The Art, Science, History and Future of Clinical Decision Support Systems

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BIOMEDICAL INFORMATICS PhD
TRAINING OPPORTUNITIES
AT VANDERBILT

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Mrs. Jones is now 77 years old, and had worked for many years as a part-time clerk in an office. She has been healthy all her life, but has become progressively short of breath, with swelling in her legs and abdomen, over the past 6 months. She has no history of high blood pressure, chest pain or heart attack, heart disease of any type, or liver disease. She has been a non-smoker and not consumed alcohol her entire life. She is a widow and lives alone.

Her first words to you, while gasping for breath in the ER, are: “It is against my religion to be seen or cared for by a physician. A practitioner of my faith told me to go to the hospital because prayer was no longer working. Please help me.”
WHAT ARE YOUR IMPRESSIONS NOW?

1. Diagnosis?
2. Therapy?
3. Prognosis?
4. Sociocultural / psychological?
5. Clinical Information Needs?
You give her oxygen, and take her history & perform physical exam.

1. She has shortness of breath on exertion which is now so severe she cannot walk more than a small fraction of the distance across the room without resting

2. She is breathless at rest with respiratory rate 30/min (nl 14-18); BP low at 100/70 without orthostatic change; temperature normal.

3. Jugular veins distended to angle of jaw, estimated CVP > 15 cm H20 (nl < 7)

4. Breath sounds decreased with dullness to percussion 1/3 way up on R, ½ way up on L, decreased vocal and tactile fremitus in areas of dullness.

5. Heart sounds distant, barely audible. No gallops or rubs. Apical impulse (PMI) not palpable.

6. Abdomen distended, pitting edema of abdominal wall, shifting dullness and fluid wave present. No palpable masses or organomegaly (hard to tell). Normal superficial venous pattern.

7. Extremities – no arthritis. 4+ pitting edema of legs to abdomen.

8. Chest Xray – gross cardiomegaly, large pleural effusions L > R, heart border obscured
You continue oxygen and admit her to her room upstairs in the hospital.

You administer a diuretic (agent to remove fluid through renal excretion).

After two hours, her blood pressure falls to a very low 85/60.

She becomes anxious and is less comfortable than before, despite oxygen.

[NEED FOR DECISION SUPPORT]
Current Understanding of Human Diagnostic Reasoning

1. Clinicians make diagnoses by “pattern recognition” using compiled knowledge, based on reading & experience

2. Expert diagnostic reasoning is based on:
   • Recognition of key or pivotal findings (Eddy & Clanton)
   • Refinement of hypotheses as more is learned (Kassirer, Gorry, Pauker, Elstein)
   • Early diagnostic hypothesis formation; therapy before Dx at times (Elstein, others)
   • Quasi-probabilistic reasoning using prevalence (Tversky & Kahneman, others)
   • Pathophysiological reasoning (“first principles”) in unfamiliar settings

3. Experts reason more efficiently than novices: (Newell & Simon)
   • Greater store of compiled knowledge, and array of strategic approaches
   • Awareness of diagnostic "weight of evidence" in hypothesis formation (Kassirer, Patel)
INTERNIST-I Project 1973-1985  
J.D. Myers, M.D., H.E. Pople, Jr. Ph.D., R.A. Miller (then med student)

Goals and Objectives

Develop algorithm & KB that could support expert consultations for diagnosis in general internal medicine

Create program whose input would be patient's history, physical exam, and laboratory data;

Produce output consisting of either concluded diagnoses or differential diagnosis

Endow program with ability to lead physician through cost-effective patient "work-up"

Develop and maintain knowledge base for clinical diagnosis
INTERNIST-I Project 1973-1985
Sample case analysis

Positive Findings..... NEJM V324P527 1991
SEX Male
AGE Gtr Than 55
ABDOMEN Pain Epigastrium
ABDOMEN Pain Severe
UNCONSCIOUSNESS Recent Hx
HYPERTENSION Hx
MYOCARDIAL Infarction Hx
ANGINA Pectoris Hx
HEART Catheterization Recent Hx
CORONARY Arteriography Fixed Luminal Narrowing 70 Percent Or Gtr
HEART Angiocardiography Left Ventricle Adynamic Area <S>
HEART Surgery Recent Hx
PRESSURE Arterial Diastolic Gtr Than 125
DYSPNEA At Rest
BOWEL Sound <S> Decreased
CONSIDERING: SEX Male, AGE Gtr Than 55, ABDOMEN Pain Epigastrium, ABDOMEN Pain Severe, UNCONSCIOUSNESS Recent Hx, HYPERTENSION Hx, MYOCARDIAL Infarction Hx, ANGINA Pectoris Hx, HEART Catheterization Recent Hx, HEART Surgery Recent Hx, PRESSURE Arterial Diastolic Gtr Than 125, DYSPNEA At Rest

DISCRIMINATE: AORTIC DISSECTION, MYOCARDIAL INFARCTION ACUTE

DIABETES MELLITUS HX? MARFANS SYNDROME FAMILY HX? MYOCARDIAL INFARCTION FAMILY HX?
INTERNIST-I Project 1973-1985
Lessons learned

Standard model for building expert systems non-sustainable: collaboration of domain expert and knowledge engineer

**Recommendation: Use of the Biomedical Literature as a “Gold Standard” for Clinical Knowledge Bases**

For what are the classics but the noblest thoughts of man? They are the only oracles which are not decayed, and there are such answers to the most modern inquiry in them as Delphi and Dodona never gave.

**Henry David Thoreau, Walden, “Reading” (1854).**
“Feedback loop” of running system required to build and maintain high-quality KB – Beware of KBs built by committees of experts sitting in armchairs

PROFILE: ARSENIC POISONING CHRONIC  
Past Medical History.................................................  12
  0 1 AGE 16 To 25
  0 3 AGE 26 To 55
  0 2 AGE Gtr Than 55
  1 1 ALCOHOL Illicit Ingestion Hx
  2 3 ARSENIC Exposure Or Ingestion Hx
  1 2 OCCUPATION Farm Worker
  1 1 OCCUPATION Miner
  1 2 OCCUPATION Sandblaster Smelter FoundryOr Ceramics Worker
  1 1 PHARYNGITIS Recent Hx
  0 2 SEX Female
  0 4 SEX Male
  0 2 WEIGHT Loss Gtr Than 10 Percent
Symptoms of Current Illness.......................................  20
  1 2 ABDOMEN Pain Acute
  1 2 ABDOMEN Pain Chronic
DIFFERENTIAL DIAGNOSIS: DIARRHEA INTERMITTENT

Item MILDLY SUGGESTS Disease......... 2
  2 3 Ulcerative Colitis
  2 2 Intestinal Giardiasis

Item MINIMALLY SUGGESTS Disease.. 39
  1 4 Eosinophilic Gastroenteritis <MUCOSAL FORM>
  1 4 Lactose Intolerance
  1 3 Amebic Colitis
  1 3 Carcinoid Syndrome
  1 3 Glucagonoma
  1 3 Pancreatic Cholera
  1 2 Anxiety Neurosis
  1 2 Autonomic Neuropathy
  1 2 Campylobacter Enteritis
  1 2 Carcinoma Of Left Colon
  1 2 Carcinoma Of Right Colon
  1 2 Ceramide Trihexoside Lipoidosis <FABRYS DISEASE>

...
ASSOCIATED DISORDERS: ARSENIC POISONING CHRONIC

Disease Causes.................................................. 8
  1 1 CAUS Anemia Of Folate Deficiency
  1 1 CAUS Aplastic Anemia
  1 1 CAUS Cardiomyopathy Secondary
  1 1 CAUS Granulocytopenia Idiopathic Or Chemical Induced
  1 1 CAUS Hepatitis Acute Toxic
  1 1 CAUS Macronodal Cirrhosis <POSTNECROTIC>
  1 3 CAUS Peripheral Neuropathy
  1 1 CAUS Presinusoidal Portal Hypertension

Disease Predisposes to......................................... 3
  1 1 PDIS Bronchogenic Carcinoma Squamous Cell Type
  1 1 PDIS Carcinoma Of Esophagus
  1 1 PDIS Pulmonary Small Cell Carcinoma <OAT CELL>
Goals

Recognize expertise of clinician-user, in role as system "pilot"

