Keys to Successful Computerized Clinical Decision Support SINI 2007

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Objectives

- Articulate the importance of Computerized Clinical Decision support in healthcare
- Identify different types of Clinical Decision Support Systems (CDSS)
- Understand the basic process of developing a CDSS
- Understand the challenges of implementing CDSSs

What are Clinical Decision Support Systems?

- Any computer program designed to help healthcare professionals make clinical decisions *(EH Shortliffe, 1990)*
- A system consisting of a knowledge base and an inference engine that is able to use entered data to generate advice *(J.H. Van Bemmel and M.A. Musen, 1997)*

What else can a CDSS do?

- Aid and strengthen decision making and overall efficiency

Semples, 1996

- Organize information to fit new environments
- Provide analysis and advice to support a choice
- Leave the final decision with the practitioner

Hebda, Czar, Mascara, 1998

Key Functions

- Clinical Decision Making
  - Supporting clinical diagnosis and treatment plan processes; and promoting use of best practices, condition-specific guidelines, and population-based management.
- Managing clinical complexity and details
  - Keeping patients on research and chemotherapy protocols; tracking orders, referrals follow-up, and preventive care.
- Administrative
  - Supporting clinical coding and documentation, authorization of procedures, and referrals.
- Cost control
  - Monitoring medication orders; avoiding duplicate or unnecessary tests.

Perreault & Metzger (1999). A pragmatic framework for understanding clinical decision support. Journal of Healthcare Information Management. 13(2):5-21.

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Why Consider Using a CDSS?

- Clinicians cannot keep up with rapidly changing and increasing body of clinical knowledge
- Human error occurs in both routine and complex cases
  - DSS tools can supply alerts and/or reminders regarding possible concerns or omissions

Ultimately . . .

"It is simply unrealistic to think that individuals can synthesize in their head scores of pieces of evidence, accurately estimate the outcomes of different options, and accurately judge the desirability of those outcomes for patients…. All confirm what would be expected from common sense: The complexity of modern medicine exceeds the inherent limitations of the unaided human mind."

Eddy, DM. Clinical Decision Making. JAMA 1990;263:1265-1275

The Numbers…

Clinical complexity = > 236 at one “average” ICU bedside

The ventilator alone:
50 controls x Multiple settings =
> 37 BILLION Choices!

Average # of variables the human brain can remember = 7

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Benefits of a CDSS

- Efficient decision making
- Can provide a competitive edge
- Standardizes care
- Facilitates the move to managed care
- Manages data effectively and efficiently
- Provides historical and current data reports

Hebda, Czar, Mascara (1998) and Van Bemmel & Musen (1997)

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Benefits of a CDSS

- Reduction in medical errors and improvement in quality
  - Potentially dangerous situations are detected quickly and brought to the attention of the caregiver, thus avoiding undesirable patient outcomes.

- Potential reduction in long term costs
  - As quality improves, complications that could result in greater costs down the road are avoided. Also the risk of malpractice suits is reduced.

Arsala, Rosenblatt, Singer & Slouffman (2005), Source: http://www7.kellogg.northwestern.edu/techconcepts/winter2005projects/healthcaresoftware/cdss2.htm

Decision Support Tools

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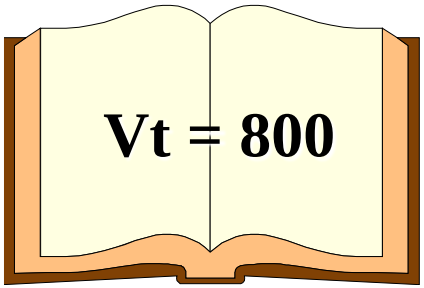
Cookbook: Post Op Adult Males



VT = 800

VR = 15

Peak Flow = 60 l/m

FiO2 = 40%

Designed for patient groups…

NOT the individual patient

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Guideline

11.5.1 Increases in Paw may result in improved oxygenation; however, Paw >12 cm H2O has been associated with barotrauma

11.5.4 PEEP increases FRC and may improve oxygenation and ventilation-perfusion relationship (PEEP is typically adjusted at 4-7 cm. H2O levels beyond this range may result in hyperinflation

Neonatal time triggered, pressure limited, time-cycled mechanical ventilation, AARC Clinical Practicw Guideline. Respir Care 1994; 39(8): 808-816

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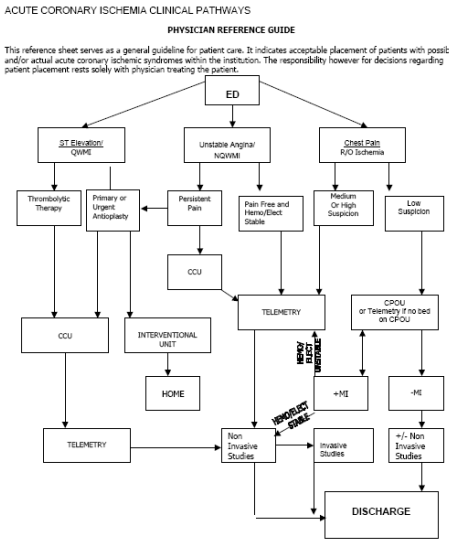
Carepath

Post Op thoracic surgery patients should be weaned within 24 hours

- Focused on patient group rather than individual patient
- Heavily oriented towards resource management



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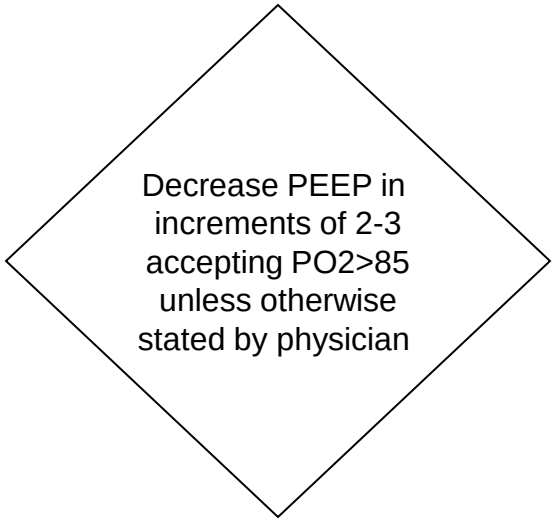
Clinical Protocols



…patient will receive a tidal volume of approximately 10-12 ml/Kg ideal body weight. Morbidly obese patients may have tidal volumes set at 5 ml/Kg actual body weight. Note: High tidal volumes at 12-15 ml/Kg in ARDS may contribute to an increased risk of barotrauma

Darin, J: Procedure 10.02, pg 7, Mechanical Ventilation Protocol Heritage Hospital, Taylor, MI in the AARC Critical Care Protocol Library Set PC1 1995

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Specific Executable Protocols

Clear & Concise

No Weasel Words

Increase PEEP by 2 cm H2O from 8 to 10 cm H2O.

Maintain FiO2 = 70%

Maintain VT set = 500 ml

Increase Rate set by 2 from 28 to 30 breaths/min

Adjust Peak Flow to maintain I:E near 1:2.3

Draw an ABG 20 min after vent change

CDSS Tools Used in Clinical Tasks

- Information Retrieval
- Alerting and Reminders
- Therapy Critiquing, Planning and Prescribing
- Image Recognition and Interpretation
- Retrospective analysis and quality assurance
- Diagnostic Assistance and Suggesting

Coiera (2003). Guide to Health Informatics: 2nd Ed. Source: http://www.coiera.com/aimd.htm

Haug, P.J, Gardner, R.M, Evans, R.S (1999). Hospital Based Decision Support Systems; Clinical Decision Support Systems; Springer-Verlag, Inc.

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Information Retrieval

- Software ‘agents’ can search for and retrieve information to answer clinical questions.
- Intelligent information retrieval systems can:
  - Assist in formulating accurate clinical questions.
  - Act as information filters.
  - Assist in identifying appropriate sources of evidence.

