplicated cesarean sections, a left oophorectomy for a benign cyst, and primary hypothyroidism, which had been diagnosed a year earlier. Her medications were levothyroxine, hydroxychloroquine, pravastatin, and alendronate. A urine dipstick was positive for leukocyte esterase and nitrites. The patient was given a prescription for ciprofloxacin for a urinary tract infection and was advised to drink plenty of fluids. On a follow-up visit with her physician 3 days later, her fever had resolved, but she reported continued weakness and dizziness despite drinking a lot of fluids. Her supine blood pressure was 120/80 mm Hg, and her pulse was 88 beats per minute; on standing, her systolic blood pressure was 84 mm Hg, and her pulse was 92 beats per minute. A urine specimen obtained at her initial presentation had been cultured and grew more than 100,000 colonies of *Escherichia coli,* which is sensitive to ciprofloxacin.



•Extract Patient History

Most Confident Diagnosis: UTI

•Extract Medications

•Use database of drug side-effects

•Together, multiple diagnoses may best explain symptoms

•Extract Findings: Confirms that UTI was present

Clinical Decision Support System (CDSS)

* Definition:

Provide clinicians or patients with computer-generated clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care" [1]

Elements of CDS [1]

* Knowledge
  * Provide evidence to meet physician information needs
  * Meta-analysis of Randomized Controlled trials as evidences
* Patient-specific Information
  * Medication List
  * Problem Lists
  * Lab results and other clinical data

Elements of CDS [1]

* Filtered
  * Gathering and presenting pertinent data
* Presented at appropriate time
  * Provider able and ready to act on the information
* Enhance Patient Care
  * Error prevention
  * Quality improvement
  * Lab results and other clinical data

MYCIN [2]

* Gives ADVICE to clinicians
* Used Artificial Intelligence
* Production Rules– knowledge gathered from discussions among experts

Example:

Rule 507

Comprised of conditional statement (IF-THEN)

Decision Making in Medicine [2]

* Uncertainty
  * What is the diagnosis?
  * What should the intervention be?
  * What is the latest research that gives evidence the intervention really works?

  Examples:
  * Should John gets another chemotherapy?
  * Should Mr. James undergo a third operation?
  * Should Mrs. Blackwood be given hepatitis B vaccination as an intervention?
* To ensure specificity and sensitivity

Sensitivity & Specificity- Wikipedia

		Condition (as determined by "Gold standard")		
		Condition Positive	Condition Negative	
Test Outcome	Test Outcome Positive	**True Positive**	**False Positive** (Type I error)	Positive predictive value = $\frac{\Sigma \text{ True Positive}}{\Sigma \text{ Test Outcome Positive}}$
	Test Outcome Negative	**False Negative** (Type II error)	**True Negative**	Negative predictive value = $\frac{\Sigma \text{ True Negative}}{\Sigma \text{ Test Outcome Negative}}$
		Sensitivity = $\frac{\Sigma \text{ True Positive}}{\Sigma \text{ Condition Positive}}$	**Specificity** = $\frac{\Sigma \text{ True Negative}}{\Sigma \text{ Condition Negative}}$	

Sensitivity & Specificity- Wikipedia

		Patients with bowel cancer (as confirmed on endoscopy)		
		Condition Positive	Condition Negative	
Fecal Occult Blood Screen Test Outcome	Test Outcome Positive	True Positive (TP) = 20	False Positive (FP) = 180	Positive predictive value = TP / (TP + FP) = 20 / (20 + 180) = **10%**
	Test Outcome Negative	False Negative (FN) = 10	True Negative (TN) = 1820	Negative predictive value = TN / (FN + TN) = 1820 / (10 + 1820) ≈ **99.5%**
		Sensitivity = TP / (TP + FN) = 20 / (20 + 10) ≈ **67%**	**Specificity** = TN / (FP + TN) = 1820 / (180 + 1820) = **91%**	

Why CDS?[1]

1. Questions
   * Unanswered Questions
   * Some doubts

Why CDS?[1]

2. Information

* Unmet information need
* Cannot process information
* Lack of time
* Unsatisfied information need
* Unrecognized information need