Emphasize real-world diagnostic decision-making by physicians, rather than by “AI” algorithm

Replace "Greek Oracle" approach to diagnosis with Catalyst/Toolkit model

Exploit the INTERNIST-1/QMR knowledge base for diagnostic reasoning

Change to microcomputer-based, ubiquitous platform
Quick Medical Reference (QMR) : 1984-1994

Disease hypotheses (DX)

Observed Findings (MX)

DXs

MX
Quick Medical Reference (QMR) : 1984-1994

Contains 130 Hypotheses arranged by relative score (1-100)

<table>
<thead>
<tr>
<th>EV-FR</th>
<th>Score</th>
<th>Condition Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 4</td>
<td></td>
<td>Fever and</td>
<td>86</td>
</tr>
<tr>
<td>2 2</td>
<td></td>
<td>Splenomegaly Moderate and</td>
<td>85</td>
</tr>
<tr>
<td>0 4</td>
<td></td>
<td>Heart Murmur Present and</td>
<td></td>
</tr>
<tr>
<td>1 4</td>
<td></td>
<td>Hemoglobin Blood Less Than 12</td>
<td>83</td>
</tr>
</tbody>
</table>

**Endocarditis Subacute Infective Left Heart**

Leukemia Acute Lymphoblastic

Rheumatoid Arthritis
Causes Anemia Of Chronic Disease

Endocarditis Acute Infective Left Heart

Rheumatoid Arthritis
is the Systemic Component of Feltys Syndrome
Causes Anemia Of Chronic Disease
Quick Medical Reference (QMR) : 1984-1994

Contains 130 Hypotheses arranged by relative score (1-100)

- Fever and Splenomegaly Moderate and Heart Murmur Present and Hemoglobin Blood Less Than 12

- Autoimmune Hemolytic Anemia Involving Warm Reacting Antibody
  - Endocarditis Infective Right Heart 81
  - Pernicious Anemia 81
  - Myeloid Metaplasia (Primary Myelofibrosis) 80
  - Anemia Of Decreased Vitamin B12 Absorption 79
  - Crohns Disease Of Small Intestine Causes Iron Deficiency Anemia 79

Line 14 of 416
Rationale for Clinical Decision Support: Recent Observations by Clinical Researchers

Institute of Medicine, National Academy of Sciences November 1999 Report: To Err is Human

interpreted by lay press to imply:

"Doctors and nurses are incompetent & cause errors through lack of knowledge; their errors kill ~100,000 annually"
Recent Case Report:  
The Imperfectability of Man

Protocol-based computer reminders, the quality of care, and the non-perfectability of man

McDonald CJ, New England Journal of Medicine  
1976; 295(24):1351-5

“Using controlled crossover design, nine physicians given computer suggestions from 390 protocols related to conditions managed (e.g., elevated blood pressure) or caused (e.g., liver toxicity) by drugs. Physicians responded to 51 per cent of 327 events when given, and 22 per cent of 385 events when not given computer suggestions.”

“It appears that the prospective reminders do reduce errors, and that many of these errors are probably due to man's limitations as a data processor rather than to correctable human deficiencies.”

[HANDOUTS]
1 Patient-Specific Information
Core “Portable” Patient Summary:
Problems, Allergies, Meds
Local Electronic Patient Record
Orders: Active/Inactive

2 Local Knowledge
“Best of Care” Pathways
Institutional policies & costs
Drug interactions & formulary
Physician preferences

3 Global Knowledge
Medical literature
Diagnostic databases regarding diseases
National guidelines
Patient databanks with outcome data

4 Algorithms to enhance care
Reminders, Alerts
Quality checks
Self-Generated Monitors
Decision support programs

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WizOrder purpose and demographics

**WizOrder** was developed at Vanderbilt by DBMI faculty and Informatics Center staff to help ensure the highest quality of care for our patients, reducing medical errors.

It provides “point-of-care” relevant information resources to enhance and support clinicians’ decision-making at the time of order entry.

It has been refined by ongoing clinical feedback from House staff, nurses, attending MDs, committees, others at VUMC for the past 6 years.

**WizOrder** is now used on 640 of 650 beds at VUH by: Medicine, Surgery, Pediatrics, and OB/GYN services.

Over 12,000 orders/day, 70% by MDs, rest by clinical staff.
WizOrder Main Screen Layout: Simple, fixed format: functionally oriented, designed with users

1) Active orders
2) Common useful orders based on patient location
3) What to do next in WizOrder
4) Buttons for commonly used features

Physician enters order for antibiotic, Gentamicin, by partially typing its name

gen 80 iv q12h
**Gentamicin Inj: Garamycin**

Estimated CrCl=21 ml/min based on Creat=1.8 on Apr 25 06:00

---

**Generic name**: gentamicin. **Trade name**: GENTAMICIN SULFATE

**Recommended doses are**:
- less than 7 days: 0 to 5 mg/kg/24h
- between 7 days and 12 years: 6 to 7.5 mg/kg/24h
- more than 12 years: 1 to 2 mg/kg/dose

*All iv gentamicin doses should be infused over 30 minutes regardless of dose.*

**Indications**: treatment of serious aerobic bacterial infections due to susceptible organism, including pseudomonas, klebsiella, proteus, e. Coli & staph.

**Dose**: i.m or iv over 30 min: dose based on body wt & renal function (calculated CrCl). Adult dose: based on recent meta-analysis [Ann Intern Med 1996;124:717-725] in pts w/CrCl >60ml/min, dose is 1.3-1.6mg/kg q8hrs; or 2-3mg/kg q12hrs; or 4-6mg/kg q24hrs (hartford hospital suggests up to 7mg/kg/day w/normal crcl)

Max dose used in pts >70yrs was 4mg/kg/day; w/elderly maintain trough <1.4mg/l

**Children**: 6-7.5mg/kg/day or 240mg/m2 in 3-4 divided doses; infants & neonates 7.5 mg/kg/day in 8hr intervals; premature neonates, 2.5mg/kg/dose q12hrs.

Reduce dosage or prolong interval w/renal impairment. Side eff: nephrotoxicity (reversible tubular damage) & ototoxicity (high pitched hearing loss/vertigo).

Notes: individualized dosing may be needed based empirically on renal function measured peak/trough. Usual peak/trough w/qd dosing 10-14mcg/ml & <2mcg/ml.

- **gentamicin**
- succinylcholine  Aminoglycosides may potentiate neuromuscular blockade
- metocurine  Aminoglycosides may potentiate neuromuscular blockade
- atracurium besylate  Aminoglycosides may potentiate neuromuscular blockade
- ethacrynic acid  Ethacrynic acid may enhance ototoxicity of aminoglycosides

- *gentamicin sulfate*
- *viavelix* 250ml iv fluids  All gentamicin doses go in 100ml bags

- **aminoglycoside class**
- *temafloxacin protocol* m91-626  Additional antimicrobials prohibited-temafloxacin protocol

- **aminoglycosides-parenteral**
WizOrder uses pharmacokinetic model to estimate drug distribution in this patient, based on parameters such as weight and renal function, and displays warning and suggested proper dose if MD’s dose out of range (too high or too low).
WizOrder: Pharmacy warning about potential drug interaction

1) MD prescribed “cyclosporine” with currently active “gentamicin” order; WizOrder displays drug interaction warnings

2) Clicking on drug interaction warning displays monograph from VUMC pharmacists about nature and severity of interaction

3) WizOrder NEVER stops MDs from doing what they want to (they know patients better than computer does), so option to override warning always offered; log is kept of MD being warned
The VUMC Antibiotic Subcommittee recommends Cefepime (Maxipime®) over Ceftazidime (Fortaz®) for most indications where an anti-pseudomonal cephalosporin is needed.*

Cefepime 1000 mg q12h = Ceftazidime 1000 mg q8h

* Exception for neonates and selected pediatric patients. Safety and effectiveness of Cefepime in pediatric patients below the ages of 2 months have not been established.

