Dedication

This presentation is dedicated to the memory of Jean-Raoul Scherrer, MD, PhD, one of the greatest European informaticians of the last century, who passed away last month. He was the ultimate example of a gentleman and a scholar.

Jean-Raoul was in part responsible for the Vanderbilt WizOrder project, because he encouraged his student, Antoine Geissbuhler, MD, to train in Informatics with Vanderbilt faculty in the USA.

Antoine was the "father" of WizOrder at VUMC; he wrote over 90% the original WizOrder code while a Fellow and junior faculty member in Biomedical Informatics.
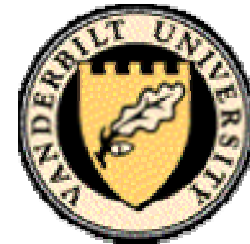
Antoine left VUMC in July, 1999 to assume Professor Scherrer's academic position as Director of the Informatics Program in Geneva, at the time of Jean-Raoul's retirement.

Two and one-half Millennia And Four Decades of Clinical Decision Support: From Standalone "Oracles" to "Assistance Integrated into Clinical Workflow"

Randolph A. Miller, MD '71 P '03

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Disclosure of (Non) Conflicts of Interest

Dr. Miller receives royalties from the University of Pittsburgh for his work there in authoring the Internist-I and Quick Medical Reference programs and knowledge bases for diagnostic decision support in Internal Medicine; donated to charity

Dr. Miller receives royalties through Vanderbilt University based on Vanderbilt's commercialization of the WizOrder clinician order entry system, which he helped to develop and support. The majority of income from WizOrder goes directly to Vanderbilt School of Medicine, per se.

Definition

Biomedical Informatics is the study of the generation, utilization, structure, transformation, and application of

data, information and knowledge

to basic biological research, clinical sciences, health care delivery, and health services research.

The first 2000 years of observations by earliest Biomedical Informaticians

ON THE NEED FOR DECISION SUPPORT:

1. Life is short, the art long, opportunity fleeting, *experience treacherous, judgment difficult*. Hippocrates. *Aphorisms,* ~460-400 BC

ALSO ON THE NEED FOR DECISION SUPPORT:

2. Men are men; the best sometimes forget. Shakespeare. *Othello,* 1604-5

ON THE NEED TO EVALUATE DECISION SUPPORT SYSTEMS:
(also interpreted as avoidance of medical informatics vaporware)

3. The proof of the pudding is in the eating.

Miguel de Cervantes. *Don Quixote*, 1605

Rationale for Clinical Decision Support:
More Recent Observations by Clinicians & Educators

1. Information in biomedical science is expanding exponentially (count/weigh pages in biomedical journals annually).

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

2. The half-life of biomedical information is approximately 5 years (repeat medical school after graduation recursively).

3. After completing residency training, a physician's knowledge of medicine tends to decline over time.

Ramsey PG, Carline JD, Inui TS, Larson, LoGerfo JP, Norcini JJ, Wenrich MD. **Changes over time in the knowledge base of practicing internists.** *JAMA*. 1991;266(8):1103-7.

Leigh TM, Young PR, Haley JV. **Performances of family practice diplomates on successive mandatory recertification examinations**. *Acad Med.* 1993;68(12):912-8.

Rationale for Clinical Decision Support:
More Recent Observations by Clinical Researchers

4. **Analyses of unmet clinical information needs, from academic centers to small clinics, indicate 0.12 to 5.2 unanswered questions occur per clinician half-day.**

Osheroff JA, Forsythe DE, Buchanan BG, Bankowitz RA, Blumenfeld BH, Miller RA. **Physicians' Information Needs: An Analysis of Questions Posed During Clinical Teaching in Internal Medicine**. *Ann Intern Med*. 1991(7); 114:576-581.

Gorman PN, Helfand M. **Information seeking in Primary Care: how physicians choose which clinical questions to pursue and which to leave unanswered**. *Med Decis Making*. 1995;15(2):113-9.

5. **The effect of unmet information needs on patient outcomes is unknown. Williamson surveyed primary care practitioners in the U.S. and found "…physicians face a serious problem in their effort to keep current with recent medical advances."**

Williamson JW, German PS, Weiss R, Skinner EA, Bowes F. **Health science information management and continuing education of physicians**. A survey of U.S. primary care practitioners and their opinion leaders. *Ann Intern Med*. 1989;110(2):151-60.

Rationale for Clinical Decision Support:
Recent Observations by Clinical Researchers

**Institute of Medicine,
National Academy of Sciences,
1999 Report: <u>To Err is Human</u>**

interpreted by lay press to imply:

**"doctors and nurses
incompetent, cause errors through**

lack of knowledge, kill ~100,000 anually"

Medical Diagnostic Decision Support Systems (MDDSS)

1. **MDDSS old as medical informatics as a discipline: 1950-present, > 3000 MDDSS articles in peer-reviewed medical literature**

2. **Majority of concepts and methods relevant to MDDSS described/anticipated prior to 1985**

3. **As an academic activity, development of MDDSS has been successful, as reflected by the literature**

4. **However, only MDDSS in widespread use are small, focused applications for EKG, ABG, PFT interpretation, despite attempts to create general applications**

