

CDSS

Clinical Decision Support System

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Management Information Systems

Chapter 12 Enhancing Decision Making Systems for Decision Support

- **What have you learned so far?**

- Health Information Systems
- Electronic Health Record
- Medical Error and how to overcome ME

Functions of Health Information Technology:

- Improve Clinical Outcomes/ Enhance Patient Care
- Efficiency and Effectiveness
- To improve decision making



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?

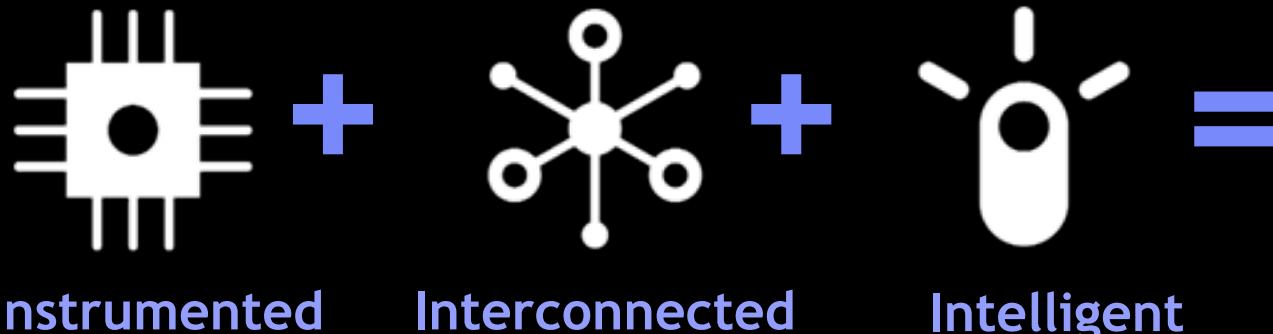


On February 14, 2011, IBM Watson changed history introducing a system that rivaled a human's ability to answer questions posed in natural language with speed, accuracy and confidence.

- 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 Fan 



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 incomplete



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

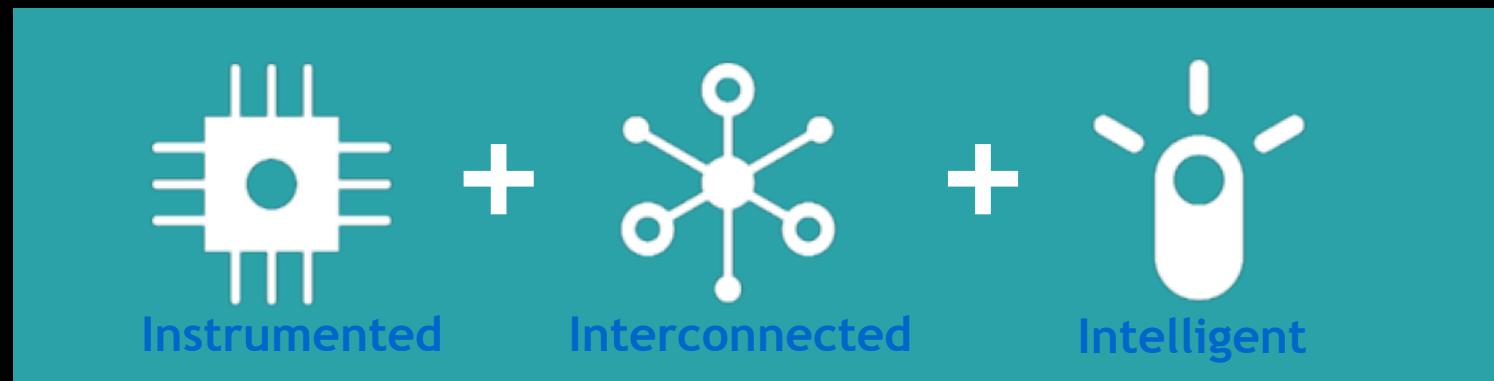


44,000 - 98,000 # of Americans who die each year from preventable medical errors in hospitals