Compared to ceftazidime, Cefepime has the following advantages:
- Similar coverage against Pseudomonas, improved coverage against Enterobacter species
- Enhanced stability against inducible/repressed chromosomal beta-lactamases
- Better activity against Gram-positive pathogens, including Staphylococci, S. viridans, pneumococci
- Q12 hour dosing except for empiric therapy for febrile neutropenia

### Adults (Age > 16 years)

<table>
<thead>
<tr>
<th>Dose</th>
<th>Example of Infection being treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 mg IV q12h</td>
<td>Uncomplicated urinary tract infection</td>
</tr>
<tr>
<td>1000 mg IV q12h</td>
<td>Nosocomial pneumonia in ICU patient</td>
</tr>
<tr>
<td>1000 mg IV q8h</td>
<td>Empiric coverage of febrile neutropenic patient</td>
</tr>
<tr>
<td>2000 mg IV q8h</td>
<td>The FDA approved a dose of 2 gm IV q8h for febrile neutropenic patients and this is preferred over the 1gm IV q8h dose if cefepime is given as monotherapy for this indication. The 1 gm IV q8h dose has been used in the Bone Marrow Units and is appropriate for febrile neutropenic patients receiving other antibiotics with activity against Gram-negative aerobic pathogens such as aminoglycosides or quinolones. Documented infection with Pseudomonas aeruginosa should be treated with the higher (2 gm IV q8h) dose.</td>
</tr>
</tbody>
</table>

### Other

| Intraocular      | order I.M. Cefepime (with Lidocaine)                                                    |
| Non-standard Dose | order non-standard dose of Cefepime                                                    |

"Click" the CLOSE button to return to WizOrder without ordering cefepime
**Guidelines Regarding Enoxaparin (LMWH):** The resource utilization committee recommends the use of low molecular weight heparin (enoxaparin) over unfractionated heparin based on studies demonstrating equal or improved efficacy and safety for DVT prophylaxis, DVT-PE treatment, and acute coronary syndrome. Enoxaparin is more cost effective because of its predictable dose-response curve and lack of costs associated with need for monitoring.  **NOTE:** Unfractionated heparin may be preferred over LMWH in selected patients, including those with renal insufficiency (GFR < 30), those who are obese (>160kg), or those where reversibility in under 12 hours may be required.

1. **Review Clinical Data:** Last Serum Creatinine: None available () -- Estimated Creatinine Clearance: Unknown mL/min

Select appropriate indication, test, and/or heparin type from the list below.

<table>
<thead>
<tr>
<th>Pick an Indication</th>
<th>Pick a Test to order</th>
<th>Pick a Heparinoid (if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(pick ONE from below)</td>
<td>LE Venous Doppler</td>
<td>V/Q Scan</td>
</tr>
<tr>
<td>DVT prophylaxis</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>DVT or PE, suspected (initial workup)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE suspected (with negative bilateral LE Doppler)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>PE suspected and... LE Doppler negative AND V/Q Scan inconclusive</td>
<td>Consider chest CT (helpful only if positive), pulmonary arteriogram, or pulmonary consult</td>
<td></td>
</tr>
<tr>
<td>Massive PE suspected and patient in shock</td>
<td>Start with CT Chest</td>
<td>Consider thrombolytic or invasive radiological embolectomy</td>
</tr>
<tr>
<td>DVT or PE, confirmed</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Acute Coronary Syndrome</td>
<td></td>
<td>(Recommended)</td>
</tr>
<tr>
<td>Atrial Fibrillation or Prosthetic Valve</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Other Indications for Heparin use</td>
<td></td>
<td>(Recommended)</td>
</tr>
<tr>
<td>Diagnostic test only (Not for acute DVT-PE workup)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. **Verify / enter patient weight:** 0 kg 0 lb

**Clinical Warnings:** Current renal function is unknown. Patient weight is not entered.

**Major Contraindications to All Forms of Heparin Therapy**
- Intracranial hemorrhage
- Active internal bleeding
- Bleeding peptic ulcer
- Heparin-induced thrombocytopenia anytime in the past
- Concern for spontaneous bleeding
- Inpatient surgery/invasive procedure planned or likely
- Malignant hypertension

**More Information and Recommendations**
- Diagnostic tests to confirm or exclude the diagnosis of DVT
- Diagnostic tests to confirm or exclude the diagnosis of PE
- Medical therapy of acute DVT
- Medical therapy of acute PE
- Low molecular weight heparin
- Heparin induced thrombocytopenia

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Deep venous thrombosis in a general hospital.

Stein PD, Patel KC, Kalra NK, El Bagee TY, Savarapau P, Silbergloit A, Check FE.

St. Joseph Mercy Oakland Hospital, Pontiac, MI 48341, USA. steinp@trinity-health.org

PURPOSE: To determine the prevalence of proximal deep venous thrombosis (DVT) in a general hospital. BACKGROUND: In spite of the importance of proximal DVT, its prevalence in hospitalized patients has been only sparsely studied. METHODS: Patients hospitalized with DVT between July 1998 and June 2000 were identified by a computer search of discharge diagnoses. The discharge diagnosis was confirmed by a review of the records for positive findings on compression ultrasound or venogram of the lower extremities. In addition, records of all compression ultrasound examinations and venograms during that period were examined. RESULTS: The prevalence of proximal DVT in adults > or = 20 years old was 271 of 34,567 patients (0.78%). DVT was associated with pulmonary embolism in 57 of 271 patients (21.0%). The prevalence of DVT in adult men was 117 of 13,722 patients (0.85%), and in adult women was 154 of 20,845 patients (0.74%) [not significant]. The prevalence of DVT among men aged 20 to 49 years was higher than in women the same age: 19 of 3,982 patients (0.48%) vs 22 of 9,442 patients (0.23%), respectively (p < 0.02). The prevalence of DVT, however, was comparable among men and women > or = 50 years old. The prevalence of DVT was also comparable in black adults (30 of 4,344 patients; 0.69%) and in white adults (240 of 28,615 patients; 0.84%) [not significant]. CONCLUSION: Proximal DVT continues to be a frequent illness among hospitalized patients.

PMID: 12226039 [PubMed - indexed for MEDLINE]
Adult Deep Venous Thrombosis Prophylaxis Advisor

Your patient is not receiving a treatment known to deter deep venous thrombus formation (or you specifically requested this advisor).

Recent literature (click HERE for information) indicates the risk of DVT is significant in hospitalized patients due to multiple DVT risk factors (CLICK for risk factors). Almost all patients should receive some form of prophylaxis. Anticoagulant therapy is preferred over mechanical devices unless anticoagulants are contraindicated (See contraindications - below).

For the highest risk patients (CLICK for list) lacking contraindications to anticoagulation, low molecular weight heparin is the preferred agent. For all other patients, 5000 Units of unfractionated subcutaneous heparin every 8 to 12 hours is the preferred treatment.

Would you like to order any form of DVT prophylaxis at this time?
- Order unfractionated heparin 5000 U sq q 12 hours (preferred) ($2/day)
- Order unfractionated heparin 5000 U sq q 8 hours ($3/day)
- Order enoxaparin 40 mg sq q day (preferred) ($16/day)
- Order enoxaparin 30 mg sq q 12 hours ($24/day)

Patient is in a high risk group and requires low molecular weight heparin now:
- Order enoxaparin 40 mg sq q day (preferred) ($16/day)
- Order enoxaparin 30 mg sq q 12 hours ($24/day)

Patient has a contraindication to anticoagulation and should receive mechanical prophylaxis:
- Order lower extremity sequential compression devices now: cost varies with size ($35 - $65)
  - TED Hose - Knee High ($4)
  - TED Hose - Thigh High ($7)

Add elastic stockings?

OR: Please provide reason below:
- I am not a physician, but I will contact physician responsible for this patient regarding DVT prophylaxis (tell physician to use "dvt prophylaxis advisor")
- Patient admitted for labor or delivery so heparin not ordered
- I do not wish to order DVT prophylaxis at this time because:
  reason for not ordering:

Anticoagulation contraindications:
1. Active serious bleeding or bleeding in a critical location (e.g. intracranial)
2. Current or history of heparin-induced thrombocytopenia
3. Severe thrombocytopenia
4. Recent or scheduled procedure or operation with high bleeding risk
5. Presence of, or plans to insert epidural catheter

Current Date and Time: 11/27/2002 01:40 PM

<table>
<thead>
<tr>
<th>Labs</th>
<th>Value</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTT</td>
<td>42.3</td>
<td>11/27/2002 00:15 AM</td>
</tr>
<tr>
<td>INR</td>
<td>1.6</td>
<td>11/27/2002 00:15 AM</td>
</tr>
<tr>
<td>Platelet Count</td>
<td>149</td>
<td>11/27/2002 00:15 AM</td>
</tr>
</tbody>
</table>

NOTE: It is NOT appropriate to order PTT tests to monitor PROPHYLAXIS of DVT.
WizOrder Development History

Key concepts:

System implementation represents a profound workflow change for users.