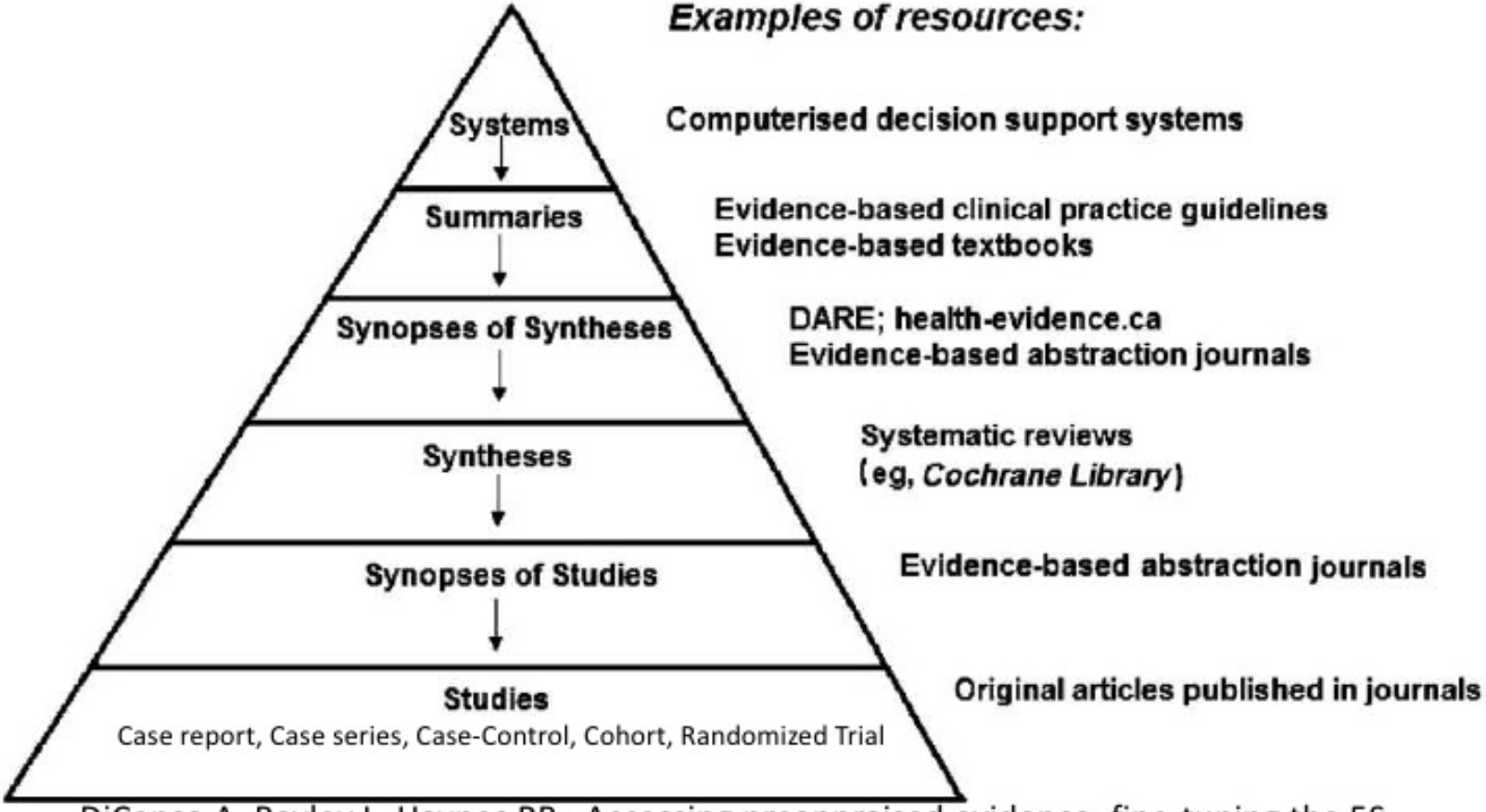
Why CDS? [1]

3. Inquiry
   * Needs time
   * Resource Intensive (Evidence, Literature, Knowledge)

Solutions are needed…. CDS can help provide ALERTS and REMINDERS

* To avoid errors and increase patient safety– new knowledge discovery – average 17 years to take evidence into clinical practice
* CDS embedded in EMR to improve patient safety and reduce medical error

Searching for evidence



DiCenso A, Bayley L, Haynes RB. Accessing preappraised evidence: fine-tuning the 5S model into a 6S model. ACP Journal Club, 2009