“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

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



Family History, Patient Interview, Physical Exam, Current Medications

Supports iterative dialogue to refine results

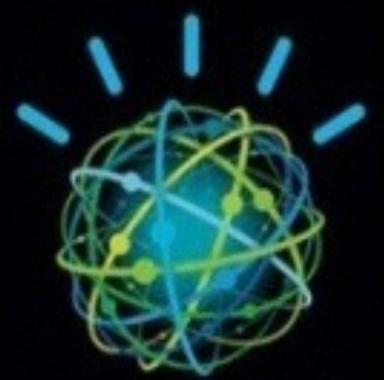


Learns from results over time



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



IBM Watson

WellPoint
Serving 1 in 9 insured
Americans

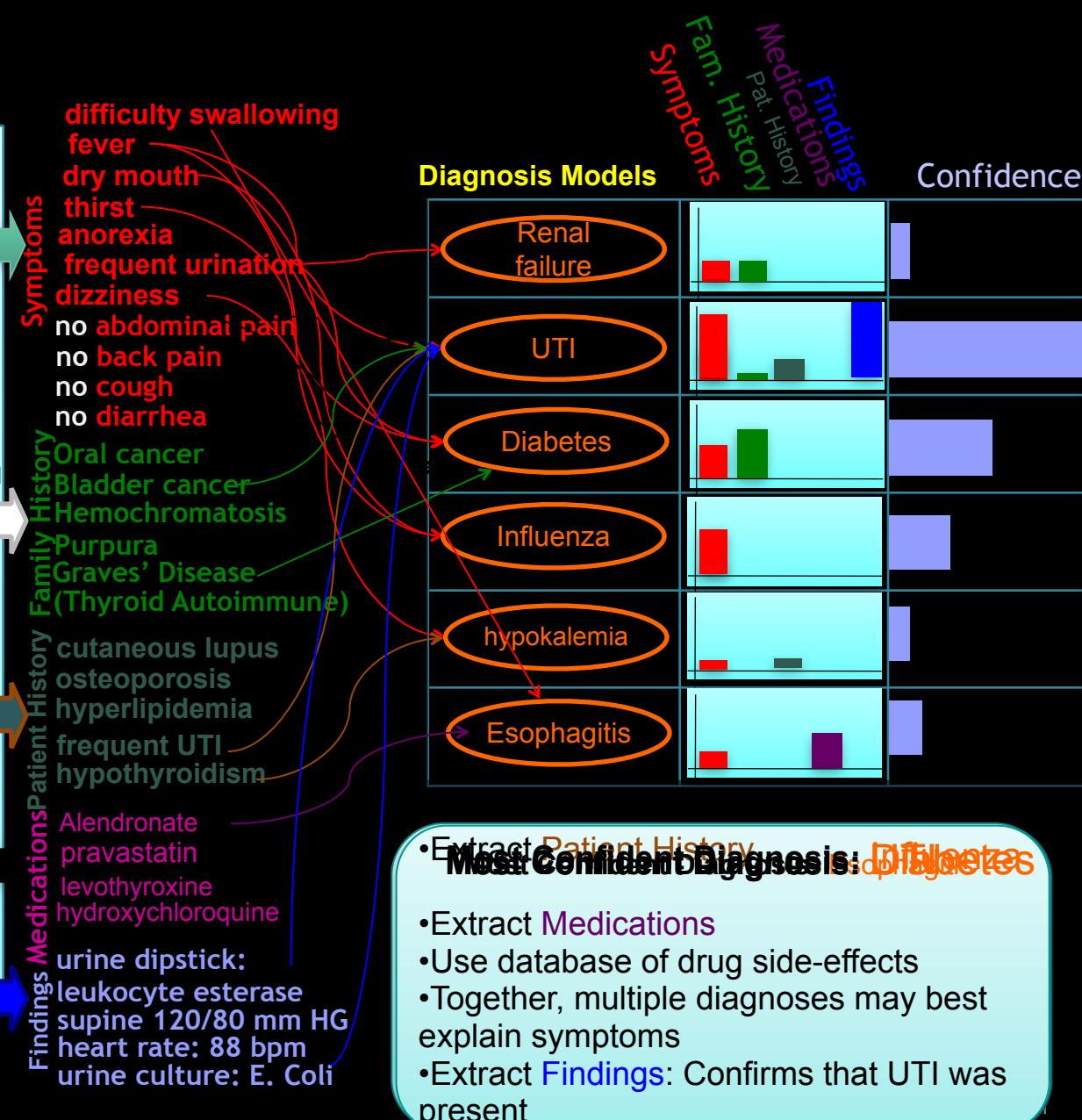
Leverage medical records
TO
diagnose and identify
treatment options
TO
enhance the quality of
medical care delivered

"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.