Users’ concerns must be continuously respected, listened to, and addressed.
The PC-POETS Study: Integrating Patient Care-Provider Order Entry with Tactical Support

Research Supported by NIH / NLM:

1 R01 LM06226
PC-POETS Goal: Use of Decision Support

The project tested a fundamental and long-held tenet in medical informatics, that:

**medical decision support systems can gain widespread acceptance when a critical mass of functionality is delivered through a common interface on a readily available platform**

“Good counselors lack no clients”

(Shakespeare, Measure for Measure, 1605; Act I, Scene ii)
PC-POETS interventions in WizOrder

(“Standard” safety already in place)

1. Cost/Charge for current order session for RADIOLOGY, LAB, PHARMACY
2. Lab trend Alerts (abnormal or about to be so)
3. Pharmacy monographs: WizRx, Mosby GenRx
4. Diagnostic Electronic Textbook Medicine (QMR KB)
5. Literature searches based on patient diagnoses
6. Antibiotic adviser (developed with Dr. D. Kernodle)
PC-POETS Control Screen: Use B&W to seek interventions

Select an item from the list

or enter another order.


New features and problems in WizOrder and MARS are discussed. PIZZA and stokes are provided.
**Admit as inpatient**

**Patient care unit:** Orthopaedic unit

**Diagnosis**
- Fracture of shaft of femur, closed (821.01)
- Pericarditis acute nonsuppurative

**Condition**
- Critical but stable
- Good

**Vital signs**
- Neurovascular checks q4h

**Activity/limitations**

**Allergies**
- Allergy: Keflex

**Nursing instructions**
- Nursing: Femostop pressure 60 mmHg for 30 min. then decrease pressure to 40 mmHg.
- Nursing: Femostop protocol: Strict bedrest for six hours then ooB with assistance.
- Nursing: Femostop protocol: For bleeding, apply direct pressure and notify MD.
- Nursing: Femostop protocol: Notify MD for diminished pulses as directed.
- Nursing: Femostop protocol: Vital signs q15 min x4, q30 min x2 then q1h until admit.

**Diet**

---

**PC-POETS Interventions**

**Ciprofloxacin (Cipro)**

- **Dose:** 500 mg
- **Route:** PO
- **How often:** Q12h
- **When to start (first dose):** NOW

**For how long:**
- **N** D(ays)
- **H**(ours)
- **DO**(ses)

Or **ENTER = UNTIL D/C**
# Lab trend Alerts

## Alarming Values/Trends

<table>
<thead>
<tr>
<th>PCV:</th>
<th>9 days ago</th>
<th>6 days ago</th>
<th>3 days ago</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50</td>
<td>42</td>
<td>25</td>
<td>31</td>
<td>30</td>
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</tbody>
</table>

## Watch These Borderline Values/Trends

<table>
<thead>
<tr>
<th>Na:</th>
<th>9 days ago</th>
<th>6 days ago</th>
<th>3 days ago</th>
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<tbody>
<tr>
<td>145</td>
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<td>136</td>
<td>134</td>
<td>136</td>
</tr>
</tbody>
</table>

## Normal Values/Trends

<table>
<thead>
<tr>
<th>BUN:</th>
<th>9 days ago</th>
<th>6 days ago</th>
<th>3 days ago</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>-25</td>
<td>-5</td>
<td>29</td>
<td>35</td>
<td>35</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>CO2:</th>
<th>9 days ago</th>
<th>6 days ago</th>
<th>3 days ago</th>
<th>Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30</td>
<td>-23</td>
<td>-24</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>
Pharmacy monographs

Cyclosporine (000932)

Categories: Pregnancy Category C, FDA Approved 1993 Nov, Orphan Drugs, WHO Formulary

FDA Drug Class: Immunosupressants

Brand Names: Cyclosporin, Consylpin, Neoral, Imurol, Sandimmune, Sandimmune Neoral, Sandimmune (Foreign brand names outside U.S. in Italics)

Cost of Therapy: $4,663.39 (Transplantation; Solution, 100 mg/ml; 2/day, 365 days)

HCFA JCODE(5): JT503 50 mg IV

Warning:

Only physicians experienced in immunosuppressive therapy and management of organ transplant patients should prescribe cyclosporine. Patients receiving the drug should be managed in facilities equipped and staffed with adequate laboratory and supportive medical resources. The physician responsible for maintenance therapy should have complete information required for the follow-up of the patient.

Cyclosporine should be administered with oral corticosteroids but not with other immunosuppressive agents. Increased susceptibility to infection and the possible development of lymphoma may result from immunosuppression.

The absorption of cyclosporine during chronic administration of cyclosporine soft gelatin capsules and oral solution was found to be erratic. It is recommended that patients taking the soft gelatin capsules or oral solution over a period of time be monitored at repeated intervals for cyclosporine blood levels and subsequent dose adjustments be made in order to avoid toxicity due to high levels and possible organ rejection due to low absorption of cyclosporine. This is of special importance in liver transplants. Numerous assays are being developed to measure blood levels of cyclosporine. Comparison of levels in published literature to patient levels using current assays must be done with detailed knowledge of the assay methods employed. See DOSEAGE AND ADMINISTRATION, Blood Level Monitoring.

NEOIRAL

Neoral may be administered with other immunosuppressive agents. Increased susceptibility to infection and the possible development of lymphoma and other neoplasms may result from the degree of immunosuppression.

Neoral Soft Gelatin Capsules (cyclosporine capsules for microemulsion) and Neoral Oral Solution (cyclosporine oral solution for microemulsion) have increased bioavailability in comparison to Sandimmune Soft Gelatin Capsules (cyclosporine capsules) and Sandimmune Oral Solution (cyclosporine oral solution). Neoral and Sandimmune are not bioequivalent and cannot be used interchangeably without physician supervision. It is recommended that cyclosporine blood concentrations be evaluated to ensure the therapeutic range is maintained.
Links to the diagnostic information (Quick Medical Reference)

Description of disorders ("disease profiles") based on previously entered "diagnosis" order(s)

- aortic valvular stenosis
- cardiac failure left chronic congestive
- arteriosclerotic nephropathy benign (essential hypertension)

Additional information on a disease or finding

Differential diagnosis tool
aortic valvular stenosis

Past medical history
- 4 sex
- 3 age > 55
- 2 angina pectoris hx
- 2 rheumatic fever hx
- 2 syncope or syncope recent hx
- 2 heart disease family hx
- 2 heart failure congestive hx
- 2 age 26 to 65
- 2 heart murmur hx
- 2 sex female
- 1 chorea hx
- 1 seizure(s) grand mal hx
- 1 age 16 to 25

Symptoms of current illness
- 3 dyspnea exertional
- 2 chest pain substernal at rest
- 2 chest pain substernal crushing
- 2 palpitation(s)
- 1 chest pain substernal lasting 20 minute(s) or grtr

Findings on physical examination
- 4 heart murmur systolic ejection second right interspace
- 4 heart impulse apical forceful localized
- 4 heart sound(s) 4 short left atrial gallop
- 2 heart murmur present
- 1 heart gallop rhythm present
- 1 heart murmur systolic ejection second right interspace transmitted to neck
- 3 heart sound(s) a2 decreased
- 3 pulse arterial plateau
- 2 heart impulse apical lateral displacement
- 2 heart percussion left border lateral displacement
- 2 heart thrill systolic second right interspace
- 2 pulse arterial anerobic
- 2 heart murmur decreased during valsava

causes
- 2 cardiac failure left chronic congestive
- 2 left ventricular failure acute
- 1 anemia

predisposes to
- 3 angina pectoris
- 2 endocarditis subacute infective left heart
- 2 endocarditis acute infective left heart

coincides with
- 2 aortic regurgitation chronic
- 2 mitral stenosis
- 2 angiodysplasia of right colon
- 2 patent ductus arteriosus
- 1 mitral regurgitation rheumatic
- 1 purpura vasculare stenosis

is caused by
- 1 carcinoid syndrome
- 1 ceramide trihexoside lipidosis (Fabry's disease)

is preceded by
- 2 rheumatic carditis acute

Moderately similar diseases
- 65 hypertensive heart disease
- 64 hypertrophic subaortic stenosis
- 59 arteriosclerotic heart disease
- 58 cardiomypathy primary
- 57 aortic regurgitation chronic
- 54 mitral regurgitation due to papillary muscle dysfunction
- 54 mitral valve prolapse
- 52 cardiomypathy secondary
- 51 thyrotoxic heart disease
Literature search based on patient diagnoses

