

# Improving Quality using Order Entry, Decision Support and Electronic Health Record Systems

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# The Non-Perfectibility of Man

If to do were as easy as to know  
what were good to do,  
chapels had been churches, and  
poor men's cottages princes' palaces.

... I can easier teach twenty what  
were good to be done than  
to be one of the twenty  
to follow my own teaching.

-- William Shakespeare

*The Merchant of Venice*, Act I, Scene ii, 1597

# Clinical Decision Support

## ■ Background

- exponential growth of biomedical literature
- “current volume of scientific literature” is unmanageable
- Pubmed includes more than twelve million citations
  - added more than 460 000 in 2001, 500 000 in 2002, 525 000 in 2003, and 570 000 in 2004 ([http://www.nlm.nih.gov/bsd/bsd\\_key.html](http://www.nlm.nih.gov/bsd/bsd_key.html)).
  - “to keep up with the 400 000 articles [added yearly], a physician could read two articles each day, every day of the year and by the end of the year fall 550 years behind”
- physicians often encounter multiple questions during practice
- questions generated during patient care are not answered

# Clinical Decision Support

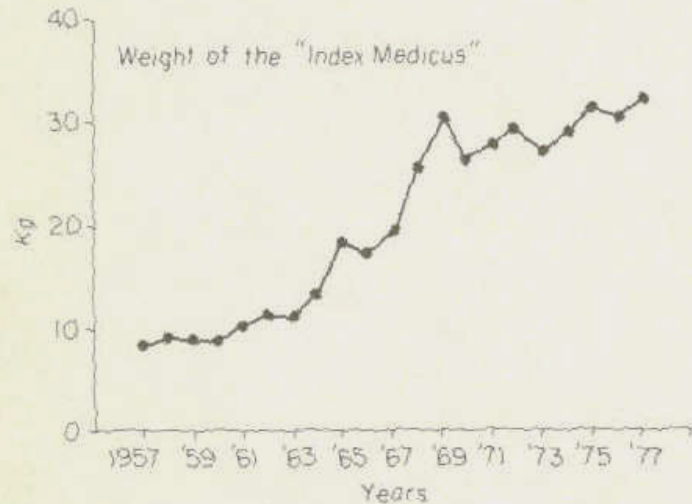


Figure 2. Weight of the *Index Medicus*, 1957-1977.

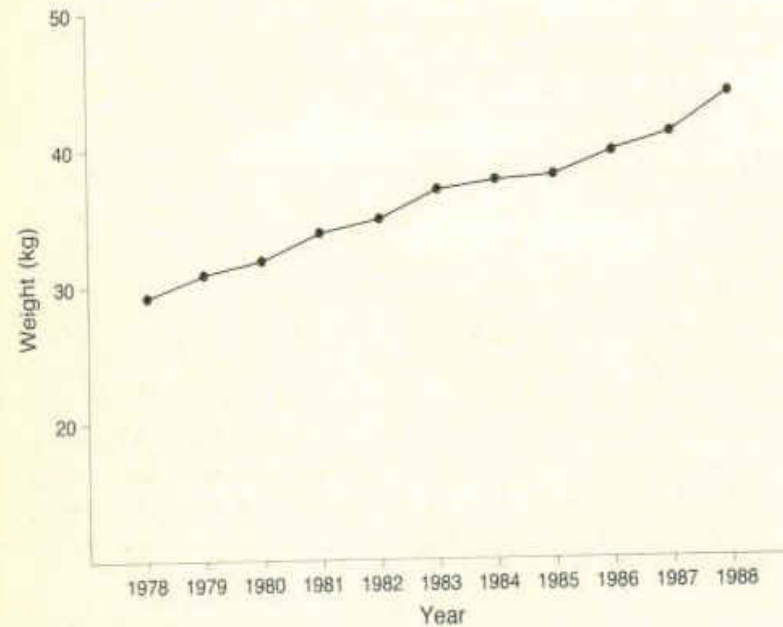


Figure 1. Weight of the *Cumulated Index Medicus*, 1978-1988.

Durack DT. The weight of medical knowledge. *N Engl J Med* 1978 Apr 6;298(14):773-5.

Madlon-Kay DJ. The weight of medical knowledge: still gaining. *N Engl J Med*. 1989 Sep 28;321(13):908

# Clinical Decision Support

- Decision Support is...
  - Opening a textbook
  - Turning on a PDA
  - Reviewing laboratory results
  - Going to PubMed
  - Flipping through a patient's chart
  - Discussing a case with a colleague
  - a “therapeutic substitution” warning

# Clinical Decision Support

- Clinical Decision Support is:
  - The provision of information to help clinicians make informed decisions
  - The elucidation of implicit expert knowledge into explicit rules usable by all clinicians
  - The integration of distinct and disparate pieces of data into a single clinical workflow
- To be successful, Clinical Decision Support should be part of normal workflow

**Patient Care Provider  
at Decision Point**

**IDEA**



**ACTION**

**Decision  
Support  
Integrated  
into  
Workflow**

# Clinical Content

- Clinical content is the actual elements of knowledge presented by clinical decision support tools
  - Drug Dosing Information
  - Laboratory Results
  - Patient Problem Lists
  - Disease Management Guidelines
  - Pathway or Institutional Rules
  - Basic Medical Knowledge

## 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

**IDEA**

Patient Care Provider  
at Decision Point

**ACTION**

Decision  
Support  
Integrated  
into  
Workflow

## 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

# Provider Order Entry

- Provider Order Entry is a process in which clinicians enter clinical orders directly into a computerized system
  - It permits real time consolidation of clinician's intent with available orderable items
  - It helps to reduce errors of transcription and errors in communication
  - It is used at “the point of care”

# Provider Order Entry

- Provider Order Entry is often integrated into an electronic health record.
  - Sensitive to patients' specific information
  - Can utilize patients' allergies, medication list, laboratory results, vital signs to drive Clinical Decision Support
  - Clinical Decision Support can drive the generation of new orders

# Provider Order Entry

- Provider Order Entry is used at the Point of Care.
  - Most non-procedural care results from a written order
  - Delivery of Clinical Decision Support during order entry provides instant feedback to the “decision maker”

# A Case of CDS in CPOE

- A Case of Clinical Decision Support integrated into Provider Order Entry
  - WizOrder is a CPOE system developed at Vanderbilt University Medical Center.
  - Used on 648/662 hospital beds
  - Used by Medicine, Surgery, Pediatrics, OB/GYN, Emergency services.
  - Over 13, 000 orders entered daily
  - Over 70% of orders entered by physicians
  - Integrated into an Electronic Health Record system
  - Includes Clinical Decision Support tools