Clinical Decision Support System (CDSS) [3]

* CDSS in Patient Monitoring Systems
  * Example: ECG that gives out warning
* CDSS embed in Electronic Medical Record (EMR) and Computerized Patient Order Entry (CPOE)
* Example: Send reminders/warnings in test results, drug-drug interaction, dosage errors etc.
* Formulating Diagnosis
* Formulating Treatment

Roles of Computer in Decision Support or Clinical Decision Support (CDS)

CDSS in Prescription [4]

* Guiding prescribing practices
* Flagging adverse drug reactions
* Identify duplication of therapy

Constructing DSS[1]

* Elicitation of Medical Knowledge
* Reasoning and Representation
* Validation of System Performance
* Integration of CDSS Tools

Types of CDSS [1]

1) Documentation Tool
    * Provide complete documentation
    *Well-designed order form
    * Required fields & Proper information
    * Reduce error of Omission by providing selection
    * Provide **coded data** for CDSS

Types of CDSS [1]

Types	Sub-types	Examples
1. Documentation Tool		
	1.1 Patient Assessment Form	***Pre-visit questionnaires***
	1.2 Nursing Patient Assessment Form	***Inpatient admission assessment***

Types of CDSS [1]

Types	Sub-types	Examples
1. Documentation Tool		
	1.3 Clinical Encounter Patient Form	*Intelligent Referral Form*
	1.4 Departmental/multidisciplinary clinical documentation forms	*Emergency department documentation*
	1.5 Data Flowsheets	*Immunization flowsheet*

Types of CDSS [1]

2) Relevant Data Presentation

* Display relevant data –including costs
* Pertinent Data are displayed
* Complex Data – to show overall picture
* To highlight needed ACTIONS

Types of CDSS [1]

Types	Sub-types	Examples
2. Relevant Data Presentation		
	2.1 Relevant data for ordering	***Display of relevant lab tests when ordering a medication***
	2.2 Choice list	***Suggest dose choice lists***

Types of CDSS [1]

Types	Sub-types	Examples
2. Relevant Data Presentation		
	2.3 Practice status display	ED tracking display
	2.4 Retrospective/aggregate reporting/filtering	Physician "report cards"
	2.5 Environment parameter report	Recent antibiotic sensitivities

Types of CDSS [1]

Types	Sub-types	Examples
3. Order Creation Facilitators		
	3.1 Single-order completers-consequent orders	***Prompt Order Consequent Order Suggestions***
	3.2 Order sets	***General Order Set Post Op Order Set***
	3.3 Tools for complex ordering	***Guided Dose Active Guidelines***

Types of CDSS [1]

Types	Sub-types	Examples
4. Time-based checking & protocol/pathway support		
	4.1 Stepwise processing of multi-step protocol	*Tools for Monitoring and supporting patient clinical pathway*
	4.2 Support for managing clinical problems	*Computer assistant management algo*

Types of CDSS [1]

Types	Sub-types	Examples
5. Reference Information and guidance		
	5.1 Context-insensitive	***General Link from EMR to a reference program***
	5.2 Context-sensitive	***Direct link to a specific reference program***

Types of CDSS [1]

Types	Sub-types	Examples
6. Reactive Alerts & Reminders		
	Alerts to prevent potential errors	***Drug Allergy Alerts*** ***Drug Interaction aler*** ***Under/Overdose Alert***

Summary

* CDS

Provide clinicians or patients with computer-generated clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care” [1]

References

[1] Carter, J.H. (2008) . Electronic Health Records, 2nd edition, American College of Medicine.

[2] Shortliffe, E.H., Cimino, J.J. (2006).*Biomedical informatics: computer applications in health care and biomedicine*, 3rd Edition, Springer.

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[3] Jaspers , M.N.W, Smeulers, M., Vermuelen, H., Peute, L.W. (2010). Effects of clinical decision-support systems on practitioner performance and patient outcomes: a synthesis of high-quallty systematic review findings. *Journal of American Medical Informatics Association,* No 18, pp. 327-334.

[4] Moxey, A., Robertson, J., Newby, D., Hains, I. , Williamson, M., Pearson, S.A. (2008). Computerized clinical decision support for prescribing: provision does not guarantee uptake. *Journal of American Medical Informatics Association,* No 17, pp. 25-33.