Review of MDDSS Development: Current Understanding of Humans' 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**
   - **Refinement of hypotheses as more is learned**
   - **Early diagnostic hypothesis formation**
   - **Quasi-probabilistic reasoning using prevalence**
   - **Pathophysiological reasoning ("first principles") in unfamiliar settings**

3. **Experts reason more efficiently than novices:**
   - **Greater store of compiled knowledge, and array of strategic approaches**
   - **Awareness of diagnostic "weight of evidence" in hypothesis formation**

Early MDDS system development: 1954-1985
Ledley and Lusted, *Science*, 1959

Physicians have imperfect self-knowledge of their own
    diagnostic problem solving methods

Protocol analysis is an important tool for
    understanding diagnostic reasoning

Both logic (as embodied in set theory and Boolean algebra
    in computer systems) and probabilistic reasoning
    (as embodied in Bayes' rule on computers) are
    essential components of medical reasoning

Computers can assist in diagnosis

MDDSS using decision-analytic approach are possible

Early MDDS system development: 1954-1985

Systems using discriminating questions, models, and mathematical techniques:

1967+ Bleich and colleagues -- branching logic "20 questions" acid-base and electrolyte disorders

1970+ Statistical Clustering / Probabilistic Models: many

1970+ Semiquantitative & quantitative deterministic physiological & mathematical models: Guyton, Kuipers & others

1980+ Expert systems using pathophysiological models: ABEL

Early MDDS system development: 1954-1985

Work on Bayesian systems:

1960+ HR Warner & Colleagues, JAMA 1961 --
        Diagnosis of congenital heart diseases

1968+ Sequential diagnostic strategies
        by Gorry and Barnett

1970+ Abdominal pain program & UK clinical trials
        by de Dombal and colleagues

Early MDDS system development: 1954-1985

Early Heuristic MDSS employing criteria tables

      1956+ Lipkin, Hardy, Engle: HEME

      1966+ Lindberg et al: CONSIDER (CMIT)

      1979+ Blois et al: RECONSIDER (CMIT)

      1980+ Kulikowski & Weiss: EXPERT shell,
          AI/Rheum

Early MDDS system development: 1954-1985

Early Rule-based medical expert systems

      1969+ DENDRAL - Feigenbaum & Buchanan

      1974+ MYCIN - Shortliffe 1976

      1976+ SEEK-I and SEEK-2 - Politakis and Weiss

Early MDDS system development: 1954-1985

Early Heuristic MDDSS Utilizing Symbolic Reasoning ("AI")

Gorry 1968: General principles for expert system MDDSS

Formal definition of the diagnostic problem

Analysis of relationships among:

Generic inference function

(used to generate diagnoses from observed findings)

Generic test-selection function

(dynamically selects the best test to order)

Generic pattern-sorting function

(determines which diagnoses belong to a "problem area")

Difference between the information value, the economic cost, and the morbidity/mortality risk of performing tests

Cost of misdiagnosis of life-threatening or disabling disorders

Potential influence of "red-herring" findings described

"Multiple diagnosis" problem described

Early MDDS system development: 1954-1985

Descendants of Gorry's schemata: expert systems

1973+ PIP (the Present Illness Program) - Pauker, Gorry et al

1973+ INTERNIST-I developed by Myers, Pople, and Miller

1984+ QMR, developed by Miller, Masarie, and Myers

1986+ DXplain, developed by Barnett and colleagues

1986+ ILIAD, developed by Warner and colleagues

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

INTERNIST-I Project 1973-1985
Sample case analysis

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

1) "Greek Oracle" model of MDSS flawed

Quick Medical Reference (QMR) 1984-85 embodied change in philosophy in MDSS: abandoned "Greek Oracle" (INTERNIST-I) model for new "catalyst" model: build toolkits to address potential rate-limiting end-user problems

$$A \rightarrow B \rightarrow C \rightarrow \ldots L \rightarrow M \rightarrow \ldots Y \rightarrow Z$$

Goal is to improve performance of both the user and the MDSS over their native (unassisted) states

Unit of intervention for evaluation studies is man plus MDSS, not MDSS analyzing cases in isolation

INTERNIST-I Project 1973-1985

Lessons learned

2) 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).

INTERNIST-I Project 1973-1985
Lessons learned

3) "Feedback loop" of running system required to build and maintain high-quality KB –

Beware of KBs built by committees of experts sitting in armchairs

Giuse NB, Giuse DA, MILLER RA, Bankowitz RA, Janosky JE, Davidoff F, Hillner BE, Hripcsak G, Lincoln MJ, Middleton B, Peden JG. **Evaluating Consensus Among Physicians in Medical Knowledge Base Construction.** Meth Inform Med. 1993; 32:137-45.

Quick Medical Reference (QMR) : 1984-1994

R.A. Miller, M.D., F.E. Masarie, Jr., M.D., and J.D. Myers, M.D.

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
N.Guise MD & D.Guise DrIng: QMR-KAT
R.A. Miller, M.D., F.E. Masarie, Jr., M.D., and J.D. Myers, M.D.