WizOrder Popup

[citation links to publications]

Display Abstract report

Order: for the articles selected (default all).

documents on this page through Leansome Doc

- Sagner HY, et al. [See Related Articles]

- de Tesauro Barry JM, et al. [See Related Articles]

- Jadhoye LM, et al. [See Related Articles]

- Silberman SI, et al. [See Related Articles]

- Smith JD, et al. [See Related Articles]

- Jones TK, et al. [See Related Articles]

- Kiat A, et al. [See Related Articles]
## PC-POETS: Evaluation - Results

<table>
<thead>
<tr>
<th>Opportunity Type</th>
<th>Rate Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABA antibiotic advisor</td>
<td>1.45</td>
<td>0.98 - 21.34 (small N)</td>
</tr>
<tr>
<td>MSB Mosby Drug Ref</td>
<td>12.97</td>
<td>4.31 - 39.03 **</td>
</tr>
<tr>
<td>WRX AHFS drug info</td>
<td>10.64</td>
<td>3.12 - 36.30 **</td>
</tr>
<tr>
<td>MSH Pub Med Search</td>
<td>6.04</td>
<td>2.32 - 15.73 **</td>
</tr>
<tr>
<td>QMR Diagnostic KB</td>
<td>11.64</td>
<td>2.76 - 49.14 **</td>
</tr>
<tr>
<td>TRD Lab Trend Alerts</td>
<td>11.12</td>
<td>3.62 - 34.18 **</td>
</tr>
<tr>
<td>LMR Cost/Charge Details</td>
<td>1.36</td>
<td>0.56 - 3.30</td>
</tr>
<tr>
<td>OVERALL</td>
<td>4.41</td>
<td>2.35 - 8.26</td>
</tr>
</tbody>
</table>

PGY1 rate ratio 6.02 (2.30-15.78)  
PGY2/3 2.53 (.91-7.05)

Overall, there were 364 responses (1 per 2000 opportunities)
PC-POETS: Evaluation – Results
Effect of LMR availability on session costs

78,480 LMR opportunities overall

Mean LMR costs per control session $411.75
Mean intervention LMR cost $410.22 (p=0.003)
Approx potential savings $120k per year on Medicine; if effect similar on other wards, up to $500K/yr overall
Problem: Excess test ordering

RUC = Resource Utilization Committee, Eric Neilson, MD, Chair

In December, 1999 RUC and DBMI used WizOrder to examine more closely patterns of test ordering.
Chem7 (BUN, Creat, Lytes, Gluc = Basic Metabolic Panel) was identified as most commonly ordered test; and, in some ICU settings, daily CXRs were being done for weeks.
Problem: Excess test ordering

1. First intervention: Pop-up for tests recurring > 3 days
2. Based on RUC discussion and deliberation:

a. On Jan. 20th, 2000, WizOrder limited all radiology orders to “one time only”

b. On Feb. 1, 2000, WizOrder limited all EKG orders to 1x or 2x (q8h)

c. On Mar. 20, 2000, WizOrder limited LBCG to “only within 24 hrs”

d. Subsequently, ordering of Comprehensive Metabolic Profile restricted
# RUC Portable CXR Intervention

\[ \$145/xray \times 20/day \times 365\text{ days} = \$1,058,500/\text{yr} \]

<table>
<thead>
<tr>
<th>Test</th>
<th>Orders Entered</th>
<th>Orders Discontinued</th>
<th>Net Orders</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value</td>
<td>P Value</td>
<td>Value</td>
</tr>
<tr>
<td><strong>Portable Chest X Ray</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A*. Mean daily orders during baseline interval</td>
<td>128</td>
<td></td>
<td>40.6</td>
</tr>
<tr>
<td>B*. Trend in the baseline daily order rate</td>
<td>-0.0844</td>
<td>(&lt; 0.0005)</td>
<td>-0.0409</td>
</tr>
<tr>
<td>C*. Expected tests at end of baseline interval</td>
<td>114</td>
<td></td>
<td>34.2</td>
</tr>
<tr>
<td>D*. Trend in daily order rate between interventions</td>
<td>-0.392</td>
<td>0.18</td>
<td>-0.140</td>
</tr>
<tr>
<td>E*. Expected tests just prior to second intervention</td>
<td>94.1</td>
<td></td>
<td>27.3</td>
</tr>
<tr>
<td>F*. Overnight drop in orders after second intervention</td>
<td>-18.6</td>
<td>0.03</td>
<td>-15.9</td>
</tr>
<tr>
<td>G*. Trend in the post-intervention daily order rate</td>
<td>0.00996</td>
<td>0.32</td>
<td>-0.00718</td>
</tr>
<tr>
<td>H*. Mean daily orders after second intervention</td>
<td>75.8</td>
<td>8.746</td>
<td></td>
</tr>
</tbody>
</table>

---

Copyright © 2004, Vanderbilt University Medical Center
Metabolic Panel

New orders/day

Stopped orders/day

First Intervention
December 5, 1999

Second Intervention
March 21, 2000

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If it takes a village to raise a child,
What does it take to build and implement order entry for a Neonatal ICU?

Randolph A. Miller, MD
William W. Stead, MD
WizOrder Development team,
VUMC System Support Services,
VUMC Informatics Center, Clinical Staff of VUMC
In a remote location and at a time long ago …

After planning and postponing NICU implementation for several years (mostly due to concerns about safe medication dosing) …

In mid-July, 2002, both the WizOrder team and the System Support Services Group began having discussions about a Fall 2002 NICU go-live target …

Followed by an initial visit of both teams to the NICU to see: what work is done where; where equipment is needed and will fit; what sorts of equipment, etc …

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# Teamwork

## WizOrder development group
- **8 people**: 4 MDs, 4 code developers, 3 content/data

## Informatics Center WizOrder Support
- **10 people**: 1 MD/CIO, 8 technical, 3-4 administrative

## System Support Services NICU Group
- **9 people**: 7 RNs; 2 clerical; most long-term VUMC employees

## Pharmacy NICU Group
- **5+ Pharmacists**

## NICU MDs and Staff
- **2 MD Directors; 2 nurse directors; dozens of other MDs, RNs, ancillaries from Unit**
Setting: VUMC NICU

57 Beds total, 7 rooms

Vanderbilt University Hospital

Newborn Nursery

Medical Center East

Main Nursing Station

Copyright © 2004, Vanderbilt University Medical Center
Subject: NICU Order Entry implementation

Date: Tue, 24 Sep 2002 16:49:03

From: Holder, Gwen (System Support Services RN)  
To: Strauss, Arnold (MD Chair, Pediatrics Department); Lead Pediatrics Services RN;  
    NICU MD Leadership; NICU Nursing Leaders/Staff; System Support Services NICU Team;  
    Randolph A. Miller (For Wiz Team); Pharmacy Director

The original plan was to implement WIZ order entry in one room of the NICU area in mid November and the remainder of the unit in mid to late January.

The phased approach was proposed for two reasons. First, to accommodate the physicians request to initially implement in a small controlled area allowing time to "work out any kinks" before rolling out to the entire unit. Secondly, from a support standpoint, Systems Support Services does not have the number of staff needed to adequately support a 60 bed unit implementing at one time.

Staged implementation planned across NICU rooms
As we move through the pre-implementation process, several key people have voiced concern about the feasibility of this plan. Consensus is needed from the key players involved in this project for implementation to be successful.

Resolution to these issues is needed as soon as possible. Are you available to meet on 10/7 anytime except 2-3:30? If this doesn't work, is there any day/time the week of 10/7 that would work for you.