# A Case of CDS in CPOE

- *Implementation by unit,*
  - *CCU 4/95*
  - *MICU, BMT 9-10/1995*
  - *Adult Medicine & Surgery 1996*
  - *Pediatrics & OB/Gyn 1997*
  - *PICU 12/2001*
  - *NICU 4/2003*
  - *Children's Hospital opened 2/2004*

# Order Entry Screen with three types of Decision Support Elements Explicitly Displayed

8000-B ZTRAINADM, Adm1 1556766-2 29y/o F (ROSELTS)

**Condition**

**Vital signs**  
vital signs as dir "q2h x 2; q4h x 48h; then q shift if stable & afebrile "

**Activity/limitations**  
activity: "per protocol " »Oct 2 12:00...

**Allergies**

**Nursing instructions**  
in and out cath q6h prn "for inability to void after foley d/c'd " »Oct 2  
intake and output "until drains/tubes/iv's d/c'd; notify if uop <50cc/2h o  
nursing: "complete environmental assessment -- ensure that: (1) ambul  
nursing: "identify fall risk patients: caution sign on door " »Oct 2 12:0  
ted hose - thigh high "rle: 2; lle: 23; keep snugly in place except may r

**Diet**

**Medications**

**IV fluids**

**TPN orders**

**Respiratory therapy**  
ventilator settings  
- Mode: a/c  
- Rate (bpm): 10  
- FiO2 (%): 21  
- Tidal volume (ml): 200  
- PEEP/CPAP (cm H2O): 5

**8n common orders**

1. pathway orders (adult) »
2. general medicine orders »
3. 8N admission orders »
4. pulmonary medicine/critical care orders »
5. STAT labs / tests »
6. next morning stat labs / tests »
7. next morning ROUTINE labs / tests »
8. medications »
9. workups »
10. « Return to previous list

**1. Active orders**

**2. Common useful orders, based on patient location**

**Select an item from the list**  
or enter another order

**3. Commonly used features**

**Clinician enters order for antibiotic, Gentamicin, by partially typing its name**

gent 80 iv q12h

print <F1> display <F2> D/C <F3> renew **cosign** order sets <F4> oops <F5> help <F6> complain <F7> done <F8>

# Order Entry Screen with two types of Decision Support Elements Explicitly Displayed

8000-B ZTRAINADM, Adm1 1556766-2 29y/o F (TRAINIO)

ADC VAAN DISML display

## 1. Pertinent results displayed

### Admission

admission service: "gmd (general internal med) " »Oct 2 12:00...  
attending: provider#2497 beeper#  
- Comments: name: abbate, matthew.j. »Oct 2 12:00...  
○ creatinine clearance: 28.1 ml/min ; using the cockroft-gault method w  
○ weight: 75.000kgs/165lb;

### Diagnosis

### Condition

### Vital signs

vital signs as dir "q2h x 2; q4h x 48h; then q shift if stable & afebrile "

### Activity/limitations

activity: "per protocol " »Oct 2 12:00...

### Allergies

### Nursing instructions

in and out cath q6h prn "for inability to void after foley d/c'd " »Oct 2  
intake and output "until drains/tubes/iv's d/c'd; notify if uop <50cc/2h o  
nursing: "complete environmental assessment -- ensure that: (1) ambul  
nursing: "identify fall risk patients: caution sign on door " »Oct 2 12:0  
ted hose - thigh high "rle: 2; lle: 23; keep snugly in place except may re

### Diet

### Medications

GENTAMICIN INJ: GARAMYCIN

Weight=75.0 kgs on Thu Oct 25 10:03

Estimated CrCl=28 ml/min

Information: recommended dose for single daily iv dosing: 4-7 mg/kg/24h

- a) Dose: 80 MG
- b) Route: IV
- c) How often: Q12H

## 2. Entry of additional information is assisted

**When to start (first dose): (with optional start date & time)**

GenRx

WizRx

1 NEXT SCH (default) (next schedule)

\$0.00

2 NOW

literature

or enter a start date, time and priority

QMR

or press ENTER = NEXT SCH

antibiotics

alerts

print <F1>

display <F2>

D/C <F3>

renew

cosign

order sets <F4>

oops <F5>

help <F6>

complain <F7>

done <F8>

# Order Entry Screen with one type of Decision Support Element Explicitly Displayed

8000-B ZTRAINADM, Adm1 1556766-2 29y/o F (TRAINIO)

ADC VAAN DISML display

## Admission

admission service: "gmd (general internal med) " »Oct 2 12:00...

attending: provider#2497 heener#

- Comment

creatinine c

weight: 75.0

## Diagnosis

## Condition

## Vital signs

vital signs a

## Activity/limita

activity: "pe

## Allergies

## Nursing instr

in and out ca

intake and o

nursing: "co

nursing: "iden

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## Medications

GENTAMICIN INJ: GARAMYCIN

Weight=75.0 kgs on Thu Oct 25 10:03

Estimated CrCl=28 ml/min

Information: recommended dose for single daily iv dosing: 4-7 mg/kg/24h

a) Dose: 80 MG

b) Route: IV

c) How often: Q12H

d) When to start (first dose): NOW

## Warning

Dose: 80 mg q12h

Dosing weight: 75 kg

Creatinine clearance: 28.08 ml/min

Estimated steady-state levels:

peak: 6.7 ug/ml

trough: 2.9 ug/ml

Peak level too low!

Trough level too high!

Suggested dose: 120 mg q24h

peak: 7.2 ug/ml

trough: 1.2 ug/ml

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Print

Ok

Pharmacokinetic model used to estimate drug distribution, and to prompt a warning and suggested proper dose if the ordered dose out of range.

OK to process this order ?