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 = $\frac{\sum \text{True Positive}}{\sum \text{Test Outcome Positive}}$
	Test Outcome Negative	False Negative (Type II error)	True Negative	Negative predictive value = $\frac{\sum \text{True Negative}}{\sum \text{Test Outcome Negative}}$
		$\frac{\sum \text{True Positive}}{\sum \text{Condition Positive}}$	$\frac{\sum \text{True Negative}}{\sum \text{Condition Negative}}$	



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 $= TN / (FN + TN)$ $= 1820 / (10 + 1820)$ $\approx 99.5\%$
		Sensitivity $= TP / (TP + FN)$ $= 20 / (20 + 10)$ $\approx 67\%$	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

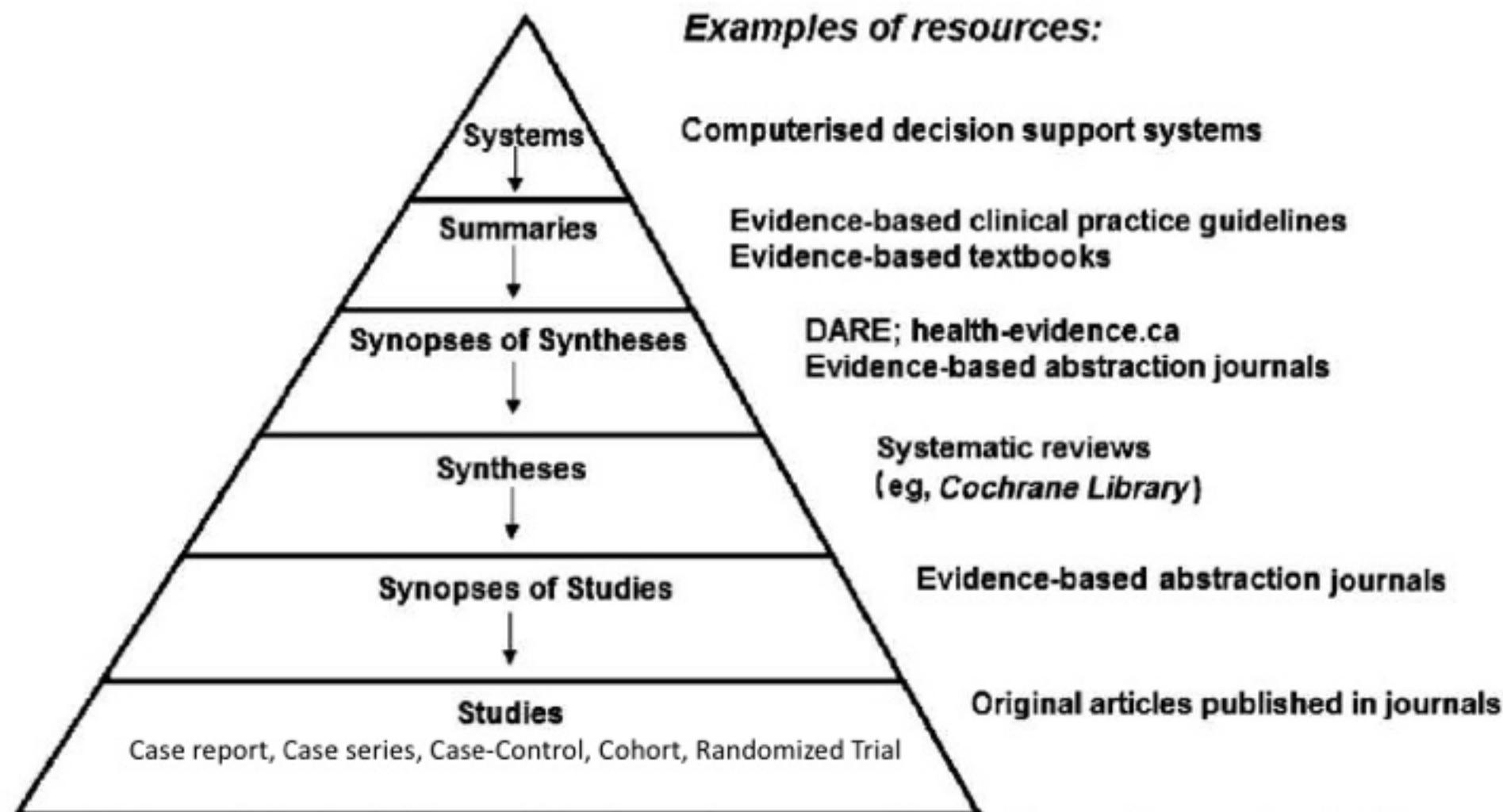
- * Needs time
- * Resource Intensive (Evidence, Literature, Knowledge)

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	<i>Intelligent Referral Form</i>
	1.4 Departmental/multidisciplinary clinical documentation forms	<i>Emergency department documentation</i>
	1.5 Data Flowsheets	<i>Immunization flowsheet</i>



Types of CDSS [1]