Disease: PERINEPHRIC ABSCESS   Number: 3.10.6   Author: Randolph A. Miller, M.D.
Institution: University of Pittsburgh Reviewer: Jack D. Myers, M.D. Completed: 1/8/91.
Findings:
1 1   ABDOMEN TRAUMA RECENT HX
         [1]1   Mentioned as predisposing factor, p. 72
         [5]1   Mentioned as common antecedent, 1925-1940
         [7]2   Case report
         [9]2   Case reports of trauma leading to renoalimentary fistulae
         [13]2   Several cases due to trauma, 1920-1930
         [101]3 2/46 cases had flank trauma 1-2 weeks earlier
         [25]2   2/49 had history of trauma
         [30]2   67 cases, 1896-1902, in series of 230 reportedly due to trauma
         [62]1   Mentioned as cause 1910; cited as reason for male dominance of illness and age in
                             "years of greatest physical activity"
         [82]3   2 of 55 cases had recent trauma (1931)
         97]2   Motorcycle accident 11 days before admission in case report
[12]   Brust RW, Morgan AL
        Renocolic fistula secondary to carcinoma of the colon.
        J Urol 1974;111:439
[13]   Campbell MF
        Perinephric abscess.
        Surg Gynecol & Obstetrics 1930;51:674.
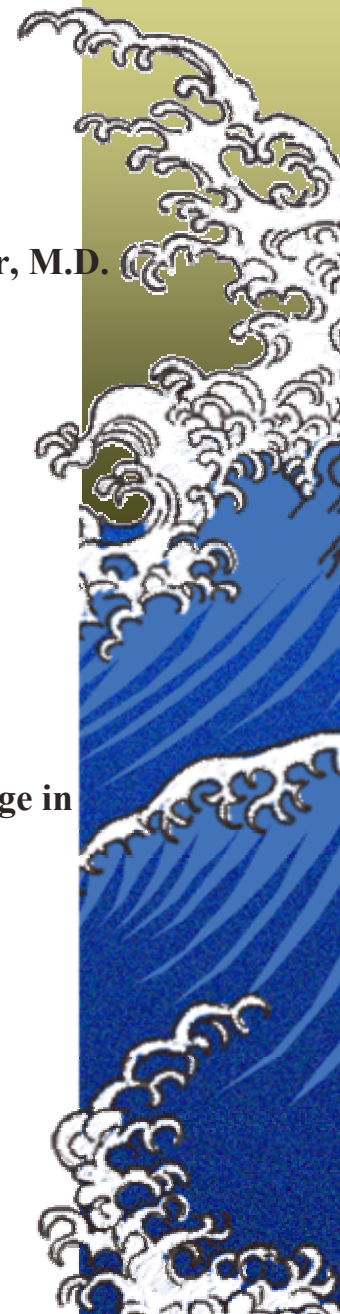
Quick Medical Reference (QMR) : 1984-1994

QMR Program

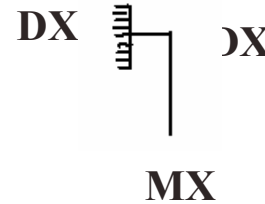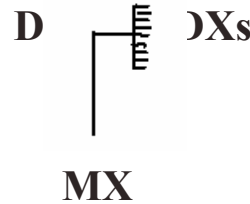QMR   View   Explore   Simulation   Case   Utilities   Window   Help

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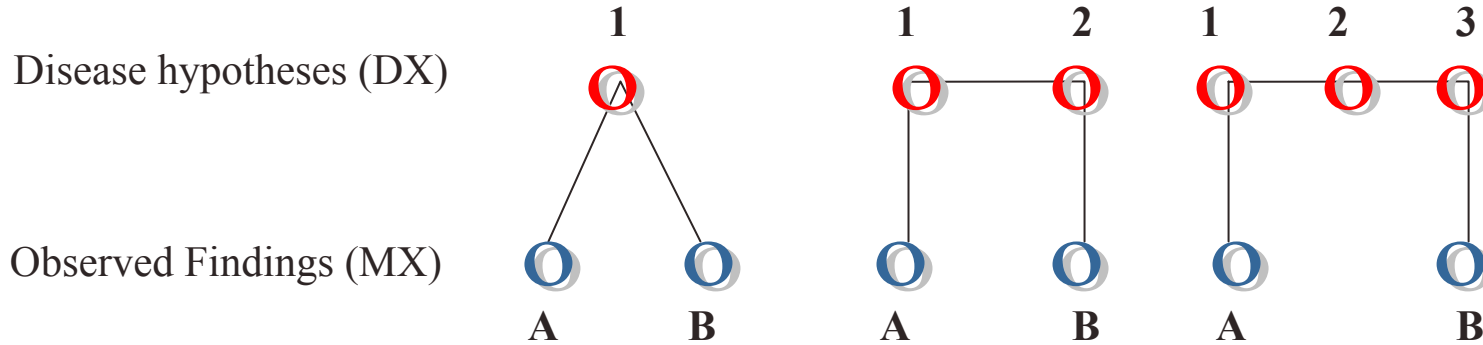
Contains 130 Hypotheses arranged by relative score (1-100)

EV	FR	
0	4	Fever and
2	2	Splenomegaly Moderate and
0	4	Heart Murmur Present and
1	4	Hemoglobin Blood Less Than 12

	SCORE	EV	FR
▶ Endocarditis Subacute Infective Left Heart	91		
Leukemia Acute Lymphoblastic	86		
Rheumatoid Arthritis	85		
Causes Anemia Of Chronic Disease		2	3
Endocarditis Acute Infective Left Heart	83		
Rheumatoid Arthritis	82		
is the Systemic Component of Feltys Syndrome		5	2
Causes Anemia Of Chronic Disease		1	4

Line   1 of 416

Focus-ENTER   Menu-ALT

Quick Medical Reference (QMR) : 1984-1994

Quick Medical Reference (QMR) : 1984-1994

Disease hypotheses (DX)

Observed Findings (MX)

	1		1	2	1	2	3
	O		O	O	O	O	O
	A	B	A	B	A		B
	O	O	O	O	O		O

DXs

DX   DXs   DX   DX

MX   MX   MX

Early Case Report:
The Imperfectability of Man

Shakespeare, W. *The Merchant of Venice.* 1597; Act I, Scene ii

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.