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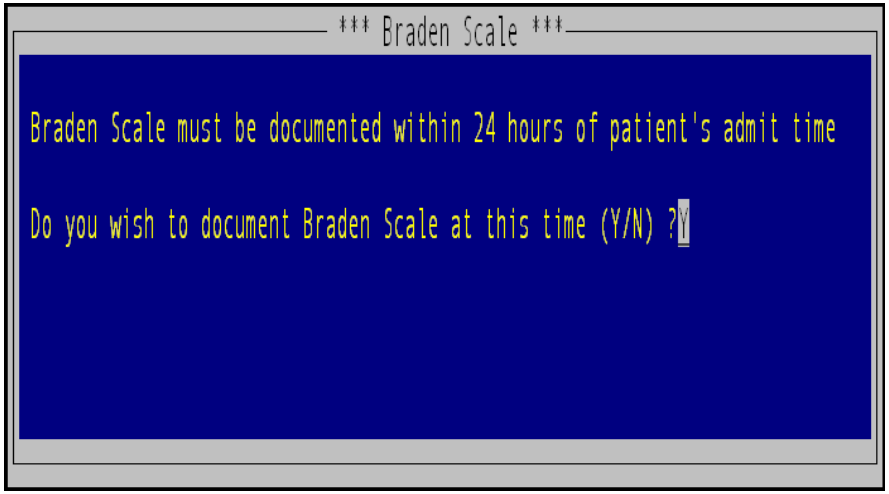
Alerting & Reminders

Test Status	Na	K	Cl	CO2	Anion Gap (Na Cl CO2)	Glucose	BUN	Creatinine	Ca
	137-146 mmol/L	3.5-5.0 mmol/L	98-109 mmol/L	19-30 mmol/L	3-16 mmol/L	65-99 mg/dL	6-21 mg/dL	0.8-1.3 mg/dL	8.4-10.2 mg/dL
Final	137	4.1	107	23	7	106 H	36 H	1.6 H	8.2 L
Final	139	3.7	109	24	6	100 H	36 H	1.6 H	8.5

- Function continuously
- Monitor clinical data “behind the scenes” as it is entered into the patient’s record
- Designed to test specific types of data against pre-defined criteria



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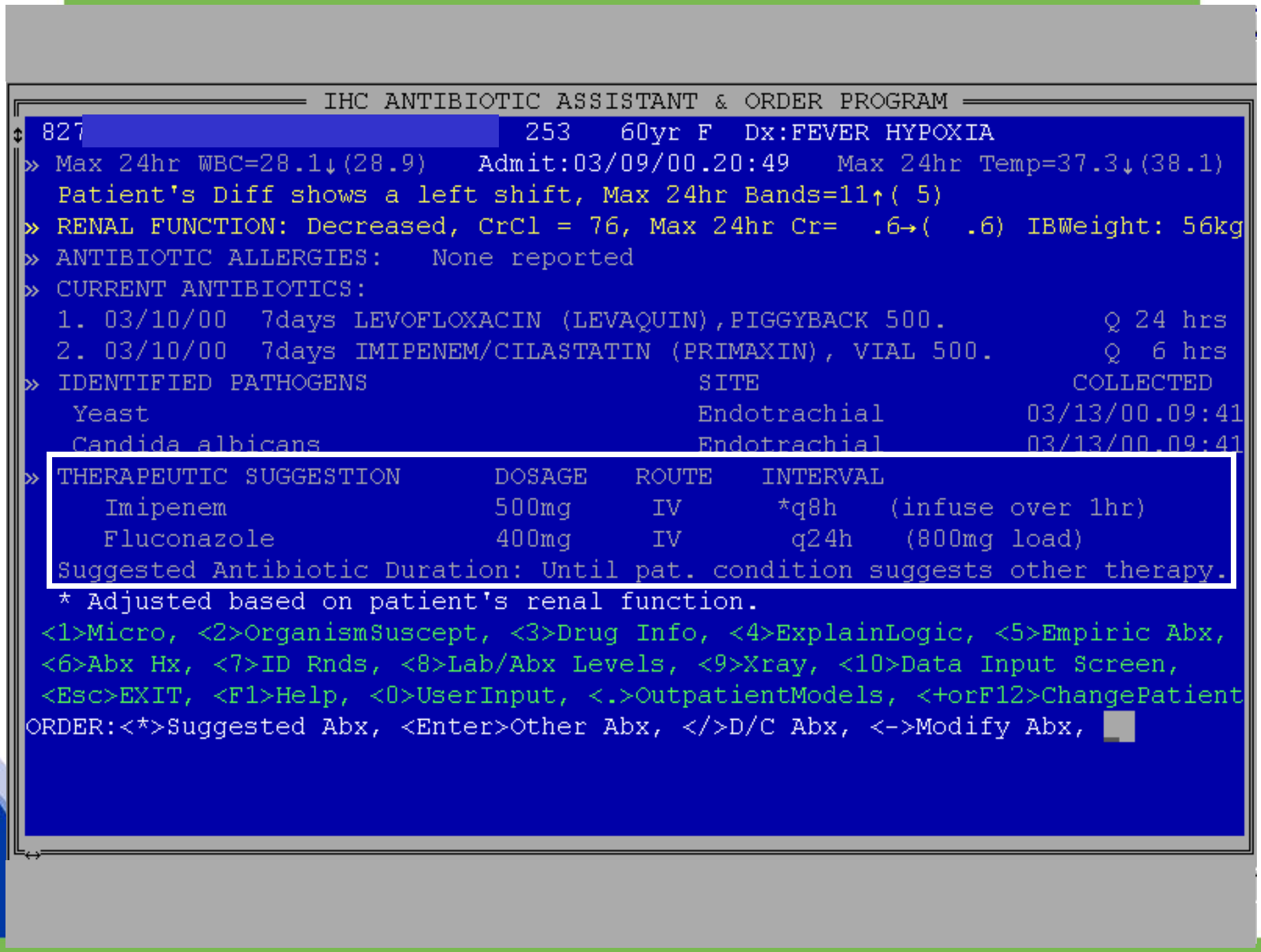
Critiquing & Suggesting

- Begin with the entry of an intervention order into the system
- Evaluate the order
- Point out disparities between the order and an internal definition of proper care or propose and alternative approach
- System responds with concrete suggestions concerning which actions to take next
- Processes are designed to react to requests for assistance


IHC ANTIBIOTIC ASSISTANT & ORDER PROGRAM
827 253 60yr F Dx:FEVER HYPOXIA
» Max 24hr WBC=28.1↓(28.9) Admit:03/09/00.20:49 Max 24hr Temp=37.3↓(38.1)
Patient's Diff shows a left shift, Max 24hr Bands=11↑(5)
» RENAL FUNCTION: Decreased, CrCl = 76, Max 24hr Cr= .6→(.6) IBWeight: 56kg
» ANTIBIOTIC ALLERGIES: None reported
» CURRENT ANTIBIOTICS:
1. 03/10/00 7days LEVOFLOXACIN (LEVAQUIN),PIGGYBACK 500. Q 24 hrs
2. 03/10/00 7days IMIPENEM/CILASTATIN (PRIMAXIN), VIAL 500. Q 6 hrs
» IDENTIFIED PATHOGENS SITE COLLECTED
Yeast Endotrachial 03/13/00.09:41
Candida albicans Endotrachial 03/13/00.09:41
» THERAPEUTIC SUGGESTION DOSAGE ROUTE INTERVAL
Imipenem 500mg IV *q8h (infuse over 1hr)
Fluconazole 400mg IV q24h (800mg load)
Suggested Antibiotic Duration: Until pat. condition suggests other therapy.
* Adjusted based on patient's renal function.
<1>Micro, <2>OrganismSuscept, <3>Drug Info, <4>ExplainLogic, <5>Empiric Abx,
<6>Abx Hx, <7>ID Rnds, <8>Lab/Abx Levels, <9>Xray, <10>Data Input Screen,
<Esc>EXIT, <F1>Help, <0>UserInput, <.>OutpatientModels, <+orF12>ChangePatient
ORDER:<*>Suggested Abx, <Enter>Other Abx, </>D/C Abx, <->Modify Abx,