GenRx

WizRx

1 yes (default)

\$0.00

2 no

literature

or select an item to modify

QMR

antibiotics

alerts

print <F1>

display <F2>

D/C <F3>

renew

cosign

order sets <F4>

oops <F5>

help <F6>

complain <F7>

done <F8>

# gentamicin

- trade name: GENTAMICIN
- AHFS category: 081202
- on VUMC formulary

[WizRx drug reference](#)  
[GenRx drug reference](#)  
[information for patients](#)

## VUMC pharmacy suggested dosage range limits

Recommended doses are:

- less than 29 days: 2.5 to 3.5 mg/kg/dose
- between 29 days and 5 years: 2.5 to 3.3 mg/kg/dose
- between 5 years and 12 years: 6 to 9.9 mg/kg/24h
- more than 12 years: 1 to 6 mg/kg/dose

**Drug monographs available as clinicians order medications.**

## VUMC pharmacy monograph

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Gentamicin is an aminoglycoside antibiotic used to treat serious infection due to susceptible aerobic bacteria, incl. Pseudomonas, kelbsiella, citrobacter, serratia, & yersinia; used empirically w/other drugs in febrile neutopenia. Dose:im or iv over 30 min: dose based on body wt & renal function (calculated crcl). Adult dose: for most infections (except endocarditis) adult dose in pts w/crcl >60ml/min can be 4-6mg/kg/day, given q24hrs. Max dose in pts >70yrs old is 4mg/kg/day; w/elderly. Maintain trough <1.4mg/l. (ann intern med 1996;124: 717-25). In endocardtis, use q8hr dosing if indicated (jama 1995;274:1706-13). Nursury protocol doses for <27wks gestation is 3.5mg/kg qod; >27wks gestation use 3.5mg/kg qd; full term-1month give 3.5mg/kg q12-24h; 1-6 mo use 2.5-3mg/kg q8-24hrs based in renal function & clinical status. In pediatrics, qd dosing is usually limited to cf pts-suggested dose is 10mg/kg/dose q24hrs. See ahfs

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**Help is just one click away**

# Order Entry Screen with three types of Decision Support Elements Explicitly Displayed

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Comments: name: abbate, matthew j. »Oct 2 12:00...

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○ weight: 75.000kgs/165lb;

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Allergies

Nursing instructions  
in and out cath q6h prn "for inability to void after foley d/c'd " »Oct 2  
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nursing: "identify fall risk patients: caution sign on door " »Oct 2 12:0  
ted hose - thigh high "rle: 2; lle: 23; keep snugly in place except may r

Diet

Medications  
=Antibiotics  
○ gentamicin inj: garamycin 120 mg iv q24h

IV fluids

TPN orders

**1. Recently ordered medication**

### GENTAMICIN MONITORING

1. gentamicin peak level after 3rd dose
2. gentamicin trough level before 3rd dose
3. gentamicin level...
4. « Return to previous list

**2. Drug level monitoring orders "one click away"**

**Select an item from the list** GenRx

or enter another order WizRx

or press **END** to return to the previous list \$333.95

literature

QMR

antibiotics

alerts

**3. Running "cash register" for cost/charges of medications, lab tests, radiology exams from this order entry session**

8000-B ZTRAINADM, Adm1 1556766-2 29y/o F (ROSELTS)

**Condition**

**Vital signs**  
vital signs as dir "q2h x 2; q4h x 48h; then q shift if stable & afebrile "

**Activity/limitations**  
activity: "per protocol " »Oct 2 12:00...

**Allergies**

**Nursing instructions**  
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**Diet**

**Medications**  
=Antibiotics  
o gentamicin inj: garamycin 80 mg iv q24h

**IV fluids**

**TPN orders**

**Respiratory therapy**  
ventilator settings  
- Mode: a/c  
- Rate (bpm): 10  
- FiO2 (%): 21

management of GVHD (CSA and MTX)

1. protocol: GVHD (CSA and MTX)
2. cyclosporin 1.5 mg/kg over 4hr q12hr at 8am/8pm begin day -1  
+ cyclosporin trough levels mon/wed/fri @730am thru red port
3. methotrexate 15mg/m2 ivp day +1  
+ leucovorin 10mg/m2 iv q6h x 4, begin day +2  
+ methotrexate 10mg/m2 ivp day +3  
+ leucovorin 10mg/m2 iv q6h x 4, begin day +4  
+ methotrexate 10mg/m2 ivp day +6  
+ leucovorin 10mg/m2 iv q6h x 4, begin day +7  
+ methotrexate 10mg/m2 ivp day +11  
+ leucovorin 10mg/m2 iv q6h x 4, begin day +11  
+ MD reminder: adjust day+11 methotrexate dose for mucositis or  
elevated serum creatinine

**Select an item from the list**  
or enter another order  
or press **END** to return to the previous list

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# Order Entry Screen with three types of Decision Support Elements Explicitly Displayed

8000-B ZTRAINADM, Adm1 1556766-2 29y/o F (ROSELTS)

Condition

Vital signs

vital signs as dir "q2h x 2; q4h x 48h; then q shift if stable & afebrile "

**2. Clicking on drug interaction warning displays monograph about nature and severity of interaction**

Nursing instructions

in and out cath q6h prn "for inability to void after foley d/c'd " »Oct 2

intak

nursi

nursi

ted h

Diet

Medic

=Anti

gent

IV fluid

TPN orders

Respiratory therapy

ventilator settings

- Mode: a/c

- Rate (bpm): 10

- FiO2 (%): 21

Pharmacy warning for CYCLOSPORINE INJ: SANDIMMUNE:

1. Aminoglycosides may potentiate cyclosporine nephrotoxicity
2. Avoid aminoglycosides + cyclosporine in renal transplant pts

**1. Drug interaction warnings**

WizOrder Popup

Aminoglycosides may potentiate cyclosporine nephrotoxicity

Aminoglycoside antibiotics, when used in combination with cyclosporine have been shown to have additive nephrotoxicity when used in combination. The severity of this reaction probably depends on the duration of combined use and the diagnosis of the patient. Bone marrow transplant patients on dr wolff's or dr greer's service should generally "Not" receive the two drugs in combination since therapy with an aminoglycoside in these patients can be expected to be prolonged due to profound neutropenia. In cardiac & renal transplant patients the potential for toxicity may be offset by the benefit of aminoglycoside therapy.