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

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."

Background: History of Integrated Clinical Decision Support

1. McDonald CJ, Wilson GA, McCabe GP Jr. **Physician response to computer reminders.** *JAMA* **1980** Oct 3;244(14):1579-81

"A computerized medical record system detected and reminded responsible clinicians about clinical events requiring possible corrective action. Reminders significantly increased the clinician response rate. **Addition of relevant medical literature citations to the reminders did not significantly increase the response rate, nor did it stimulate the physicians to read any of the cited articles kept in an immediately available "library" of reprints."**

2. Tierney WM, McDonald CJ, Martin DK, Rogers MP. **Computerized display of past test results.** Effect on outpatient testing. *Ann Intern Med* **1987** Oct;107(4):569-74

"The number of study tests ordered [by academic primary care group] decreased significantly for intervention patients (16.8%) and for controls (10.9%). **Presenting physicians with previous test results reduced the ordering of those tests."**

Background: History of Integrated Clinical Decision Support

3. Tierney WM, Miller ME, McDonald CJ. **The effect on test ordering of informing physicians of the charges for outpatient diagnostic tests.** *N Engl J Med* 1990 322:1499-1503.

"Effect of informing physicians of the charges for outpatient diagnostic tests on their ordering of such tests in an academic primary care medical practice studied. **During 26-week intervention period, the physicians in the intervention group ordered 14 percent fewer tests per patient visit than did those in the control group (P less than 0.005), and the charges for tests were 13 percent ($6.68 per visit) lower (P less than 0.05)."**

4. Evans RS, Larsen RA, Burke JP, Gardner RM, et al. **Computer surveillance of hospital-acquired infections and antibiotic use.** *JAMA* 1986 256(8):1007-11

"Computerized infectious disease monitor automatically generates surveillance "alerts" for patients with hospital-acquired infections, not receiving antibiotics to which their pathogens are susceptible, who could be receiving less expensive antibiotics, or who are receiving prophylactic antibiotics too long. Over 2 months, surveillance personnel using system found more hospital-acquired infections, while requiring only 35% of the time. Alerts identified 37 patients not receiving appropriate antibiotics, 31 patients who could have been receiving less expensive antibiotics, and 142 patients, during one month, receiving prolonged cephalosporin prophylaxis. **Computer screening can help focus the activities and improve the efficiency of hospital surveillance personnel**.

Background: History of Integrated Clinical Decision Support

5. Classen DC, Evans RS, Pestotnik SL, et al. **The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection.**
N Engl J Med **1992** Jan 30;326(5):281-6

"We prospectively monitored the timing of antibiotic prophylaxis and studied the occurrence of surgical-wound infections in 2847 patients undergoing elective clean or "clean-contaminated" surgical procedures at a large community hospital.

Of the 1708 patients who received the prophylactic antibiotics preoperatively, 10 (0.6 percent) subsequently had surgical-wound infections. Of the 282 patients who received the antibiotics perioperatively, 4 (1.4 percent) had such infections (P = 0.12; relative risk as compared with the preoperatively treated group, 2.4; 95 percent confidence interval, 0.9 to 7.9). Of 488 patients who received the antibiotics postoperatively, 16 (3.3 percent) had wound infections (P less than 0.0001; relative risk, 5.8; 95 percent confidence interval, 2.6 to 12.3).

We conclude that in surgical practice there is considerable variation in the timing of prophylactic administration of antibiotics and that [computer-prompted] administration in the two hours before surgery reduces the risk of wound infection."

Background: History of
Integrated Clinical Decision Support

6. Bates DW, Kuperman GJ, Teich JM, et al. **A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests.** *Am J Med.* **1999** 106:144-148

'We performed a prospective randomized controlled trial that included all inpatients at a large teaching hospital during a 15-week period. The **intervention consisted of computerized reminders at the time a test was ordered** that appeared to be redundant. Main outcome measures were the proportions of clinical laboratory orders that were canceled and the proportion of the tests that were actually performed. During the study period, there were 939 apparently redundant laboratory tests among the 77,609 study tests that were ordered among the intervention (n = 5,700 patients) and control (n = 5,886 patients) groups. In the intervention group, 69% (300 of 437) of tests were canceled in response to reminders. Of 137 overrides, 41% appeared to be justified based on chart review. **In the control group, 51% of ordered redundant tests were performed, whereas in the intervention group only 27% of ordered redundant tests were performed (P <0.001). However, the estimated annual savings in laboratory charges was only $35,000**.

7. Bates DW. Using information technology to reduce rates of medication errors in hospitals. *BMJ.* **2000** Mar 18;320(7237):788-91.