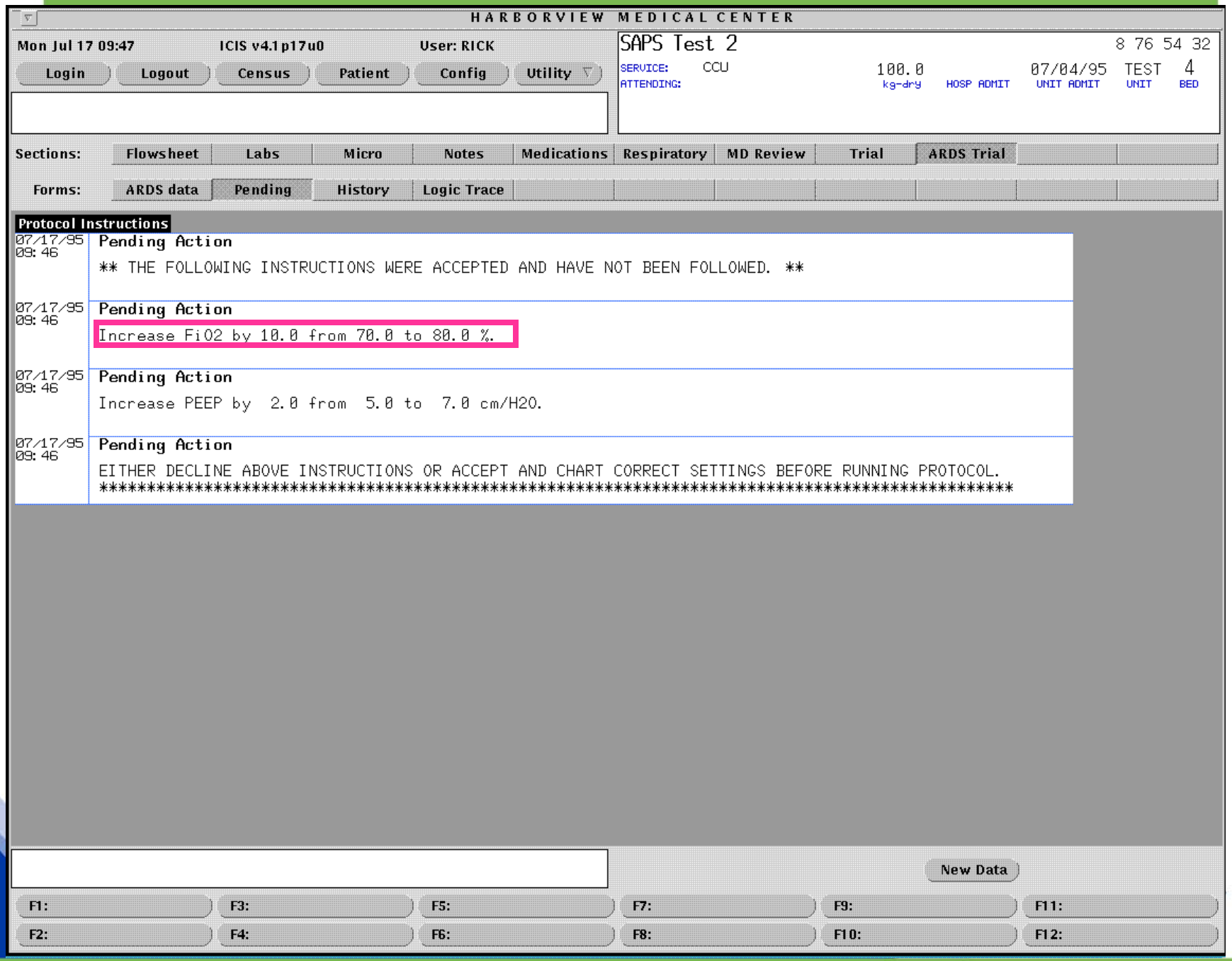
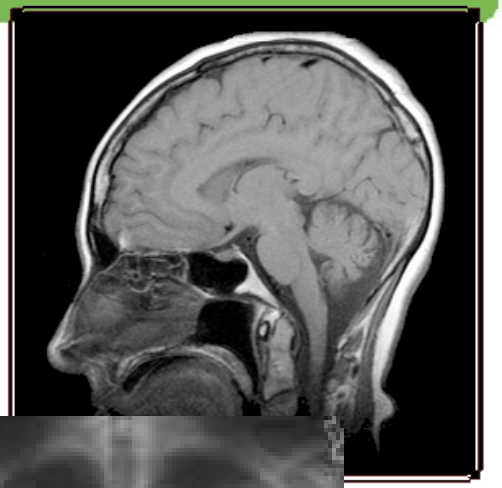
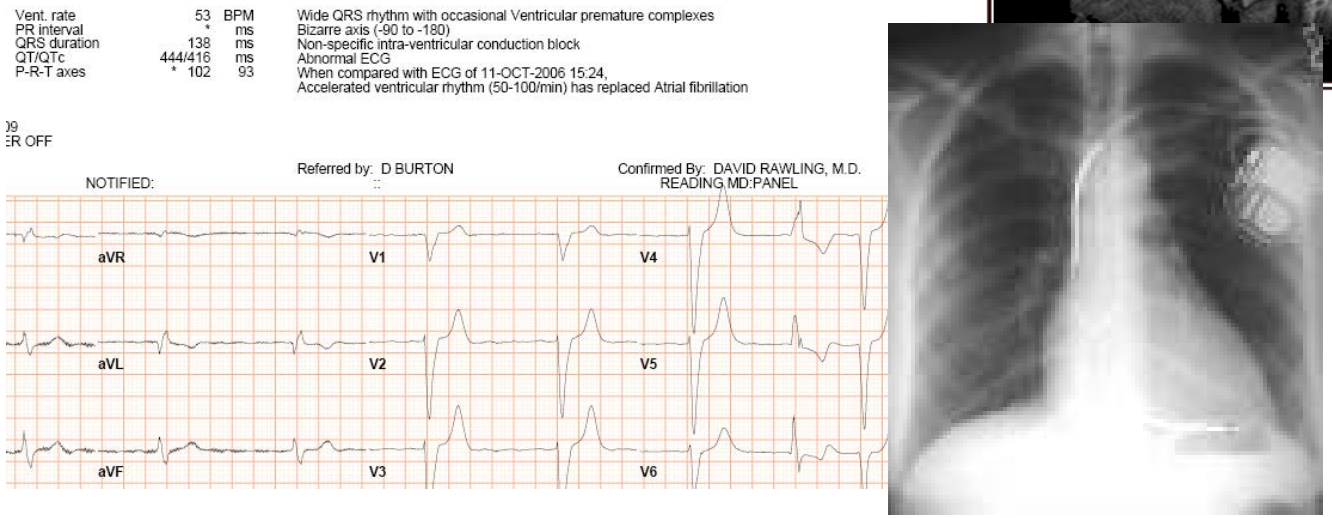

HARBORVIEW MEDICAL CENTER
Mon Jul 17 09:47
ICIS v4.1p17u0
User: RICK
Login
Logout
Census
Patient
Config
Utility
SAPS Test 2
8 76 54 32
SERVICE: CCU
ATTENDING:
100.0
kg-dry
07/04/95
HOSP ADMIT
TEST
UNIT ADMIT
4
UNIT
BED
Sections:
Flowsheet
Labs
Micro
Notes
Medications
Respiratory
MD Review
Trial
ARDS Trial
Forms:
ARDS data
Pending
History
Logic Trace
Protocol Instructions
07/17/95 09:46
Pending Action
** THE FOLLOWING INSTRUCTIONS WERE ACCEPTED AND HAVE NOT BEEN FOLLOWED. **
07/17/95 09:46
Pending Action
Increase FiO2 by 10.0 from 70.0 to 80.0 %.
07/17/95 09:46
Pending Action
Increase PEEP by 2.0 from 5.0 to 7.0 cm/H20.
07/17/95 09:46
Pending Action
EITHER DECLINE ABOVE INSTRUCTIONS OR ACCEPT AND CHART CORRECT SETTINGS BEFORE RUNNING PROTOCOL.
****
New Data
F1:
F3:
F5:
F7:
F9:
F11:
F2:
F4:
F6:
F8:
F10:
F12:

Image Recognition & Interpretation

Images can be screened and flagged for detailed human attention.