\*\*If this warning occurs in a patient on the bone marrow transplant service or in a patient of dr's greer, wolff, or stein then notify the physician about the potential for increased nephrotoxicity. Don't call in the middle of the night, however-leave a note for the day pharmacist to follow up\*\*

Back Home Print **Close**

**Pharmacy warning**

- [a](#) order it anyway
- [b](#) don't order it

or select an item to display more information

**3. Option to override warning can be offered, although log can be kept**

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print <F1> display <F2> D/C <F3> renew **cosign** order sets <F4> oops <F5> help <F6> complain <F7> done <F8>

# Developing Content

- Define a clinical problem
- Find a knowledge expert
- Review published knowledge
- Find a clinical champion
- Develop, Refine, Deploy
- Listen to feedback

# Clinician Buy-In

- Solve problems for clinicians, not just administrators
- Make certain decision support programs mirror workflow
- Make certain training is adequate
- Make interface simple
- Give something back

# Problem – Pediatric Dosing

- Need to perform drug dose / weight / concentration calculations
- Many calculations and recalculations may lead to inefficiencies and errors
  - Potential adverse drug events (e.g., known allergy)
  - Medication prescribing errors (e.g., no weight)
- Computer can:
  - Perform dose/concentration calculations
  - Generate orders
  - Generate drip charts

# Effect of Computerized Physician Order Entry and a Team Intervention on Prevention of Serious Medication Errors

David W. Bates, MD; Lucian L. Leape, MD; David J. Cullen, MD; Nan Laird, MD; Laura A. Petersen, MD; Jonathan M. Teich, MD, PhD; Elizabeth Burdick, MS; Mairead Hickey, MD; Sharon Kleefield, MD; Brian Shea, MD; Martha Vander Vliet, RN; Diane L. Seger, RPh

**Context.**—Adverse drug events (ADEs) are a significant and costly cause of injury during hospitalization.

**Objectives.**—To evaluate the efficacy of 2 interventions for preventing nonintercepted serious medication errors, defined as those that either resulted in or had potential to result in an ADE and were not intercepted before reaching the patient.

**Design.**—Before-after comparison between phase 1 (baseline) and phase 2 (after intervention was implemented) and, within phase 2, a randomized comparison between physician computer order entry (POE) and the combination of POE plus a team intervention.

**Setting.**—Large tertiary care hospital.

**Participants.**—For the comparison of phase 1 and 2, all patients admitted to a stratified random sample of 6 medical and surgical units in a tertiary care hospital over a 6-month period, and for the randomized comparison during phase 2, all patients admitted to the same units and 2 randomly selected additional units over a

patients and represented the single most common cause of injury. In addition to their human costs, ADEs are costly to health care systems. Nationally, ADEs occurring after hospitalization have been projected to cost hospitals \$2 billion per year, not including malpractice costs or the costs of injuries to patients.<sup>67</sup> Hospitalizations initiated by ADEs appear to be at least as expensive.<sup>8</sup>

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See also pp 1317, 1339, and 1360.

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These data suggest that health care

**Conclusions.**—Physician computer order entry decreased the rate of nonintercepted serious medication errors by more than half, although this decrease was larger for potential ADEs than for errors that actually resulted in an ADE.

medication-use process. Preventable ADEs declined 17% from 4.69 to 3.98 ( $P=.37$ ), while nonintercepted potential ADEs declined 84% from 5.99 to 0.98 per 1000 patient-days ( $P=.002$ ). When POE-only was compared with the POE plus team intervention combined, the team intervention conferred no additional benefit over POE.

**Conclusions.**—Physician computer order entry decreased the rate of nonintercepted serious medication errors by more than half, although this decrease was larger for potential ADEs than for errors that actually resulted in an ADE.

JAMA. 1998;280:1311-1316

the frequency and types of ADEs, but also to analyze the associated errors using a multidisciplinary, systems-oriented approach to understand their causes.<sup>10,11</sup>

We evaluated 2 interventions, the first targeting primarily the ordering stage and the second targeting the administration and dispensing stages. The first intervention was a physician computer or-



### Dopamine Infusion

Exit Without Ordering

Select Another Infusion

Patient Demographics  
 ZPRACTICESSS, Pccu14  
 3 months ; male  
 Fluid Restriction Protocol  
 Weight in Wiz: 10 kg  
 5SPI 5205B  
 Already have infusion  
 Date/Time: 01/07/02 16:32

Dosing Weight  kg  
 Ordered Dose  mcg/kg/min  
 Enter Requested Rate  ml/hr (pump can be set to nearest 0.1 ml)

Entered data summarized

**Calculate** Diluent:  D5W)  NS)  D10W)

Mix **375 mg Dopamine in 250 ml**  
**Concentration = 1500 mcg/ml**

Specify Concentration (optional)  mcg/ml (Cannot specify BOTH rate and concentration)

Based upon above mixture, 2 ml/hr delivers 5 mcg/kg/min

Drug Information  
 Absolute Maximum conc = 6000 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

Order Infusion

Comments:

Dosing concentration and rates are calculated

#### Dopamine Rate Chart (1500 mcg/ml) Dosing Wt: 10 kg

Start Chart at  mcg/kg/min Increment  mcg/kg/min

mcg/kg/min	Rate (ml/hr)	mcg/kg/min	Rate (ml/hr)	mcg/kg/min	Rate (ml/hr)	mcg/kg/min	Rate (ml/hr)
0.5	0.2 ml/hr	5.5	2.2 ml/hr	10.5	4.2 ml/hr	15.5	6.2 ml/hr
1	0.4 ml/hr	6	2.4 ml/hr	11	4.4 ml/hr	16	6.4 ml/hr
1.5	0.6 ml/hr	6.5	2.6 ml/hr	11.5	4.6 ml/hr	16.5	6.6 ml/hr
2	0.8 ml/hr	7	2.8 ml/hr	12	4.8 ml/hr	17	6.8 ml/hr
2.5	1 ml/hr	7.5	3 ml/hr	12.5	5 ml/hr	17.5	7 ml/hr
3	1.2 ml/hr	8	3.2 ml/hr	13	5.2 ml/hr	18	7.2 ml/hr
3.5	1.4 ml/hr	8.5	3.4 ml/hr	13.5	5.4 ml/hr	18.5	7.4 ml/hr
4	1.6 ml/hr	9	3.6 ml/hr	14	5.6 ml/hr	19	7.6 ml/hr
4.5	1.8 ml/hr	9.5	3.8 ml/hr	14.5	5.8 ml/hr	19.5	7.8 ml/hr
5	2 ml/hr	10	4 ml/hr	15	6 ml/hr	20	8 ml/hr