"Computerised physician order entry and computerised physician decision support ... have been found to improve drug safety

Other innovations, including using robots to fill prescriptions, bar coding, automated dispensing devices, and computerisation of the medication administration record, though less studied, should all eventually reduce error rates"

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 625 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 components include:

-- **"Intelligent, Heads-up Display" Approach to Patient Care:**
   What clinicians need to know when they need to know it

-- **Electronic record sensitive to patients' specific information**

-- **Medication prescription with safeguards**

-- **Flexible tools to present & activate guidelines**

-- **Implementation of "Best of Care" clinical pathways**

-- **Respect for individual physicians' preferences**

-- **Hooks to web-based 'just-in-time' educational resources**

-- **Linkage of patient cases to literature-based evidence**

-- **Ability to implement cost-savings precisely & humanely**
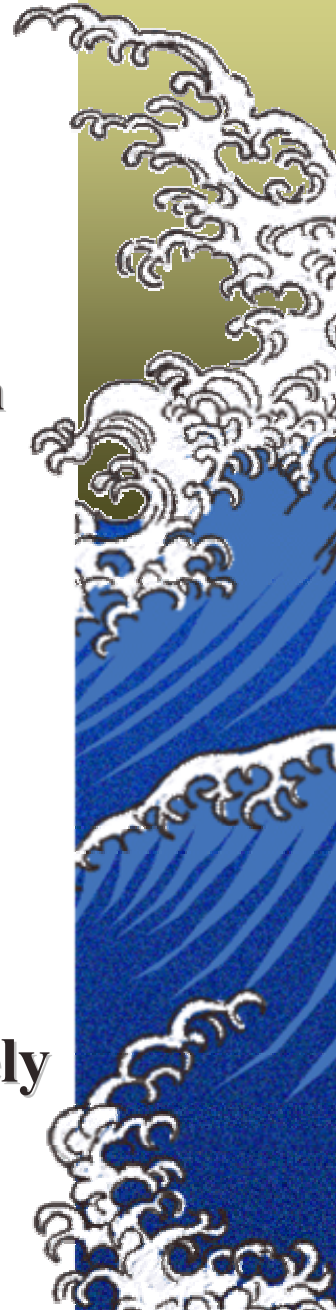
WizOrder — □ ×

ADC VAAN DISML display

Admission

Diagnosis
  bubonic plague (020.0) »Jun 5 14:00...

Condition

Vital signs

Activity/limitations

Allergies

Nursing instructions

Diet

Medications
=Scheduled medications
  captopril: capoten 6.25 mg po q12h alt "test1 " »Jul 19 18:00...

IV fluids

TPN orders

Laboratory tests

Radiographic studies

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

Select an item from the list

or enter another order
or click here for the schedule of meetings and the latest update on fixes and improvements in WizOrder

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gen 80 iv q8h

User types "gen 80 iv q8h"

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

8006X ZTESTCYCLE, Gwendolyn 3006850-6 34y/o F (TRAINIO)

ADC VAAN DISML display

Admission

Diagnosis
  bubonic plague (020.0) »Jun 5 14:00...

Condition

Vital signs

Activity/limitations

Allergies

Nursing instructions

Diet

Medications
=Scheduled medications
  captopril: capoten 6.25 mg po q12h alt "test1 " »Jul 19 18:00...

IV fluids

TPN orders

Laboratory tests

Radiographic studies

1. gentamicin injection: garamycin 80 mg iv q8h

...or maybe...

2. gentamicin ophthalmic oint: q8h
3. gentamicin ophthalmic soln: q8h
4. gentamicin 0.1% topical soln (VUH SPECIAL PREPARATION) apply
5. gentamicin fortified eye drop: (VUH SPECIAL PREPARATION) q8h
6. hypertension svc admission orders »
7. gentamicin peak & trough levels »
8. General Medicine (Scoville or Morgan) attending MD contact info
9. cyclosporine oral (Sandimmune, Neoral, Gengraf, Generic CYA)
10. general other ED labs (ED) »
11. generic chemotherapy »

Completer gives good matches

Select an item from the list

or enter another order
or press **END** to return to the previous list

Copyright (C) 2001 Vanderbilt University Medical Center

GenRx

WizRx

$0.00

literature

QMR

antibiotics

alerts

1

User selects first item from above pick list

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

8006X ZTESTCYCLE, Gwendolyn 3006850-6 34y/o F (TRAINIO)

ADC VAAN DISML display

Admission

Diagnosis
  bubonic plague (020.0) »Jun 5 14:00...

Condition

Vital signs

Activity/limitations

Allergies

Nursing instructions

Diet

Medications
=Scheduled medications
  captopril: capoten 6.25 mg po q12h alt "test1 " »Jul 19 18:00...