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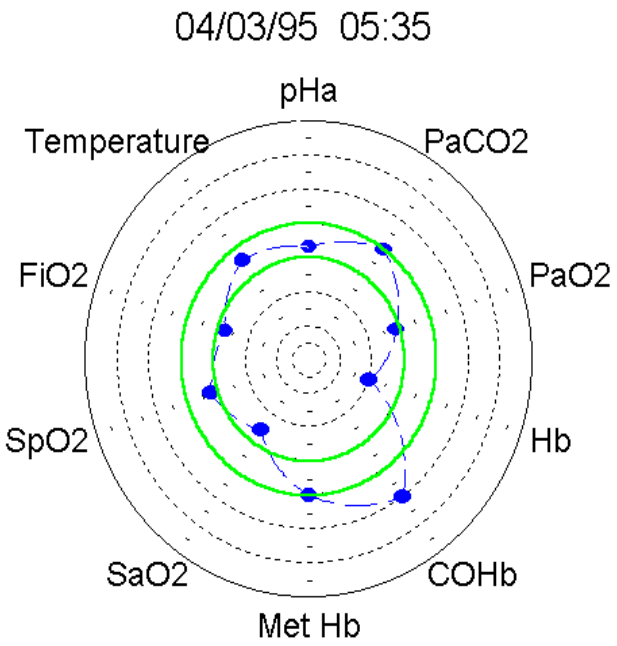
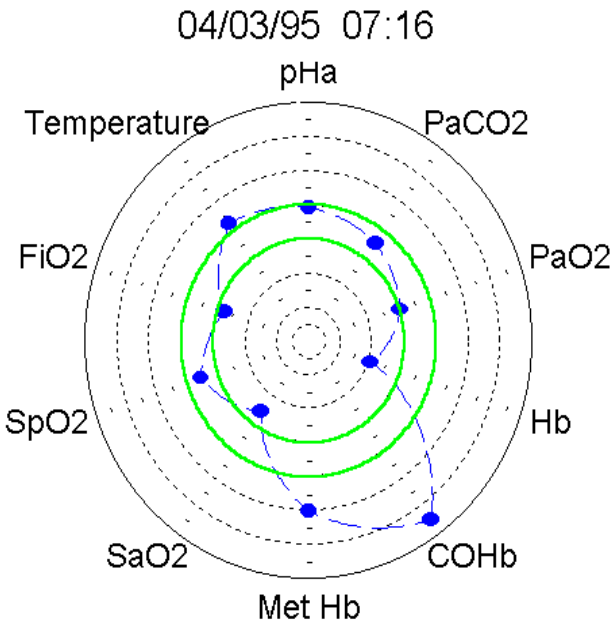
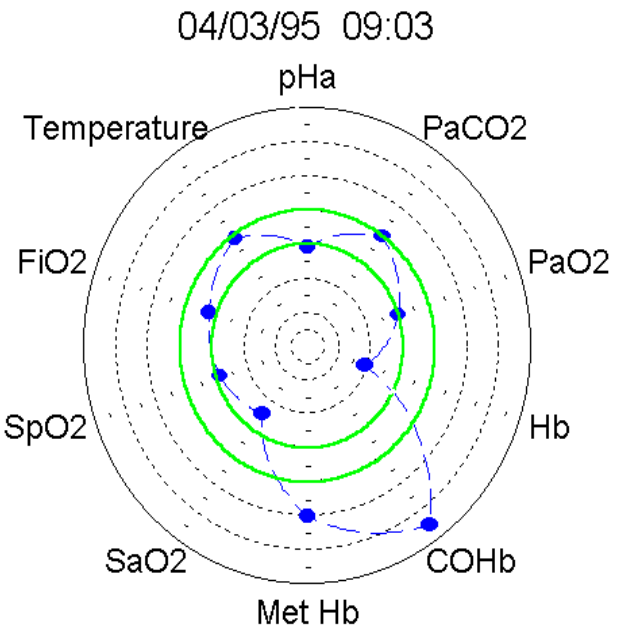
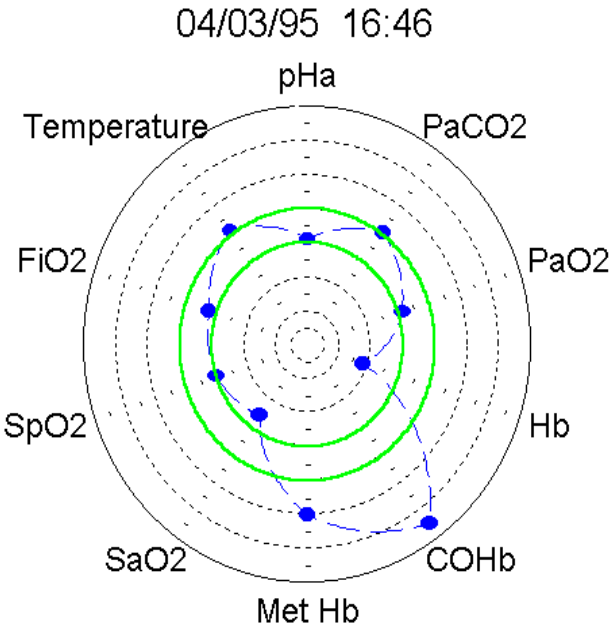
Retrospective Review

- Emphasizes computer's ability to collect and present a variety of information
- Reports can be of individual actions or patients, or aggregated across patients or clinicians
- Used most often in quality assurance activities or process improvement projects