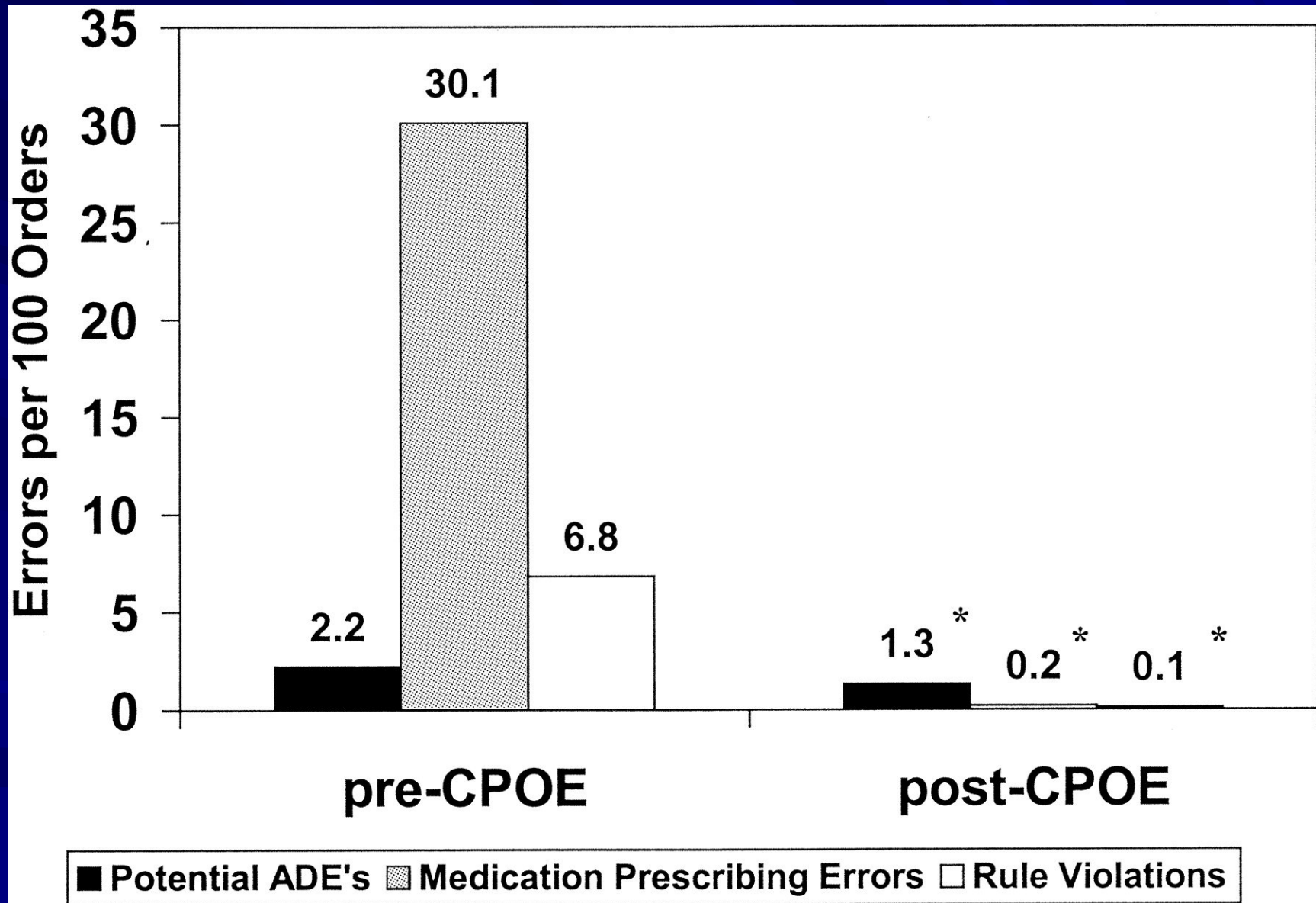
Drip infusion rate calculator for the PICU

# Problem – Pediatric Dosing

- Before CPOE implementation:
  - Potential ADEs - 2.2 per 100 orders,
  - MPEs - 30.1 per 100 orders
- After implementation,
  - Potential ADEs - 1.3 per 100 orders,
  - MPEs - 0.2 per 100 orders,
- The overall error reduction was 95.9%.
- Potential ADEs were reduced by 40.9%.

*Potts et al. Computerized Physician Order Entry and Medication Errors in a Pediatric Critical Care Unit. PEDIATRICS. 1/1/2004.*

# Problem – Pediatric Dosing



\* p Value < 0.05

# Problem - Anticoagulation

- Dosing of unfractionated heparin highly variable
- Variable dosing leads to variable therapy and variable outcomes
- Dosing guidelines exist, but they are not universally followed or simple to implement
- Need to make it easy to follow guidelines and activate multiple like orders

# Adult Low Molecular Weight (LMW) Heparin / Unfractionated Heparin Anticoagulation Treatment Advisor (Revised 9/1/03)

**Guidelines Regarding Enoxaparin (LMW Heparin):** 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: 4.2 (01/12/2005 02:30 AM ) -- Estimated Creatinine Clearance: 15 mL/min

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

2 Pick an Indication	3 Pick a Test to order		4 Pick a Heparinoid (if applicable)	
(pick ONE from below)	LE Venous Ultrasound	V/Q Scan	LMW Heparin	Unfractionated Heparin
<input type="radio"/> DVT prophylaxis	N/A	N/A	<a href="#">Click Here for DVT Prophylaxis Advisor</a>	
<input type="radio"/> DVT or PE, suspected (initial workup)	<input type="checkbox"/>	N/A	<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> PE suspected (with negative bilateral LE Doppler)	N/A	<input type="checkbox"/>	<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> PE suspected and... LE Doppler negative AND V/Q Scan inconclusive	Consider chest CT (helpful only if positive), pulmonary arteriogram, or pulmonary consult		<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> Massive PE suspected and patient in shock	Start with CT Chest		Consider thrombolytics or invasive radiological embolectomy	
<input type="radio"/> DVT or PE, confirmed	N/A	N/A	<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> Acute Coronary Syndrome	N/A	N/A	<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> Atrial Fibrillation or Prosthetic Valve			<input type="radio"/>	<input type="radio"/> (Recommended)
<input type="radio"/> Other Indications for Heparin use	N/A	N/A	<input type="radio"/> (Contraindicated)	<input type="radio"/> (Indicated)
<input type="radio"/> Diagnostic test only (Not for acute DVT/PE workup)	<input type="checkbox"/>	<input type="checkbox"/>	N/A	N/A

5 Verify / enter patient weight:   kg  lb

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**Clinical Warnings:** LMW Heparin is contraindicated: Renal function is impaired.