IV fluids

TPN orders

Laboratory tests

Radiographic studies

GENTAMICIN INJ: GARAMYCIN
Estimated CrCl=112 ml/min based on Creat=0.8 on Jan 17 02:30
Information: recommended dose for single daily iv dosing: 4-7 mg/kg/24l

a) Dose: 80 MG
b) Route: IV
c) How often: Q8H

Completer shows part of order "understood", asks for more below (also recent labs above)

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

GenRx

WizRx

1 NEXT SCH (default) (next schedule)
2 NOW

$0.00

or enter a start date, time and priority
or press **ENTER** = NEXT SCH

literature

QMR

antibiotics

alerts

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

B___, A____ /ALLEN

ADC VAAN DISML display

Pharmacy alerts ♦ (click on alerts for more information)
 Zosyn no longer available-click here for information
 Amiodarone may enhance pharmacologic effects of hydantoi

Admission
 admit to micu ►Apr 15 01:00...
 admit to service: rec
 attending: snapper x
 initiate collaborativ
 initiate level of care

Diagnosis
 diagnosis: heart fail
 patient specific data

Condition
 condition: guarded

Vital signs
 measure weight qam
 vital signs q2h ►Ap

Activity/limitations
 activity-bedrest ►A

Allergies
 no known allergies ►Apr 15 01:00...

Nursing instructions
 catheter drng-measure & record per unit save
  - to gravity drainage ►Apr 15 01:00...

GENTAMICIN INJ: GARAMYCIN
Estimated CrCl=21 ml/min based on Creat=1.8 on Apr 25 06:00
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): NEXT SCH
e) For how long: UNTIL D/C

Currently ordered medication

═══════════════════ Warning ═══════════════════

Dose: 80 mg q12h
Dosing weight: 53.5 kg
Creatinine clearance: 21.76 ml/min
Estimated steady-state levels:
    peak: 10.9 ug/ml
    trough: 5.6 ug/ml

Trough level too high!

Suggested dose: 80 mg q24h
    peak: 7.4 ug/ml
    trough: 1.8 ug/ml

Click <OK> or press <ENTER> to continue.

[OK]

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).

| Print | Change display F2 | D/C | C/S | Order sets F4 | ♥ | ☺ops F5 | Help F6 | Another patient F7 | Print orders F8 |

WizOrder: Pharmacy warning about potential drug interaction

WizOrder

8021X ZTESTPAC, Reagon 1498664-0 33y/o M (TRAINIO)

ADC VAAN DISML display

Admission
○ "protocol: gvhd (csa and mtx)"
○ day 0 for bmt: 3/5/99 6:00
○ weight: 54.885kg/121lb; height: 152cm/60.0in; ibw: 50.0kg/110.2lb; bsa: 1.51m2;

Allergi

Nursing

Diet

Medica
=Antibi
  cefazo
○ genta
=Sched
  nicard
=PRN
  acetai

IV fluid
  d5 1/2

Labora

Radiographic studies

Miscellaneous orders

Bells and whistles »

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

Pharmacy warning for CYCLOSPORINE INJ: SANDIMMUNE:

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

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

WizOrder Popup

Aminoglycosides may potentiate cyclosporine nephrotoxicity

Aminoglycoside antibiotics, when used in combination with cyclosporine a 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) 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

Start | Microsoft Pow... | Wizorder Dae... | wizscr07.bmp - ... | WizOrder   1:54 PM

ADC VAAN DISML display

Pharmacy alerts ♦ (click on alerts for more information)
 Zosyn no longer available-click here for information
 Amiodarone may enhance pharmacologic effects of hydantoir

Admission
 admit to micu ►Apr 15 01:00...
 admit to service: red ►Apr 15 01:00...
 attending: snapper xxxx ►Apr 15 01:00...
 initiate collaborative path phase 1 ►Apr 15 08:00...
 initiate level of care: level 1 ►Apr 15 01:00...

Diagnosis
 diagnosis: heart failure, congestive (428.0) ►Apr 15 01:00...
 patient specific data weight: 53.5kg/117.9lb; height: 154cm/6

Condition
 condition: guarded ►Apr 15 01:00...

Vital signs
 measure weight qam 05 ►Apr 15 05:00...
 vital signs q2h ►Apr 15 00:57...

Activity/limitations
 activity-bedrest ►Apr 15 01:00...

Allergies
 no known allergies ►Apr 15 01:00...

Nursing instructions
 catheter drng-measure & record per unit save
  - to gravity drainage ►Apr 15 01:00...

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intra abdominal infection

1. Repeat questionnaire

☻ No severe beta-lactam allergy
☻ Not able to take oral treatment
☻ High renal risk

2. $$$$$ Cefotetan 1q12 IV ►
3. $$$$$$ Unasyn 1.5q6 IV ►
4. $$$$$$$$ Cefotetan 2q12 IV ►
5. $$$$$$$$$ Pip 3q6 IV + Flagyl 500q8 IV ►
6. $$$$$$$$$$$ Unasyn 3q6 IV ►
7. $$$$$$$$$$$$ Flagyl 500q8 IV + Oflox 400q12 IV ►
8. $$$$$$$$$$$$ Flagyl 500q8 IV + Aztreonam 1q8 IV ►
9. $$$$$$$$$$$$$ Clinda 900q8 IV + Oflox 400q12 IV ►
10. $$$$$$$$$$$$$ Clinda 900q8 IV + Aztreonam 1q8 IV ►
11. ¢¢¢¢¢¢¢¢¢¢¢¢ Iminanam 500a8 IV ►

Select an item from the list

or enter another order
or press <END> to return to the previous list

MD requests advice for empirical treatment of intra-abdominal abscess (before culture&sensitivity results known)

WizOrder queries user about patient, then suggests cost-effective alternatives based on Infectious Disease experts' approach. User selects best one for patient & orders.