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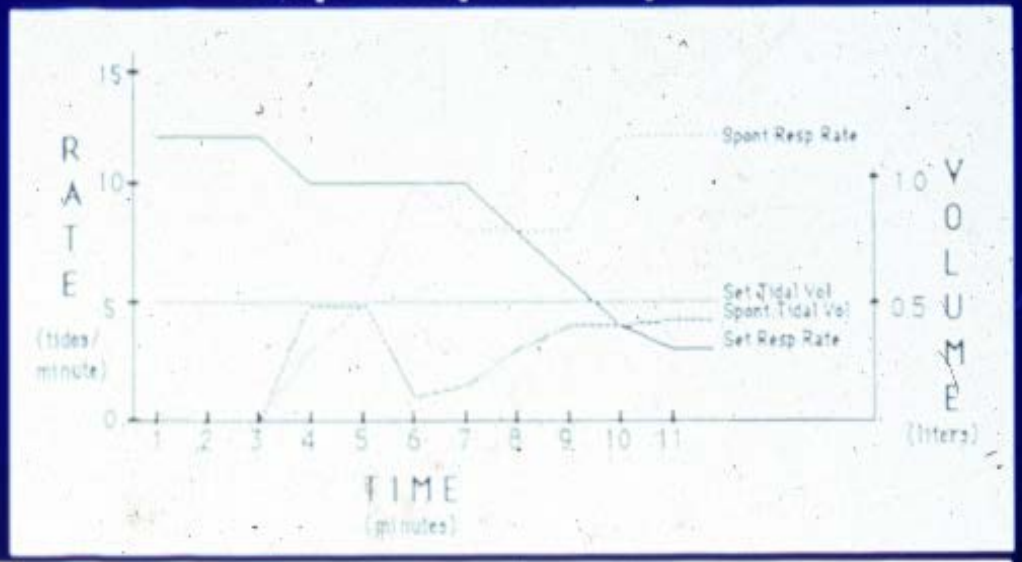
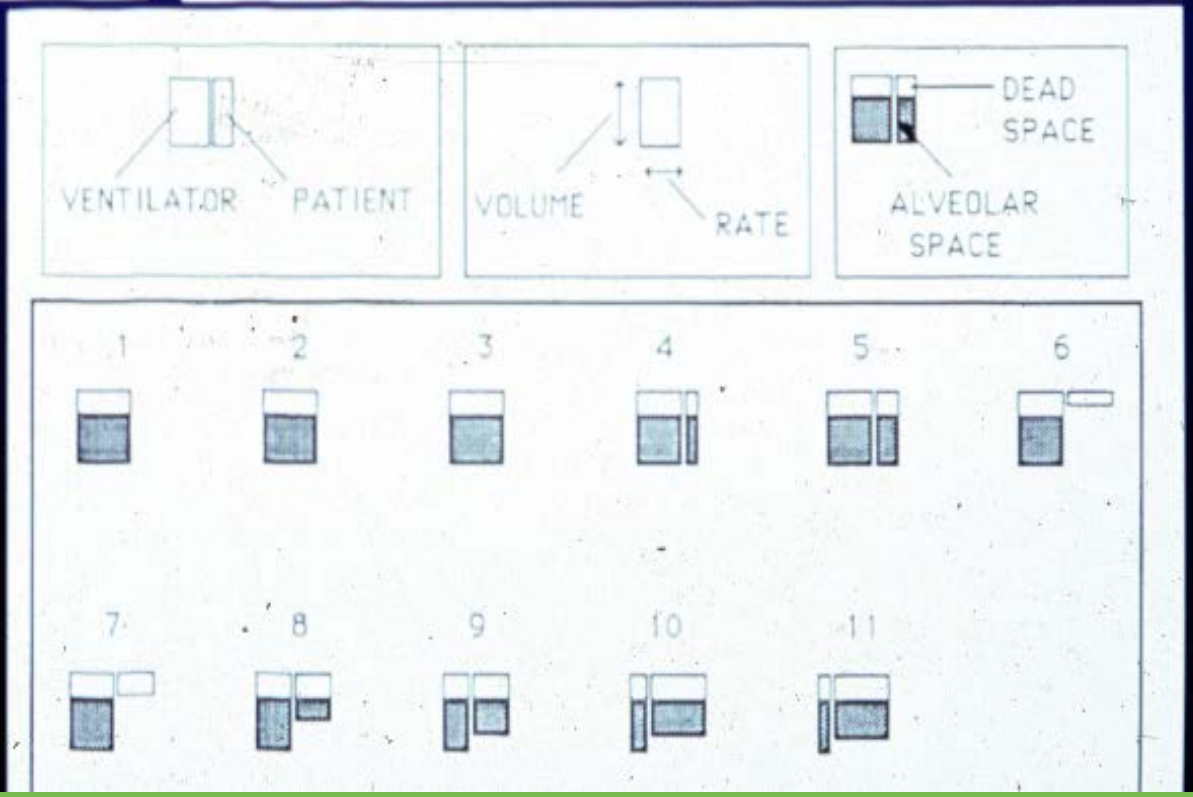
Numerical Data

	Ventilator		Patient	
Minute #	Set Rate	Set Volume	Spont Rate	Spont Volume
1	12	0.50	0	0.00
2	12	0.50	0	0.00
3	12	0.50	0	0.00
4	10	0.50	3	0.50
5	10	0.50	5	0.50
6	10	0.50	10	0.10
7	10	0.50	8	0.15
8	8	0.50	8	0.30
9	6	0.50	8	0.40
10	4	0.50	12	0.40
11	3	0.50	12	0.42

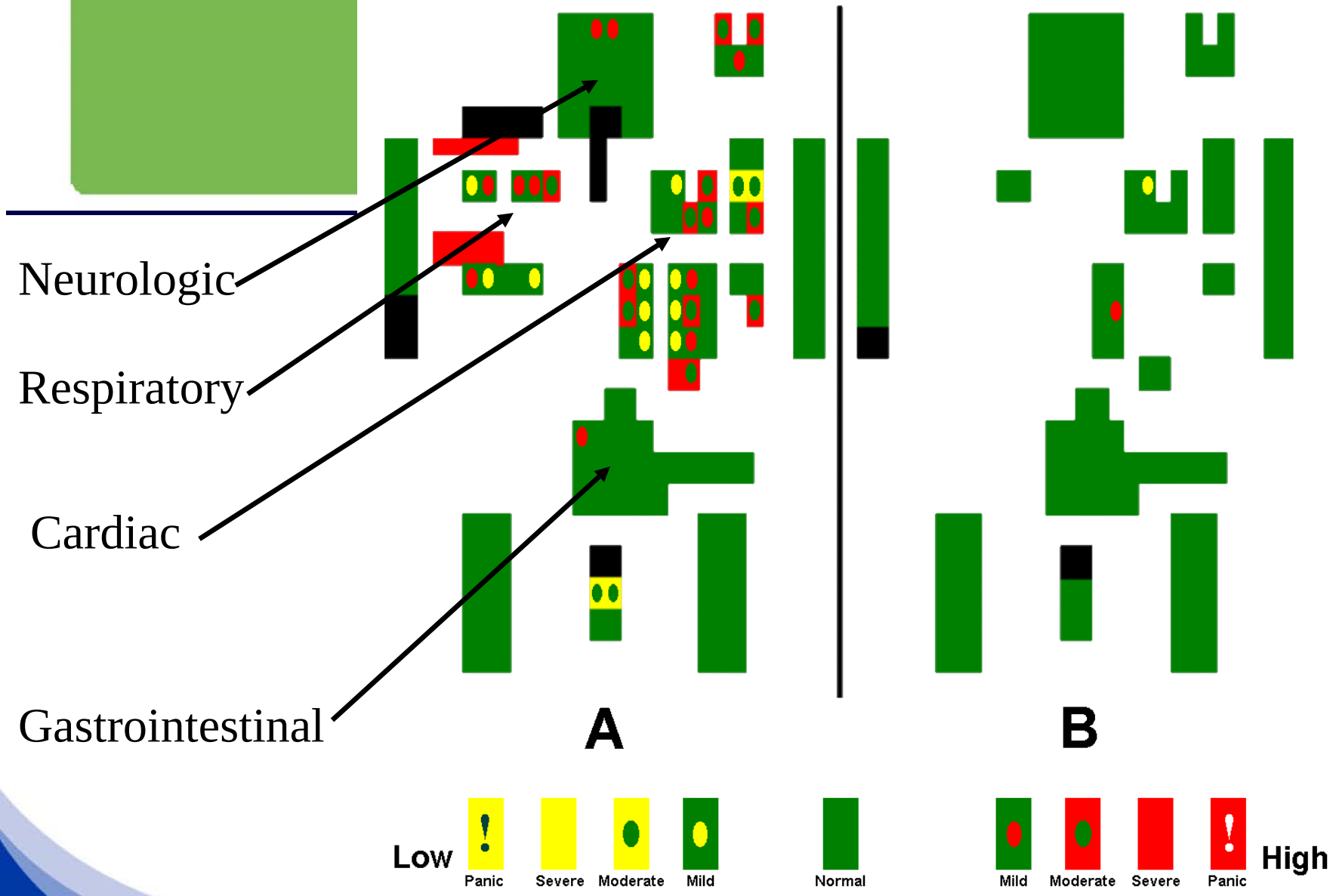
Simple Graphical Representation



Metaphor Graphics



Cole WG, Stewart JG.
Metaphor graphics to support integrated decision making with respiratory data.
Int J Clin Monit and Comp 1993;10(2):91-100.