## Major Contraindications to All Forms of Heparin Therapy

- intracranial hemorrhage
- active internal bleeding
- bleed
- hep

## More Information and Recommendations

- [diagnostic tests to confirm or exclude the diagnosis of DVT](#)
- [diagnostic tests to confirm or exclude the diagnosis of PE](#)

**A decision support module to aid in anticoagulation for several medical indications**

# System calculates dosing and makes it easy to order tests associated with guidelines

## Unfractionated Heparin for Suspected PE (previous LE Doppler Negative)

### Guidelines for evaluation of suspected Pulmonary Embolism:

- Obtain a baseline PTT, PT/INR, CBC with platelets if necessary
- Check for contraindications to heparin therapy [ [CONTRAINDICATIONS](#) ]
- If no contraindications, give heparin bolus 80 Units/kg IV [ [INFO ON HEPARIN INDUCED THROMBOCYTOPENIA](#) ]
- Order an imaging study to confirm diagnosis [ [INFO ON TESTS TO CONFIRM OR EXCLUDE PE](#) ]

Links to educational materials available in protocol

## Orders you may wish to consider (check to order) - Order only if **Clinician reviews relevant medications & labs**

- Heparinoid already given (and in effect), do NOT order heparin now
- Give unfractionated heparin per protocol:
  - Bolus with I.V. heparin  units (**80 U/kg x 60 kg = 4800 U**)
  - Start IV heparin infusion at:  units/hour (**18 U/kg/hr x 60 kg = 1080 U/hr**)  
(Give infusion ONLY if diagnostic test will NOT be done within next 3 hours)

- Order baseline PTT now (if necessary)
- Order baseline PT/INR now (if necessary)
- Order baseline CBC with platelets now (if necessary)

01/13/2005 09:22 AM		
Anticoag Meds	Dose	Date
No Anticoagulant Meds		
Labs	Value	Date
PTT	None available	
INR	None available	
Platelet Count	416	01/12/2005 02:30 AM
PCV	30	01/12/2005 02:30 AM

### Diagnostic test for PE: **VQ Scan is likely available now. However call 2-0893 if near 5:00 pm to confirm.**

- V/Q Scan** (Mon-Fri 8:00 am - 5:00 pm). Available at any time by first paging 835-1239.

#### Reason For Test (Required):

- |  |  |
|--|--|
| <input type="radio"/> Hemoptysis                 | <input type="radio"/> Acute Pulmonary Heart Disease, Other     |
| <input type="radio"/> Painful Respiration        | <input type="radio"/> Chest Discomfort, Pressure, or Tightness |
| <input type="radio"/> Respiratory Distress       | <input type="radio"/> Respiratory Abnormality (unsp)           |
| <input type="radio"/> Other <input type="text"/> |  |

**Note:** Other procedures to help in the diagnosis of PE (e.g. Pulmonary consultation, pulmonary arteriography, D-dimer, MRI pelvis, CT Chest for workup of massive PE) should be ordered after exiting this advisor.

**Clinical Warnings: Renal function is impaired.**

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Clinician selects actions and clicks buttons to activate guideline-related orders

# Problem – Test Ordering

- Clinicians order too many tests
  - The BMP was the most ordered lab test
  - Daily CXRs were being performed for weeks in some ICU settings
  - Need to make it easy to order less
  - BMP unbundled and limited to 24 hours

### Lytes, BUN, Creatine, Glucose

Patient: 8012X ZTRAINSSS, Oe36 (1198308-7) Click [here](#) for help.

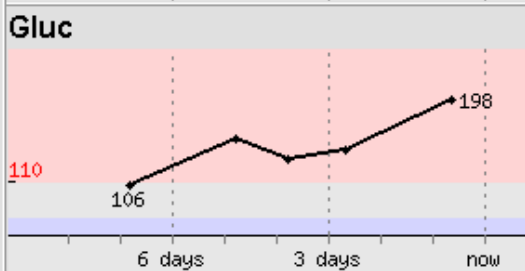
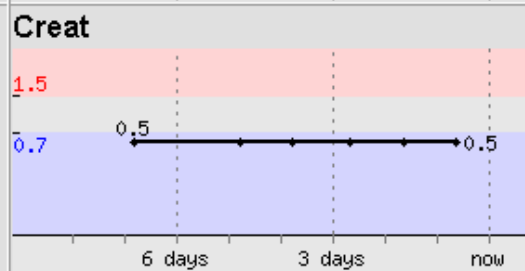
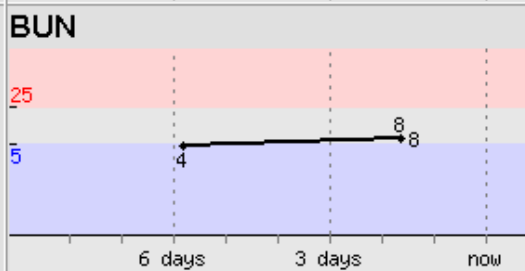
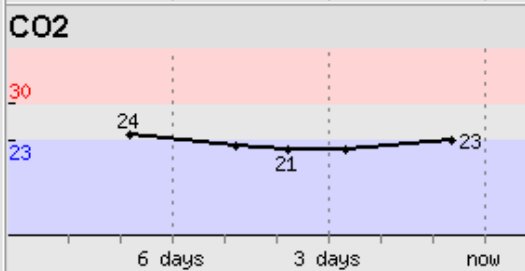
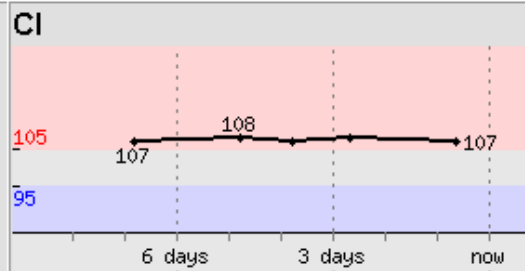
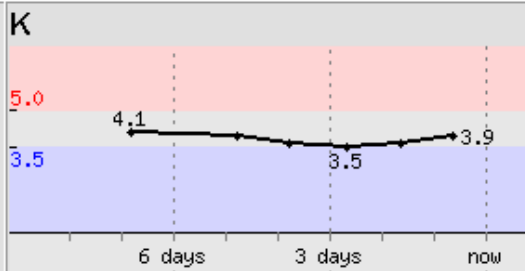
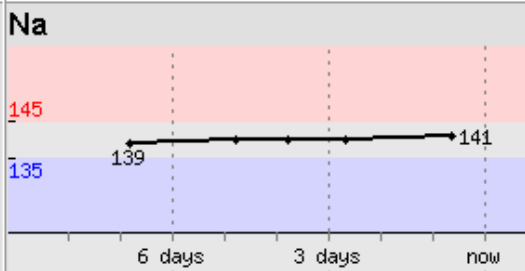
**Components**