Desired outcomes of this meeting include:
- Agreement on implementation approach (phased roll out, timing)
- Agreement on programming required in WIZ prior to implementation
- Agreement on timeframes for implementation of NICU Order Entry and Peds ED (considering move to new Children's Hospital)

Please feel free to contact me if you have any questions.
Gwen Holder
System Support Specialist II

“Kickoff” meeting involving ALL parties key to launch project
Unit-focused
Critical Issues
Tracking Form

Not typical committee-based approach

Used by System
Support Services
during planning
meetings for CPOE
implementation

Column Headers:
Feature/NICU contact
Description/Comments
Resource (s) required
Current Status
Priority (for go-live)
Subject: RE: NICU Order Entry meeting rescheduled for 10/21

From: Karen Hughart       Date: Thu, 10 Oct 2002 07:34:08
To: NICU group: Wiz, Pharmacy, System Support, NICU MDs, NICU Staff

Gwen and I are concerned that yesterday's meeting did not happen. We spent literally hours finding a time when most key players were to be available, only to have it cancelled because of a mandatory meeting that rendered some of these key players unavailable.

When critical events do not occur: evaluate why, evaluate impact, quickly reformulate, and keep on trucking ....
Some of the barriers to success with the original plan and timeline:

- Nursing Leadership learned that the Nursing Interns hired in the summer would not be available for staffing until right before Christmas.

NICU has very serious staffing shortages that cause them to have a lot of mandatory overtime. This limits ability of staff to take time off to attend training.

Nursing shortage impacts order entry implementation.
For all of these reasons, we identified the need to revisit the plan and get a more formal endorsement from all stakeholders on the best way to stagger the implementation (given that we don't have the resources to go live in a single day with all 60 patients in 7 rooms in 2 buildings)

As I said, it took a lot of time to schedule the meeting and now it's been cancelled. The earliest we were able to reschedule is Oct. 21. My honest assessment is that we cannot meet a Nov. 19 go-live date at this point even if we had consensus that it is a good date. I think the best we can do is to do a lot of staff training before Christmas and then implement in January with much less of a stagger between rooms than originally planned.

Focus on stakeholder concerns: be flexible, adjust go-live, but only for good cause (s) agreed upon by all parties at table
To meet January go-live, very aggressive development needed in next month:

1. NICU has stated since the beginning that they will not go live without some type of TPN solution. They are not asking for something elegant with a lot of decision support but are instead just looking for a way to enter the order electronically instead of writing on paper.

2. Pharmacy has considerable work to do modifying Wiz Pharmacy orders and Web-based VGR ordering pages to accommodate pts. < 2000 Gms.

3. A few other order sets are needed.

4. Minor modifications to the Once/Stat VGR are needed.

5. Once we do ADT System Room and Bed Master changes (I hope to get agreement on the plan today), we need to get the Notification Engine and printer mapping work done.

6. We need to test everything and incorporate changes into training.
I think I need to spend some time watching how the NICU works, enters orders, and their volume. I called & they said no problem to come up and round with them. I was wondering, if it would make sense for you to join as well to get an idea of 1. dosing, weight/age issues 2. the volume of orders 3. the pink sheet issues 4. how much lends itself to DPOT/VGR versus underlying code changes and how much work will be required to do either method (get and idea of the risk of trying to reach implementation in Jan).

Monday might be nice because we could then invite people to discuss further at pizza.
Pharmacy Concerns about 01/03 NICU go-live

Date: Mon, 18 Nov 2002 15:12:43
From: "Holder, Gwen" System Support Services
To: "Miller, Randolph A“, Wiz Team, System Support Services

I just wanted to let ya'll know I talked with the Lead NICU Pharmacist re: changes needed for NICU & she expressed serious concerns about getting all the work done on the drips, TPN, and VGRs that is required to meet the Jan 21 implementation date. She has discussed this with other key pharmacists as well. One key person has been working from home but will be out 3 weeks in Dec. Another is working on the TPN. The Lead NICU Pharmacist reports that she has only 90min/day to devote to NICU work & there are no more resources to assist.

At the meeting tomorrow, I suggest we discuss projections for getting work done & set a more realistic live date. Other thoughts????

Pharmacy safety concerns are allowed to delay implementation
 Representatives from Pharmacy, WIZ Team and Systems Support Services met yesterday to discuss the feasibility of meeting our January 21st implementation date. We are 9 weeks from our January implementation date. Our budget for purchase of the necessary hardware is still in the approval process. The hardware has not been ordered. The pharmacy is requesting additional time to complete the programming necessary for the specific NICU needs. There are no additional pharmacy resources to allocate to this project. Realistically, we cannot meet the January implementation date.

The group discussed alternative dates. March 4th has been identified as the new implementation date. Training for nursing staff would begin in mid January and continue throughout February.

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Pharmacy DB defines regions by gestational & birth ages + weight
Region “instance” for use of any “generic routed drug” in a region
For each drug-specific “region instance”, pharmacy can define default dose (s), minimum & maximum doses per single administration, per day, per “course”, and per lifetime.

<table>
<thead>
<tr>
<th>regioninstance</th>
<th>value</th>
<th>unit</th>
<th>lastmodified</th>
<th>m</th>
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<tbody>
<tr>
<td>0</td>
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<td>MG/KG</td>
<td>1/29/1990</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>MG</td>
<td>1/30/1990</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.1</td>
<td>MG/KG</td>
<td>1/31/1990</td>
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<td>MG/KG</td>
<td>2/1/1990</td>
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<td>4</td>
<td>0.1</td>
<td>MG/KG</td>
<td>2/4/1990</td>
<td></td>
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<tr>
<td>5</td>
<td>10</td>
<td>MG</td>
<td>2/5/1990</td>
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<td>6</td>
<td>0.1</td>
<td>MG/KG</td>
<td>2/8/1990</td>
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<td>7</td>
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<td>MG/KG</td>
<td>2/9/1990</td>
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<td>MG/KG</td>
<td>2/13/1990</td>
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</tr>
<tr>
<td>9</td>
<td>1</td>
<td>MG</td>
<td>2/14/1990</td>
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<tr>
<td>10</td>
<td>5</td>
<td>MG/KG</td>
<td>2/15/1990</td>
<td></td>
</tr>
</tbody>
</table>
Adding Educational Web Resource Links to Wiz

Subject: accessing the NICU Protocol manual from the selected web resources page
Date: Fri, 6 Dec 2002 10:35:53

From: "Holder, Gwen" System Support Services
To: "Stone, John" WizOrder Team, System Support Services,
NICU MD Leadership, NICU Staff

We would like to have a link to the NICU protocol manual placed on the selected Web Resources page. Here is its current site: http://www.xyzzy/nicuman3.htm

We begin training nursing staff 1/3 & so I need this put out there soon so we can incorporate into training how to toggle between an order entry session & the protocol manual. Is this timeframe doable?

Institutional Web-based resources such as manuals should be linked into CPOE system as “just-in-time” resources. All changes impact training and must be coordinated.
Subject: Meeting with NICU re: Order Entry
Date: Wed, 11 Dec 2002 13:01:36
From: "Holder, Gwen" System Support Services
To: "Miller, Randolph A"

Randy,
12/17 3-430 the Wiz team & NICU folks are meeting to discuss issues. **One of the issues that is slated for this meeting is management of Ventilator Orders.** I think your input on this topic is essential- will you be able to attend for all or part of this time? Let me know.
Thanks

As each new unit/ward is implemented on CPOE, its unique features MUST be considered – especially orders and order sets (order outlines). Stagger implementation!!
Subject: Turning WIZ on for NICU  
Date: Tue, 17 Dec 2002 12:39:30  
From: "Holder, Gwen" System Support Services  
To: WizOrder Team, System Support Services  

In the Downtime Review Committee meeting today, Network Team wanted to know when NICU would be turned on for WIZ. I think we need to have WIZ enabled by 0700 on 2/17 since we will need to check printing to verify the documents print where they should, & then we will start entering orders for RM 3 to go live in the afternoon.  
What are your thoughts- Is 0700 2/17 OK with the WIZ tech team? Are there other things to consider?  