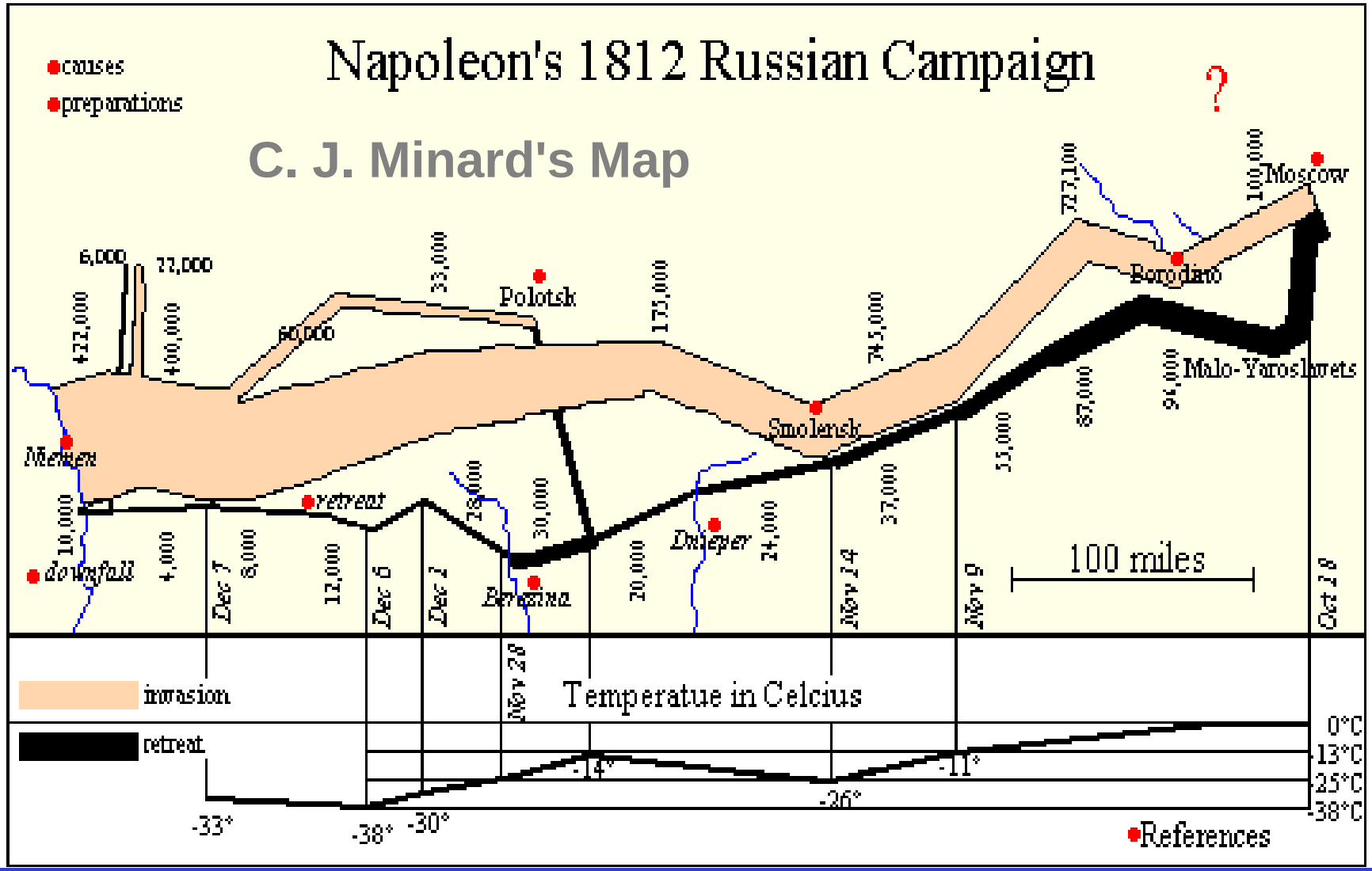
KEGS®

causes
preparations

Napoleon's 1812 Russian Campaign

?

C. J. Minard's Map

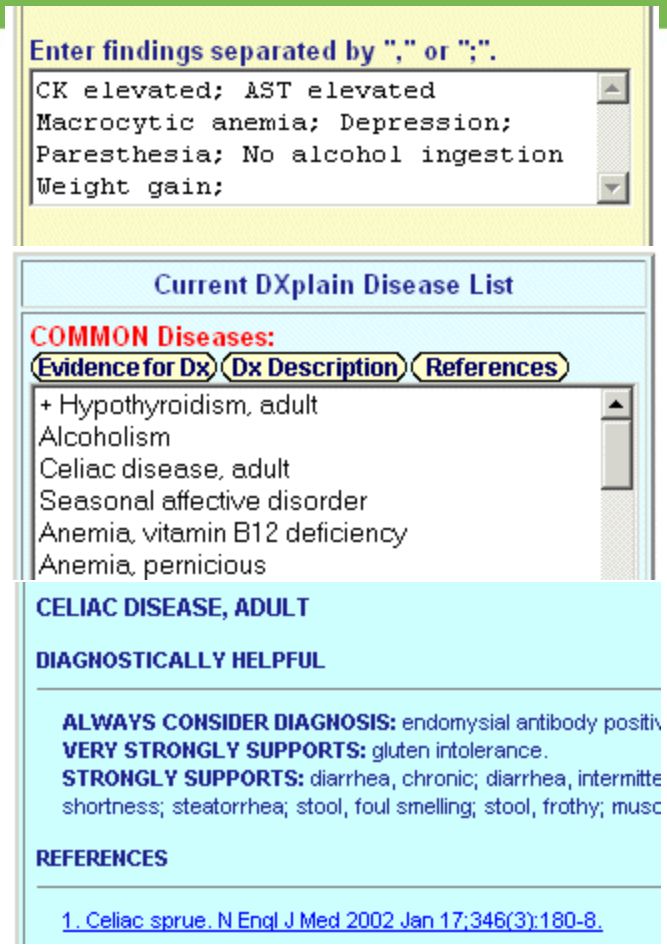


This flow map is famous for the amount of information it conveys in such a limited space. It plots several variables.

1. the size of the French army depicted by the width of the bands;
2. its location on a two-dimensional surface;
3. the direction of the movement of the advance (upper band) and retreat (lower band);
4. the temperature on certain dates during the retreat

Diagnostic Assistance

Patient information is compared against a knowledge base to assist in determining diagnosis and management.



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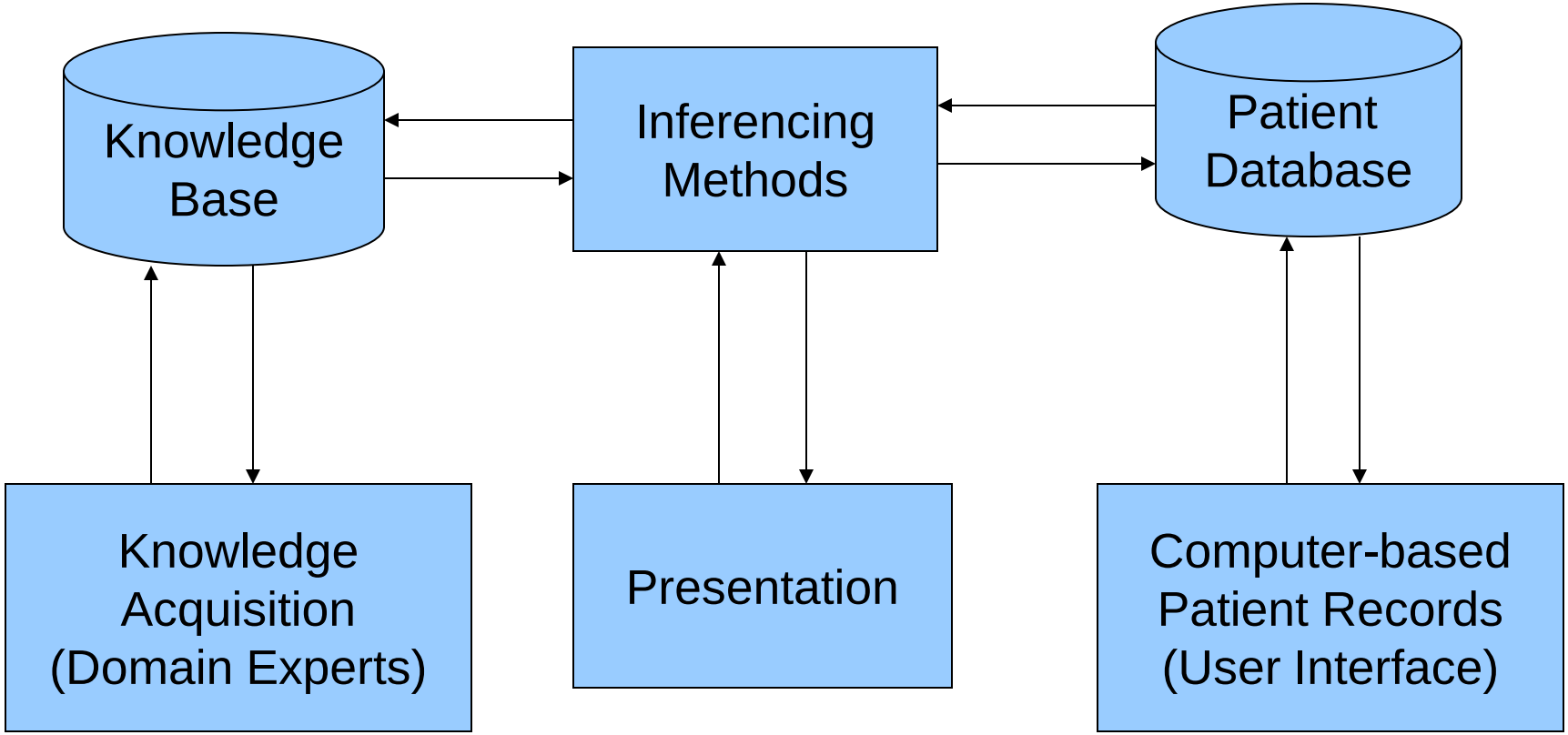
Developing and Implementing Computerized Decision Support Systems