1

Select test(s)

- Na
- K
- Cl
- CO2
- BUN<sup>1</sup>
- Creat<sup>1</sup>
- Gluc

**Graphs**



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**Graph color codes:**  Clinically high range  Clinically normal range  Clinically low range

**NOTE(S):** 1 Creat & BUN will be ordered "once, routine, now" if ordered via "Q??H" option.

2 Select timing/urgency

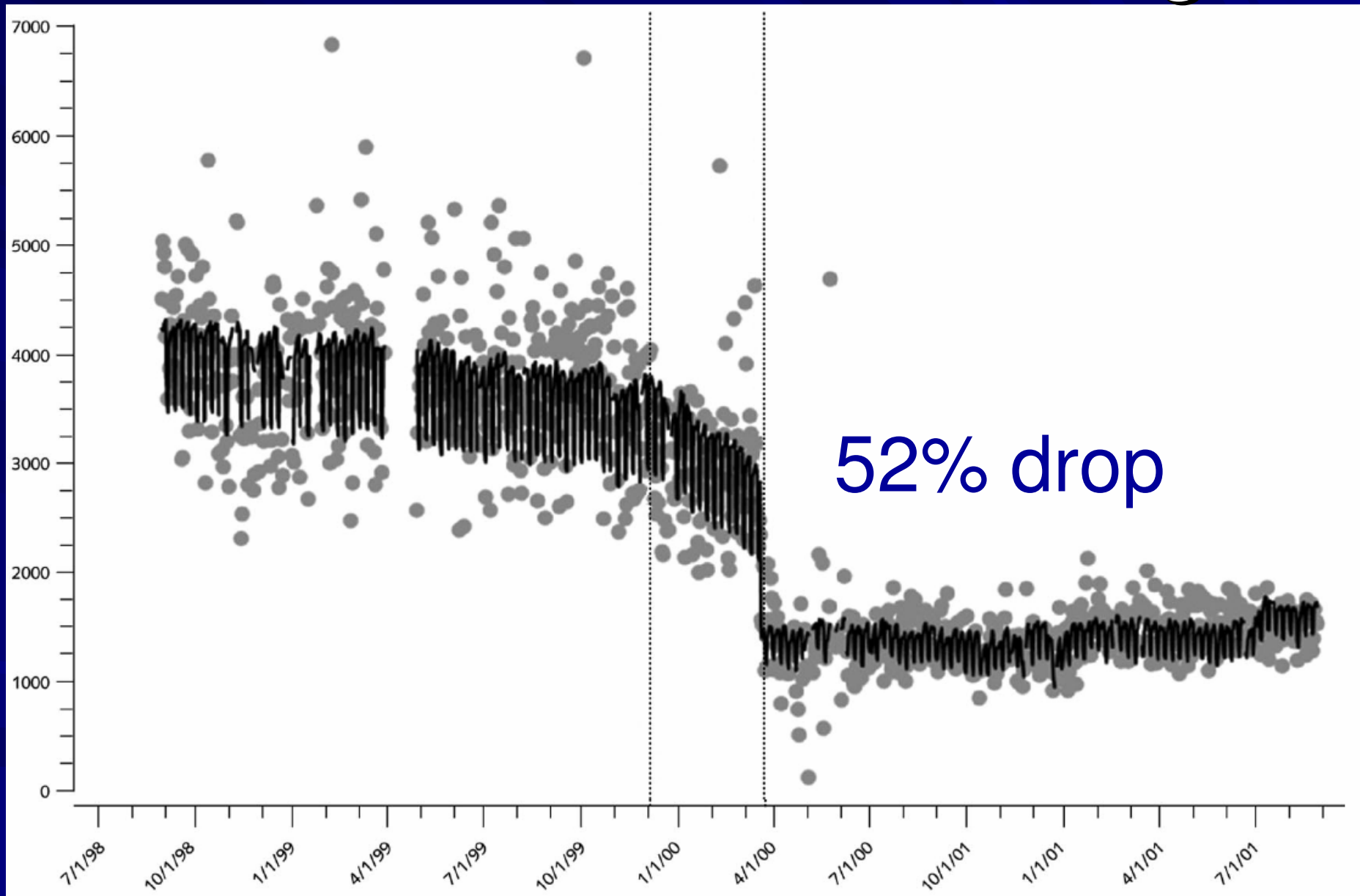
- once, in am 05, routine
- once, now, routine
- once, now, stat
- Q??H for the next ?? hours.
- once at 10/23/01 17:24

Comments:

3 Go to another page or exit

- 
- 
- 
- 
- 
-

# Problem – Test Ordering



# Problem – Formulary

- Institutional P&T committee reviews and recommends appropriate formulary based on medical and financial needs
- Therefore, the Formulary changes
- Clinicians cannot easily keep up with most up to date formulary
- Need to educate clinicians when formulary changes

**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/derepressed chromosomal beta-lactamases

Better activity against Gram-positive pathogens, including *Staphylococci*, *S. viridans*, *pneumococcus*

Q12 hour dosing except for empiric therapy for febrile neutropenia

[View Cefepime Fact Sheet](#)

[Go to Pediatric Recommendations](#)

[Go to Renal Dosing Recommendations](#)

Adults (Age > 16 years)

Dose	Example of Infection being treated
<input type="radio"/> 500 mg IV q12h	Uncomplicated urinary tract infection
<input type="radio"/> 1000 mg IV q12h	Nosocomial pneumonia in ICU patient
<input type="radio"/> 1000 mg IV q8h	Empiric coverage of febrile neutropenic patient
<input type="radio"/> 2000 mg IV q8h	<b>The FDA approved a dose of 2 gm IV q8h for febrile neutropenic patients and this is preferred over the 1 gm IV q8h dose if cefepime is given as <u>monotherapy</u> for this indication.</b> 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 <i>Pseudomonas aeruginosa</i> should be treated with the higher (2 gm IV q8h) dose.