Print | Change display F2 | D/C | C/S | Order sets F4 | ♥ | ☺ops F5 | Help F6 | Another patient F7 | Print orders F8

WizOrder Popup

IV heparin for Confirmed PE in Adults

Guidelines for the treatment of Confirmed PE are listed below with calculated values in RED based on the patient's weight (77 kg

- Bolus with heparin 80 U/kg I.V. [CONTRAINDICATIONS | LMW HEPARIN]
- Begin maintenance infusuion of heparin at 18 U/kg/hr [CONTRAINDICATIONS | LMW HEPARIN]
- check PTT at 6 hour intervals to keep PTT in range of 65 to 110 seconds
- check platelet count daily [INFO ON HEPARIN INDUCED THROMBOCYTOPENIA]
- start warfarin therapy on day 1 at 5 mg and adjust to give INR of 2-3 [CONTRAINDICATIONS]
- stop heparin therapy after at least 4-5 days of combined therapy when INR is > 2.0 for 2 consecutive days
- continue warfarin treatment for at least 3 months at INR of

2) Links to educational materials available in protocol

3) MD reviews relevant medications & labs

Orders you may wish to consider (check to order) - Order only necessary items (duplicate order checking not done on this page).

☐ Bolus/rebolus with I.V. heparin (U) 6200   (80 x 77 = 6200 IU)

☐ Begin continuous infusion of I.V. heparin (U/hr) 1390   (18 x 77 = 1390 IU/hr)

☐ Check PTT q6 (starting 6 hours after bolus)

☐ Check platelet count qAM

☐ Begin warfarin p.o. at (mg/day) 5   on (mm/dd/yy) 04/12/00

☐ check PT/INR qAM

I am not doing some/all suggestions above because:

Current Date and Time: 04/12/2000 09:10 AM		
Anticoag Meds	Dose	Date
No Anticoagulant Meds		
Labs	Value	Date
PTT	None available	
INR	None available	
Platelet Count	None available	
PCV	None available	

[Order the selected items] [Clear selections] [Cancel]

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4) MD selects actions and clicks buttion to activate guideline-related orders

"New" Teaching rounds:

Participants all have summarization "active" orders & current information

Rounds focus on diagnosis & management, not on details

Active orders

Recent Labs
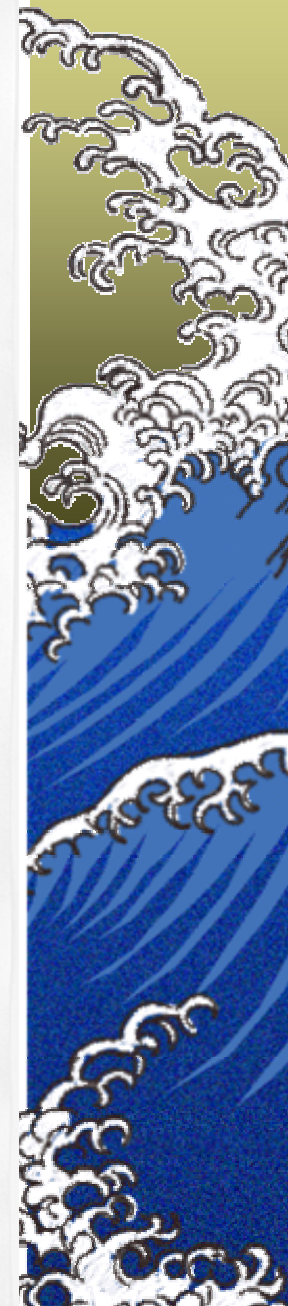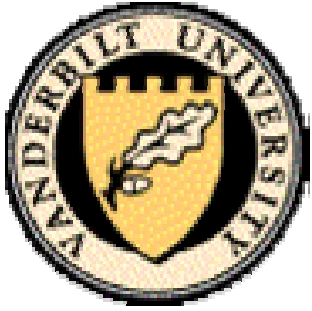
The PC-POETS Study:
Integrating
Patient Care-Provider
Order Entry with Tactical Support

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: Evaluation - Methods

House staff teams: 1 resident (PGY 2 or 3) plus 1 or 2 interns (PGY 1); 1-3 teams per ward (Medicine only) – assigned to study wards