Computerized Decision Support Logical Design



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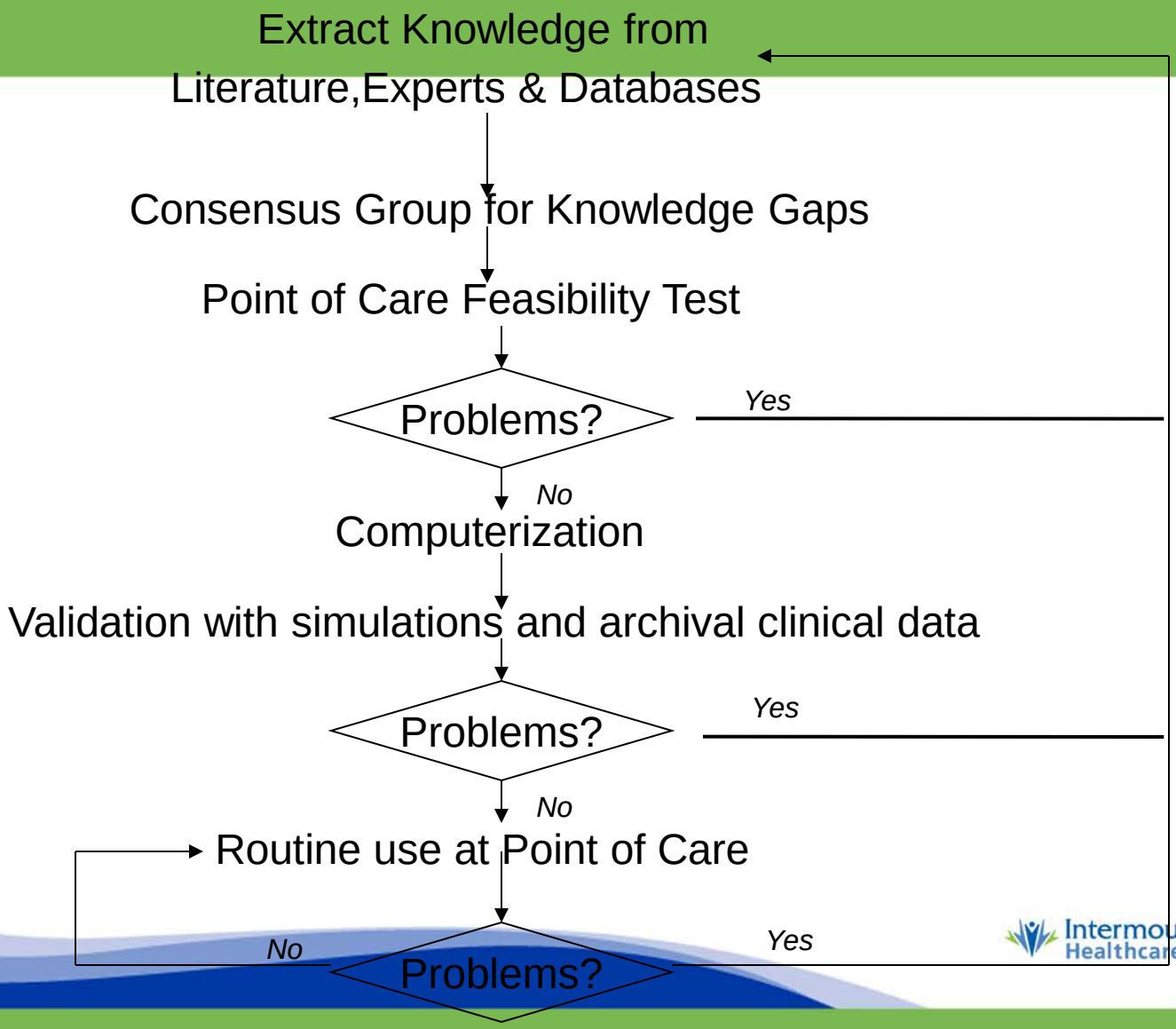
Development and Evaluation



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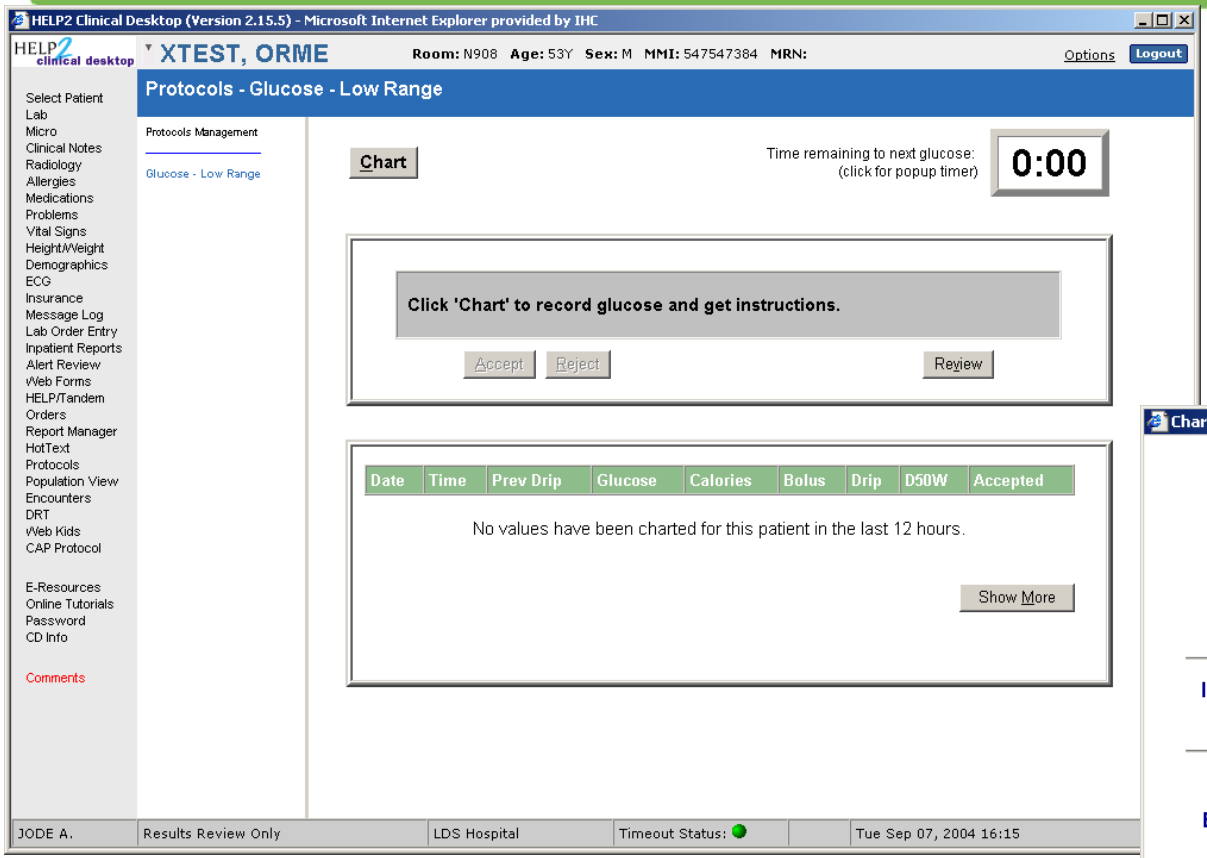
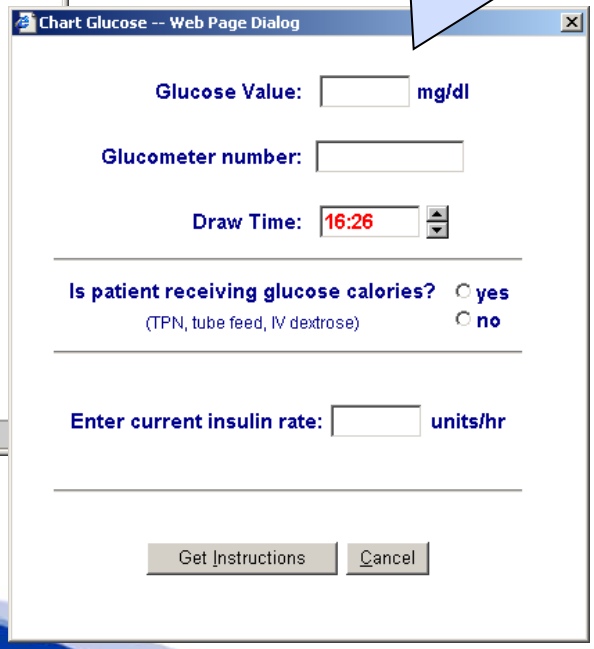
Developing a CDSS