Other

<b>Intramuscular</b>	<input type="radio"/> order I.M. Cefepime (with Lidocaine)
<b>Non-standard Dose</b>	<input type="radio"/> order non-standard dose of Cefepime

[Order Cefepime](#)

[Start Over](#)

"Click" the CLOSE button to return to WizOrder without ordering cefepime

[Order Ceftazidime](#)

[Back](#)

[Home](#)

[Close](#)

# Problem – Head Imaging

- Multiple brain imaging modalities
- Often unclear which modality matches which disease process or symptoms
- Guidelines exist, but are often hard to find (not available at the point of care)

# Dual purpose head imaging advisor / medical necessity ICD-9 capture

## Neuroradiology Ordering Guidelines -- Brain imaging Study

The Dept. of Radiology has issued guidelines to aid in the ordering of brain imaging studies (CT and MRI). You will be presented with the recommended study to order after answering the following questions. This selection process also assists in determining an ICD-9 billing code for this study.

### 1. Select the problem acuity

- Clinical Emergency
- Non-Emergent Clinically

**Clinician provides relevant clinical information for head imaging advisor**

### 2. Indicate if this test is being ordered for a SIGN/SYMPTOM or a CONFIRMED DIAGNOSIS

#### Sign or Symptom

- Any Sign or Symptom not associated with a known diagnosis
  - General Signs or Symptoms
  - Neurological Signs
  - Consciousness / Altered Mental Status
  - Headaches
  - Visual Changes
  - Previously Abnormal Studies

#### Confirmed Diagnoses

- Stroke / Vascular
- Neurological Diseases
- Tumor / Malignancy
- Infection / Inflammatory
- Trauma
- Procedures / Complications
- Systemic Diseases with CNS effects
- Congenital Abnormalities
- Otolaryngology / ENT
- Ophthalmologic / Visual Pathway Disease
- Drugs / Psychiatric / Organic Mental Disease

CONTINUE

Cancel Order

Back

Home

Print

Close

### Neuroradiology -- Signs and Symptoms

Choose the most appropriate single indication for ordering this test, then press the CONTINUE button.  
For an indication not listed, use the "Other" text box below.

- General Signs or Symptoms**
- Head Injury
  - Seizure, Convulsion
  - Face or Neck Injury
  - Fever
  - Swelling, Mass, Lump in head and neck
  - Meningismus
  - Syncope or collapse
  - Nausea & Vomiting
  - Papilledema
  - Atypical Face Pain
  - Vertigo, Dizziness (Use only if no others apply)
  - Lethargy, Tiredness, Malaise (Use if no others apply)
- Headaches (HA)**
- HA (Use only if no others apply)
  - HA with Neurological Signs / Symptoms
  - HA with Decreased LOC
  - HA with Chronic Hypertension
  - HA, Chronic or Atypical
  - HA, Severe Sudden Onset

- Neurological Signs**
- Weakness, dominant side - Right
  - Weakness, dominant side - Left
  - Weakness, non-dominant side - Left
  - Weakness, non-dominant side - Right
  - Paresthesia, Sensory Disturbance
  - Facial Weakness or Paralysis
  - Slurred Speech, Dysarthria
  - Aphasia
  - Ataxia, Lack of Coordination
  - Gait Ataxia
  - Tremor, Fasciculation, Spasm
  - Bladder Incontinence without sensory awareness
  - Abnormal Pupillary Reflex
  - Internuclear ophthalmoplegia
  - Other Abnormal Reflex

- Visual Changes**
- Sudden Visual Loss
  - Transient Visual Loss (amaurosis fugax)
  - Diplopia
  - Visual Field Deficit
  - Nystagmus
- Consciousness / Altered Mental Status (AMS)**
- Coma
  - AMS (Reduced Consciousness)
  - AMS (Confusion, Acute Delirium)
  - Subacute delirium
  - Dementia
- Previously Abnormal Studies**
- Abnormal CSF
  - Abnormal EEG

**Clinician selects reason for testing**

**Other Sign or Symptom**  (Neuroradiology ordering recommendations will be not be given )

**NOTE:** PLEASE use a diagnosis code from above if appropriate. Reimbursement by medicare and/or other insurance carriers may not be authorized.

**NOTE TO UNIT STAFF:** "Doctor ordered it" is NOT an acceptable reason. Consult with the ordering MD to select the appropriate reason.

### Neuroradiology -- Brain Study Order Page

1. Verify the information you entered and review Neuroradiology recommendation

Problem Acuity:	Emergent
Indication (with ICD-9 code):	377.00 Papilledema __
If no contraindications exist, the suggested study is:	CT Without IV Contrast

**Advisor summarizes information**



2. Verify that no contraindications exist for the desired study.

**CT Contraindications**

**If IV Contrast (Iodine Based) is Selected:**

- Contrast allergy
- Renal insufficiency (Cr > 2.0)
- Drug interactions (Glucophage)
- Sickle cell crisis

[Radiology information page for CT](#)

**MRI Contraindications**

<ul style="list-style-type: none"> <li>Contrast allergy</li> <li>Cardiac pacemakers</li> <li>Intracranial aneurysm clips</li> <li>Metallic heart valves</li> </ul>	<ul style="list-style-type: none"> <li>Metal shavings in eyes</li> <li>Cochlear implants</li> <li>Implanted insulin pumps</li> <li>Vena cava filters (placed within last 6 weeks)</li> </ul>
--	--

[Radiology information page for MRI](#)

3. Select test to order and press the ORDER button below.

**...and advises a test**

<p><b>CT Brain</b></p> <ul style="list-style-type: none"> <li><input type="radio"/> With and Without I.V. Contrast</li> <li><input checked="" type="radio"/> Without Contrast Only</li> </ul>	<p><b>MRI Brain</b></p> <ul style="list-style-type: none"> <li><input type="radio"/> With and Without Contrast</li> <li><input type="radio"/> Without Contrast</li> <li><input type="radio"/> With and Without Contrast with MRA</li> <li><input type="radio"/> Without Contrast with MRA</li> </ul>
---	--

**NOTE:** If you do not choose to perform the recommended test, provide an explanation in this text box.

*(Maximum 35 characters)*

Additional clinical details or concerns to be reviewed by the Neuroradiologist. In addition, call Radiology to schedule Stat procedures.

*(Maximum 60 characters)*

# Problem – Head Imaging

- Clinicians get the most appropriate test first and can continue to manage patient
- Institution spends less on “duplicate testing” when correct test obtained first
- Department of Radiology reimbursed for interpreting the test.

# Regarding Decision Support

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

not having it,  
to confess your ignorance

*--Confucius. ~2500 years ago*

# Discussion

- Thank you