2) Relevant Data Presentation

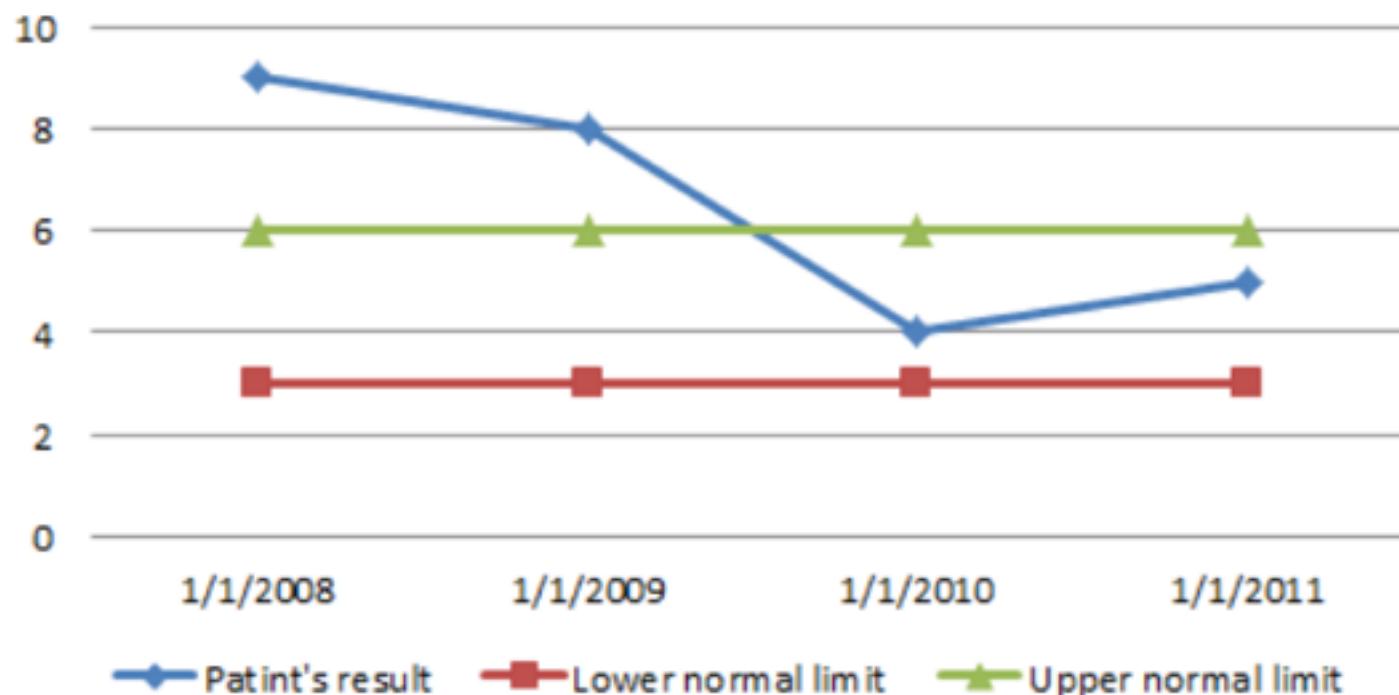
- *Display relevant data -including costs
- *Pertinent Data are displayed
- *Complex Data - to show overall picture
- *To highlight needed ACTIONS



Untitled Frame



Trend of FBS



Help

Print

OK

Types of CDSS [1]

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



Types of CDSS [1]

Types	Sub-types	Examples
2. Relevant Data		
	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]

3) Order Creation Facilitators

- * Adherence to Standards (Guidelines)
- * Making the right things EASIEST TO DO

4) Protocol and Pathway Support

- * Provide support for multi-step care plan , protocol and pathway



Types of CDSS [1]

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



Types of CDSS [1]

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



Types of CDSS [2]

5) Reference Information & Guidance

- Address recognized needs from physicians & patients
- “Infobuttons” - linked to references/standards

ALS, lab requests list

User: Jamal, Amr MD

Patient information

MRN: 1234567 Age: 13
Name: Ali, Lena Ahmed Sex: Female

Request information

Request: CBC Collection date: 23 Sep 2011
Requested by: Adam, Idriss MD Collection time: 8:00 am
Collection location: Ward 23B

#	test	Result	Unit	alert	normal range	trend
1	WBC	4.8	x10.e9/L		4 - 11	
2	RBC	4.86	x10e12/L		4.7 - 6.1	



Types of CDSS [2]

6) Reactive Alerts and Reminders

- *Data entry level
- *Immediate notification for errors and hazards
- *Lack of an order- reminder
- *Contradictions to a procedure



Types of CDSS [1]

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



Types of CDSS [1]

Types	Sub-types	Examples
6. Reactive Alerts & Reminders		
	Alerts to prevent potential errors	Drug Allergy Alerts Drug Interaction alert 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.



References

- [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-quality 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.