“Little” details like where items print from each workstation, and where each type of document should print for optimal workflow can become showstoppers during “go-live” if not anticipated and addressed beforehand.
Subject: RE: NICU IV Fluid ordering page  Date: Tue, 28 Jan 2003

From: NICU MD Leader

To: Chief Pharmacy Wiz Implementer, System Support Services, Pharmacy WizOrder

I polled the surgeons and Neonatologists about Replacement fluids and the leading answers to be pre-existing choices were:

- 1/2 NS + 10 meq/L KCl
- 1/2 NS + 20 meq/L KCl
- D5W 1/2 NS + 10 meq/L KCl
- D5W 1/2 NS + 20 meq/L KCl
- LR
- 5% albumin

-----Original Message-----

From: Chief Pharmacy Wiz Implementer

I've done more work on the NICU iv fluid page. You can view it by typing @VGR=nivf

I have incorporated the changes that were suggested Tuesday by NICU MD.

I have also included a warning if you attempt to change the weight by > 10% on the IV fluid page. This alert does not show on the replacement fluid page since weight is not a factor in any of the calculations on this screen.

GOOD SIGN when MD leadership of Unit integrally involved

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Just wanted to give you some input from the MD training class we had yesterday:

1. IVF Page

Need to be able to order > 1 U AC fluid There was concern that the section labeled rate would be confusing to users ie they'd think they were to enter the hourly rate instead of the 24h volume in this section. NICU MD Leaders suggested that this section be re-titled" Fluid Volume ____ ml/kg/day " and the ml/h calculation be placed on the line underneath & have it labeled Rate ___ml/h ( calculated)

TPN Page - one person ordered 0 pepcid but got a message that the dose for pepcid was too high & an enormous amt was ordered on TEST patient.

One clicked on peripheral & didn't get asked for cc/kg/day-

Wiz Team I assume you just haven't gotten this done yet but wanted to FYI.

Carefully observe MD training – can prevent disasters later and be a source of good new ideas
I have had discussions with other NICU pharmacists this morning regarding the testing we have been doing on Shitake. Based upon what we have tested so far, we have significant concerns about going live on 2/18. Those concerns are focused around issues related to patient safety. This will need to be part of the discussion we have this afternoon.

-----Original Message-----
From: Holder, Gwen System Support Services
Sent: Monday, February 10, 2003 4:41 PM
To: All involved in NICU implementation
Subject: Tomorrow FINAL NICU Order Entry Meeting (before going LIVE)
Please let me know if you are unable to attend
Next NICU Order Entry Meeting 2/25 & Notes from 2/18

Date: Mon, 24 Feb 2003 17:19:50
From: "Holder, Gwen" System Support Services
To: Wiz Team, Pharmacy Team, System Support Services, NICU MDs, NICU Staff, NICU respiratory therapy

New implementation date set for 3/4. 3/1 & 3/3 residents& interns change so better to wait until after that. Meet 2/25 to review of progress on outstanding issues

Highlights of 2/18 meeting- feel free to forward corrections to all.
Pharmacy testing is going well but need to fix bugs & retest.
Order set testing - 3/4 of orders have been tested; additional order sets being pushed to developer on Wed. Most likely, all order sets will need to be touched.
TPN- a lengthy discussion re: how TPN should behave. Main points are:
to enable the load previous- Ty must add in the wt piece need a TPN rate order that will display under IVF section. Need a lipid rate order just like the TPN rate- ie display under IVF, suppress on COS/CM&R etc
Wiz Team to create a way to d/c the BB "irradiated" flag when pt discharged from NICU
Blood Cultures- peds ID approved the X1 component. Randy shared a mock up of the NICU BC page- NICU and Wiz MDs to work on finalizing.

Test & re-test up to last minute
Minimum TPN volume calculation change:
If Magnesium 5 mEq/L is ordered AND neotrace/selenium, calculate based on 1.3 mEq/mL.
If no Mg ordered, selenium and neotrace can be calculated based on 2ml/L

Load previous orders currently is not working
Can this work when modifying an order as well?

Modifying order does not delete old order on orderable side

Selenium/NTE not appearing as ordered

Special instructions not appearing as ordered

Cycle rate instructions are not appearing on orderable side correctly. Does this need to be a separate orderable? (Probably prefer not)

Will we be able to hide other “TPN” menu options such as “TPN orders (initiate, renew, change)”. Currently options are available under this listing such as “discontinue TPN” which creates a miscellaneous order.

Carefully track all issues, knowing who is responsible for addressing each by what date/time. Communicate to all teams.
Notice of Final Pre-Go-Live Meeting, March 4

Subject: NICU Order Entry Meeting
Date: Thu, 27 Feb 2003 12:11:11

From: "Holder, Gwen" System Support Services
To: All involved in NICU implementation

NICU Order Entry Meeting
Tuesday 3/4 Large conference room

Review of progress on outstanding issues
Final Decision about Go-Live on March 11

All involved stakeholders should have say into whether they (and their units/functions) are ready to go-live.
From: "Holder, Gwen" System Support Services

1. All is going very well since room #3 went live on Tues am March 11. Ordered 1 TPN this am w/o problems. The census has been down and room 3 quiet so it has been very nice. Gwen made changes to some order sets & there are a few WizOrder data dictionary changes that WizTeam will be making. Russ (WizTeam) did a new code/data push so these should be in place:
   No more warning re: D5w unable to check dose when ordered as a flush with Ampho B Heparinized Saline Broviac order;

2. ECMO orders. NICU MDs have approved the use of the PCCU ECMO orders. They added a few orders so we'll clone the PCCU ones & add in the ones for NICU

3. Getting closer to having labels printing. WizTeam has finished its part. Just waiting for all the network stuff to be finished.

4. WizTeam reviewed items on "TO DO LIST FOR NICU"
   10-20 % dosing wt change alert. Two solutions discussed.

“Go-live” is not end – beginning of learning what should have been done, mission-critical adjustments must be made rapidly. MUST have unit-based debriefing meetings to identify key issues, assign people to address them in timely manner.
March 17 Debriefing Meeting Notes (from System Support Services)

PROGRESS UPDATES:
1. All continues to go well, Room #2 will go live tomorrow morning. NICU MD and TPN Pharmacist will be on hand in the morning to help get the TPN orders entered for room #2. Three SSS folk will load orders this afternoon.

2. Decided to implement room 1 by itself next week on Monday and ECMO and the small intermediate room together on Thursday.

WORKFLOW / WORK PROCESSES:
1. Who is supposed to print the COS and CMR? Unit leadership decided that the MR should print the COS and CMRs for the next shift somewhere around 5 am and 5 pm. NICU leaders to inform staff.

2. Issue around getting timely registration of new admits in the computer. E-mail sent to registration supervisor to reinforce process. Also preadmission form can be used to obtain medications from pharmacy.

Unit-based debriefing meetings similar to MD following sick patient: see often enough to avoid trouble, adjust course PRN.
Another update. I just released new code and data this morning which will address:

1. Pharm issue: drug dose checks Wiz uses from Pharmacy will now incorporate the drug dose check variances provided by Pharmacy. For example, the dose check on vitamin A was 4000/kg before and it was a hard limit. A dose for a 2.89 kg baby was getting rounded by Shitake to 12000 (which was according to the rounding table from Pharm) but that caused the dose per kg to exceed 4000 so you would get a warning. Now, Wiz checks and sees that the allowed dose check variance for Vitamin A is 20%, a dose fo 12000 will no longer generate the warning.