- Must have a problem to solve
- The problem must be understood
- A reasonable solution exists
- First ingredients:
  - Problem-solving skills
  - Pertinent knowledge
  - Accurate data

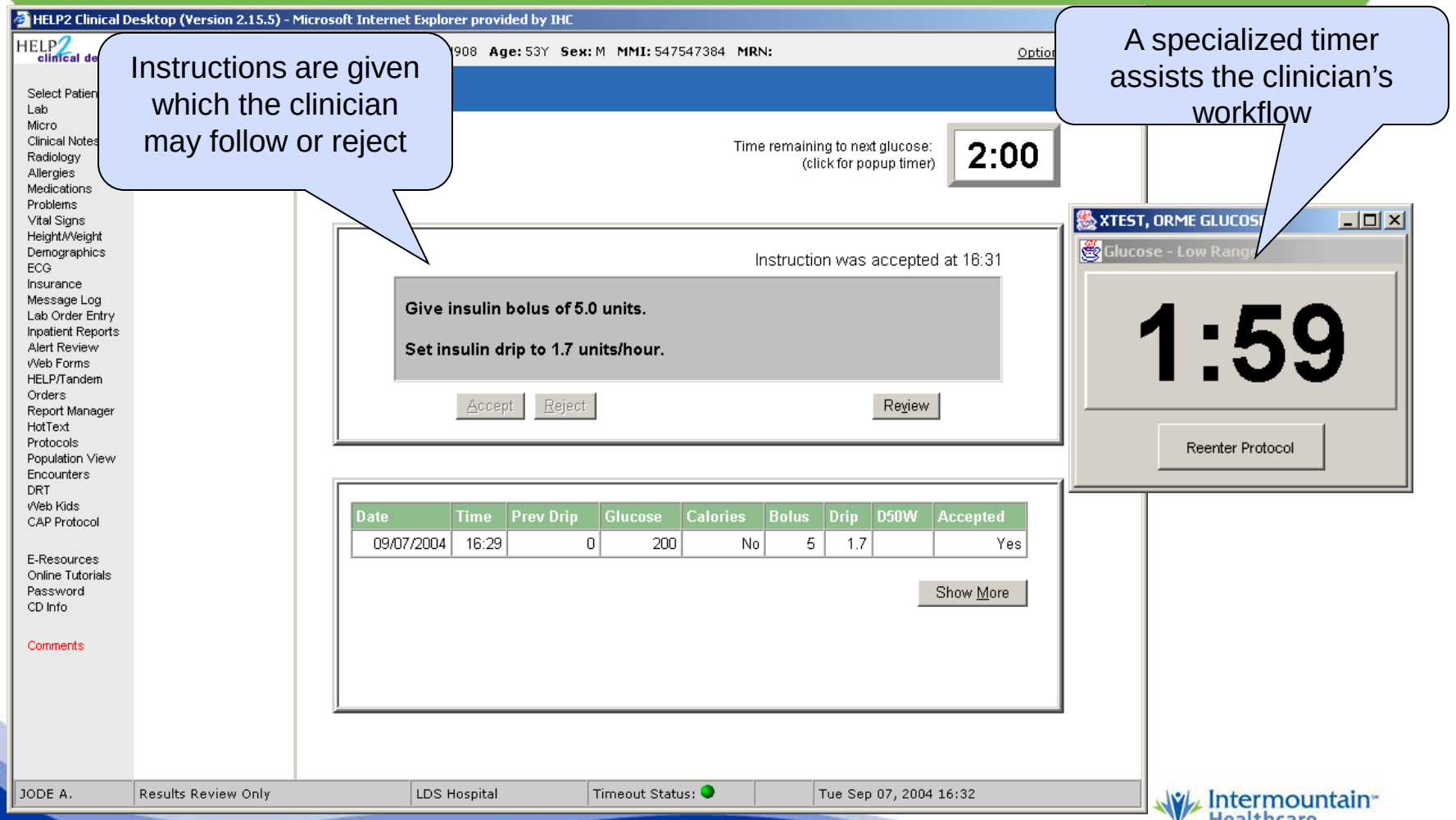
Example Problem – Glucose Management



Patient data is captured here and run against production rules



Example Problem – Glucose Management



Developing a CDSS

- Elicit the knowledge
- Model the knowledge
  - How the data and knowledge relate.
- Acquire and Validate patient data
  - Capture the data
  - Model the data
    - Capture the data in a computable form (i.e., standard terminologies like SNOMED, LOINC, etc.
    - Standardized Terminology *essential!*

Developing a CDSS

- Choose the appropriate type and level of CDSS for the problem
- DSS Tools – availability and usability
  - Represent the reasoning – turning “clinical judgment” into 1’s and 0’s
- Validate the system’s performance – how does it compare to the “gold standard”?
  - What is the gold standard?
- Integrate the tool.
  - Technical integration – all component systems working together.
  - Human integration – the tool must fit the user.

Challenges – look familiar?

- Acquiring the data
- Modeling the knowledge
- Eliciting the knowledge
- Representing the reasoning
- Validating performance
- Integrating the tool

Challenges – Training

- For success, training must be adequate to ensure users:
  - Know enough to run system
  - Value system
  - Trust system
- Changes may require new training

Challenges – Maintenance

- Determine early how the knowledgebase will be maintained and updated
- Knowledge base must be updated as clinical expertise, protocols and policies change and grow
- Patient care data base must be updated when needed to accommodate new or changes to data elements
- Changes require re-testing of entire system

Essential to Success

- Clinical Ownership
  - Involvement in idea conception
  - Workflow and requirement definition
  - Design
  - Testing
  - Refinements
  - Updates

Essential to Success

- Organizational governance and oversight
  - Safety
  - Prioritization

Questions?

Thank you!

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