Study period: April 1999 through March 2000

House staff rotations determined monthly by Medicine Chief Resident, then processed by statisticians to assure each teams' members either all control or all intervention
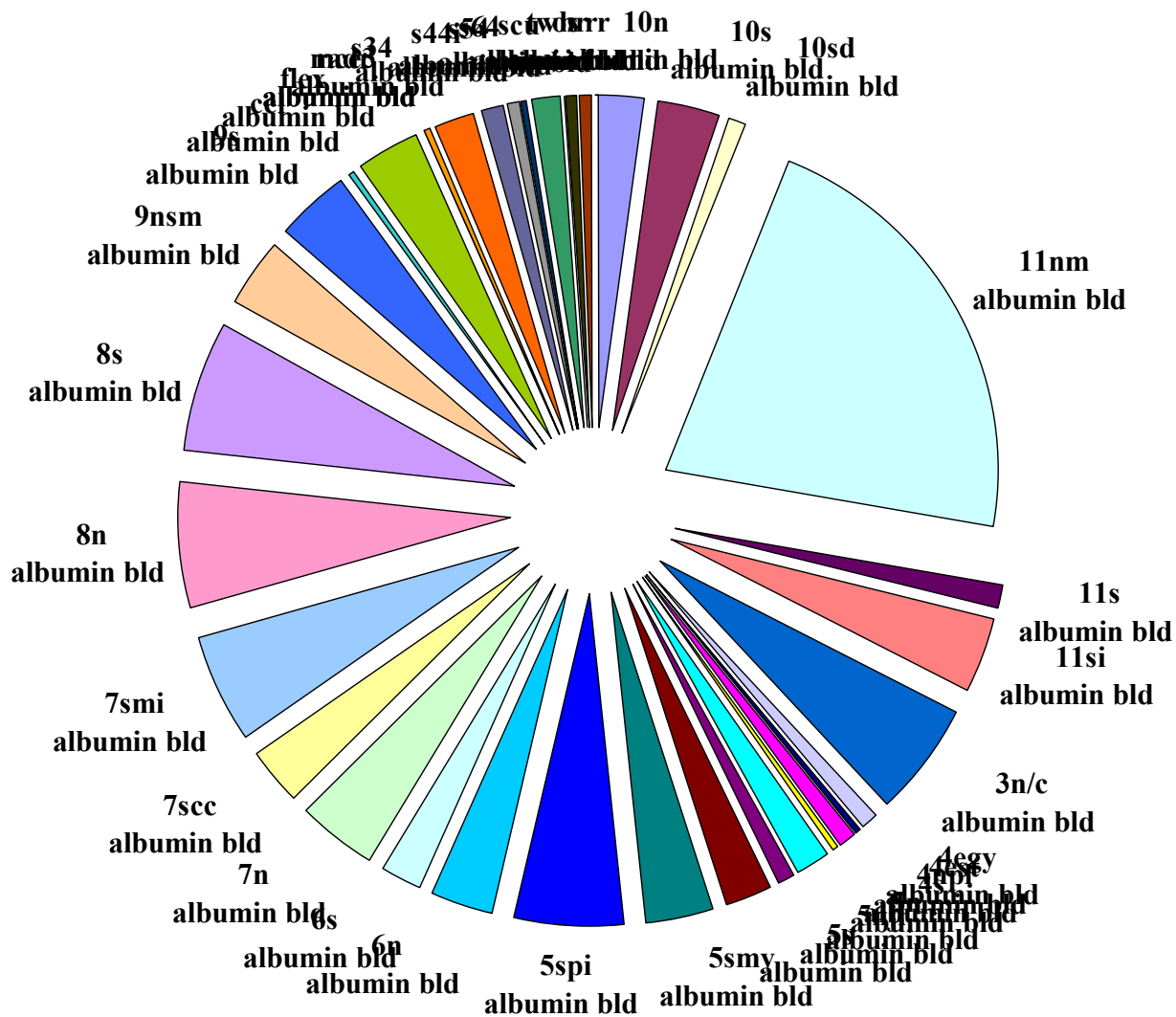
All MDs in "Control" status during July-August 1999

Switch from control to intervention in later rotations OK, but going from intervention to control forbidden; except, all statuses reset after "washout" (July/August) at year boundary
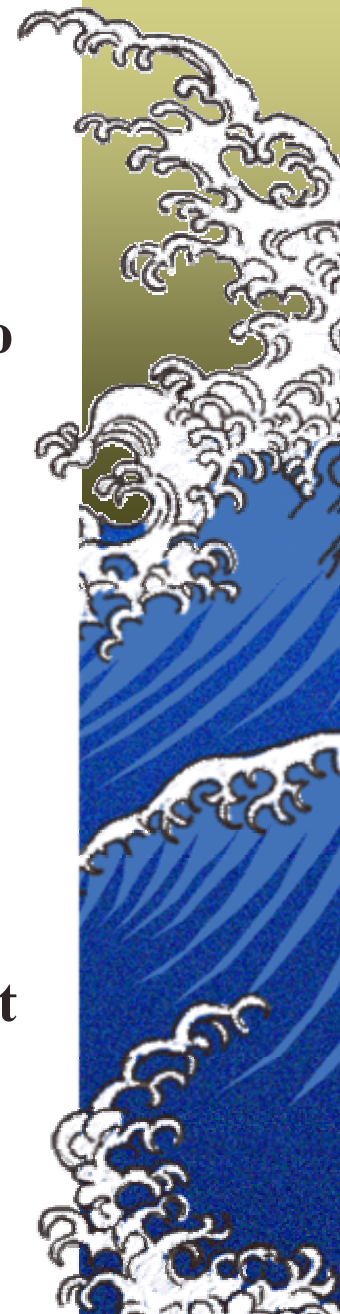
Problem: Follow-up, test ordering patterns

WizOrder Popup

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
○ 500 mg IV q12h	Uncomplicated urinary tract infection
○ 1000 mg IV q12h	Nosocomial pneumonia in ICU patient
○ 1000 mg IV q8h	Empiric coverage of febrile neutropenic patient
○ 2000 mg IV q8h	**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 <u>monotherapy</u> 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.

Other

Intramuscular	○ order I.M. Cefepime (with Lidocaine)
Non-standard Dose	○ 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

Sort by beds

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