2. The switching logic in unitinfo.dmf (see below) should now be in production (a couple servers still need to recycle).

3. The revised lab messages should now be in production (a couple servers still need to recycle). In addition to the new specimen messages regarding neonates, we also revised several VGGG codes, lab subdepartments, and updated other messages. Basically we did a major overhaul of all lab orderables.
VANCOMYCIN INJECTION:
Weight=4.000 kgs on Tue Jul 1 09:18
Peds dosing weight=4.300 kgs on Tue Jul 1 09:17
No Creat or BUN result available.
Non-CSF infections: 15 mg/kg/dose IV Q8H
Meningitis: 20 mg/kg/dose IV Q8H
Renal impairment:
Give one 15mg/kg dose and redose based on level.
Dopamine Infusion

Patient Demographics

Weight in Wiz. kg

Drug Information
Suggested Maximum conc = 3200 mcg/ml
Absolute Maximum conc = 20000 mcg/ml
Standard: 1 ml/hr = 1 mcg/kg/min
Intermediate: 1 ml/hr = 5 mcg/kg/min
Concentrated: 1 ml/hr = 10 mcg/kg/min
Dose Range: 2-20 mcg/kg/min

Mix 64.5 mg Dopamine in 250 ml

Concentration = 258 mcg/ml

Based upon above mixture, 2 ml/hr delivers 7.5 mcg/kg/min

Specify Concentration (optional):

Dosing Weight kg

Ordered Dose mcg/kg/min

Enter Requested Rate ml/hr (pump can be set to nearest 0.1 ml)

Calculate

Diluent: ( ) D5W ( ) NS ( ) D10W

NICU: WizOrder “Final” Product

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Medication Drip Calculator

Dopamine Rate Chart (258 mcg/ml) Dosing Wt: 4.3 kg

<table>
<thead>
<tr>
<th>mcg/kg/min</th>
<th>Rate (ml/hr)</th>
<th>mcg/kg/min</th>
<th>Rate (ml/hr)</th>
<th>mcg/kg/min</th>
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<td>20 ml/hr</td>
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</tbody>
</table>
### Central Line TPN Order Sheet

<table>
<thead>
<tr>
<th>NICU: WizOrder “Final” Product</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TPN fluid requirement:</strong> ml/kg/day (not including lipids)</td>
</tr>
<tr>
<td><strong>Cycle TPN over</strong> 24 hours</td>
</tr>
</tbody>
</table>

**Amino Acids as Trophamine**
- grams/kg/day
- add Cysteine [ ]
- 30 mg/g of protein

**Sodium**
- mEq/kg/day
  - Calculated ___ mEq/liter

**Potassium**
- mEq/kg/day
  - 1:1 ratio

**Calcium**
- mEq/kg/day
  - 15 mEq/liter

**Magnesium**
- mEq/kg/day
  - 5 mEq/liter

**Phosphate**
- mmol/liter
  - (calculated from calcium close)

**Acetate/Chloride**
- Minimal Chloride [ ]
- 1:1 ratio [ ]

**Added Medications and Supplements**
- MVI-PEDIATRIC: 5 ml (wt >= 2.5 kg)
- Neotrace & Selenium [ ] daily
  - [ ] M. TH
- heparin [ ]
  - 0.25 units/ml

**Other Possible Additives**
- Vitamin K [ ]
  - 1 mg/day
- famotidine (Pepcid) (mg/kg/day) [ ]
  - [ ] 1 [ ] 2
- albumin (g/kg/day) [ ]
  - 0.5 [ ]

**Lipids 20%**
- grams/kg/day over 24 hours
  - Carnitine (10 mg/kg/day) added if lipids ordered

**Dextrose**
- %

**Acid/Base**
- Minimal Chloride [ ]
- 1:1 ratio [ ]

**Amino Acid Calories:** ___ kcal/kg/day
**Fat Calories:** ___ kcal/kg/day
**Dextrose Calories:** ___ kcal/kg/day
**Total Calories:** ___ kcal/kg/day
**Lipid Rate:** ___ m/l/hr
**Total Fluid Volume (TPN + Fat): ___ ml/kg/day**

**Calculations**
- Calculate minimum TPN Rate: ___ ml/hr
- Calculate minimum TPN Volume: ___ ml/day
- Calculate TPN Rate: ___ m/l/hr
- Calculate TPN Volume: ___ ml/day

**Special Instructions to Pharmacy:**

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**NICU: WizOrder “Final” Product**

**Link to Lab Data**

**NEW TPN module designed for NICU**

**Calculate** (Updates Fields)

**Submit Final Order** OR **Exit Without Ordering**
**TPN Related Lab Trends**

**Na**
- 145, 139, 141
- 6 days, 3 days, now

**K**
- 5.0, 4.1, 3.9
- 6 days, 3 days, now

**CO2**
- 30, 24, 23
- 6 days, 3 days, now

**Gluc**
- 110, 135, 186
- 6 days, 3 days, now

**BUN**
- 18.5, 8.8
- 6 days, 3 days, now

**Creat**
- 1.5, 0.5
- 6 days, 3 days, now

**Protein, total**
- No Data Available

**Bilirubin, total**
- 1.2, 0.2
- 6 days, 3 days, now

**Albumin (Alb)**
- 5.0, 3.5
- 6 days, 3 days, now

**Calcium**
- PO4
- Magnesium

---

**Graph color codes:**
- Pink: Clinically high range
- Yellow: Clinically normal range
- Green: Clinically low range

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**NICU: WizOrder “Final” Product**
NOTE ERROR MESSAGE

TPN fluid requirement must be at least 20 ml/kg/day.

### TPN Order Sheet

**Central Line TPN Order Sheet**

**Patient:** ZTESTSSS, 7 Do (female)  
**TPN Calculation Weight:** 3.8 kg

---

**1. TPN fluid requirement:** 10 ml/kg/day
   - (not including lipids)
   - Cycle TPN over 24 hours

---

**2. Amino Acids as Trophamine**
   - 2 grams/kg/day
   - add Cysteine [☐ 0] [☐ 30 mg/g of protein]

---

**3. Dextrose**
   - 10 %

---

**4. Lipids**
   - 20 %
   - 2 grams/kg/day over 24 hours
   - Carnitine (10 mg/kg/day) added if lipids ordered

---

**5. Acetate/Chloride**
   - Minimal Chloride
   - 1:1 ratio
   - Minimal Acetate

---

**6. Sodium**
   - 50 mEq/kg/day
   - Calculated 5000 mEq/liter

---

**7. Potassium**
   - 5 mEq/kg/day
   - Calculated 500 mEq/liter

---

**8. Calcium**
   - [☐ 0] [☐ 15 mEq/liter]
   - [☐ 30 mEq/liter]

---

**9. Magnesium**
   - [☐ 0] [☐ 5 mEq/liter]

---

**10. Phosphate**
   - 15 mmol/liter
   - (calculated from calcium dose)

---

**11. Added Medications and Supplements**
   - MYI-PEDIATRIC: 5 ml (wt >= 2.5 kg)
   - Nactrace & Selenium: [☐ daily] [☐ M TH]
   - heparin: [☐ 0] [☐ 0.25 units/ml]

---

**12. Other Possible Additives**
   - vitamin K [☐ 0] [☐ 1 mg/day]
   - famotidine (Pepcid) (mg/kg/day): [☐ 0] [☐ 1] [☐ 2]
   - albumin (g/kg/day): [☐ 0] [☐ 0.5] [☐ 1]

---

**13. Special Instructions to Pharmacy:**

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**NICU: WizOrder “Final” TPN Product**

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Copyright © 2004, Vanderbilt University Medical Center
From: Waitman, Lemuel Russell (Lead WIZ developer)
Sent: Monday, June 30, 2003 1:43 PM
Subject: Pizza feedback on NICU pharmacy issues.

NICU MD director visited Pizza session today and brought up the following points:

1. In the "NICU General Admission Orders" orderset:
   - Items 36 and 37 (vitamin A and indocin) are confusing in layout because they fall under the "Buffers" heading even though they are not buffers.
   - Suggestion is to move them up under the rest of the Medications. At a minimum we should create a separate heading or at least a spacer between them and the buffers. This would be a straightforward change.

2. Tromethamine inj: THAM
   - Because of the caustic nature of THAM, NICU MD would like a warning when THAM is ordered that says:
     "Never give via umbilical catheters (either arterial or venous)."
   - This warning would display as an order entry message. Any issues applying this housewide or would we want to use a custom NICU only message (tied to Shitake)?
IMPLEMENTING CPOE IS DIFFERENT ....

At go live - everyone’s work changes at once
   So all need to be at the table - but all are busy…

An implementation has many moving parts & each affects others

   Unit & Ancillaries – buy in, workflow, protocol & order set
development, staff levels, meeting and rotation schedules

   System Support – phasing, content development, new functions,
hardware placement and funding, training, swat team support

HAVING SYSTEM SUPPORT TEAM, DEDICATED 24x7 TO
PLAN, IMPLEMENT & SUPPORT END-USERS IS CRITICAL
CONCLUSION:

Early Advice on Ideal Behavior of Clinical Decision Support Systems And Their Developers

The essence of knowledge is, having it, to apply it;

not having it, to confess your ignorance

Confucius. ~2500 years ago