

Research as a driving force for QI and broad implementation

Patrick S. Romano, MD MPH

Professor of Medicine and Pediatrics

UC Davis School of Medicine

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Quality Improvement and Implementation

Outline

- Two illustrative examples
 - Computerized physician order entry
 - Time to first dose of antibiotics for pneumonia
- Lessons learned for QI research
- Threats to validity
- Methods to minimize threats
- Infrastructure needs
- Financial needs (linked to infrastructure)

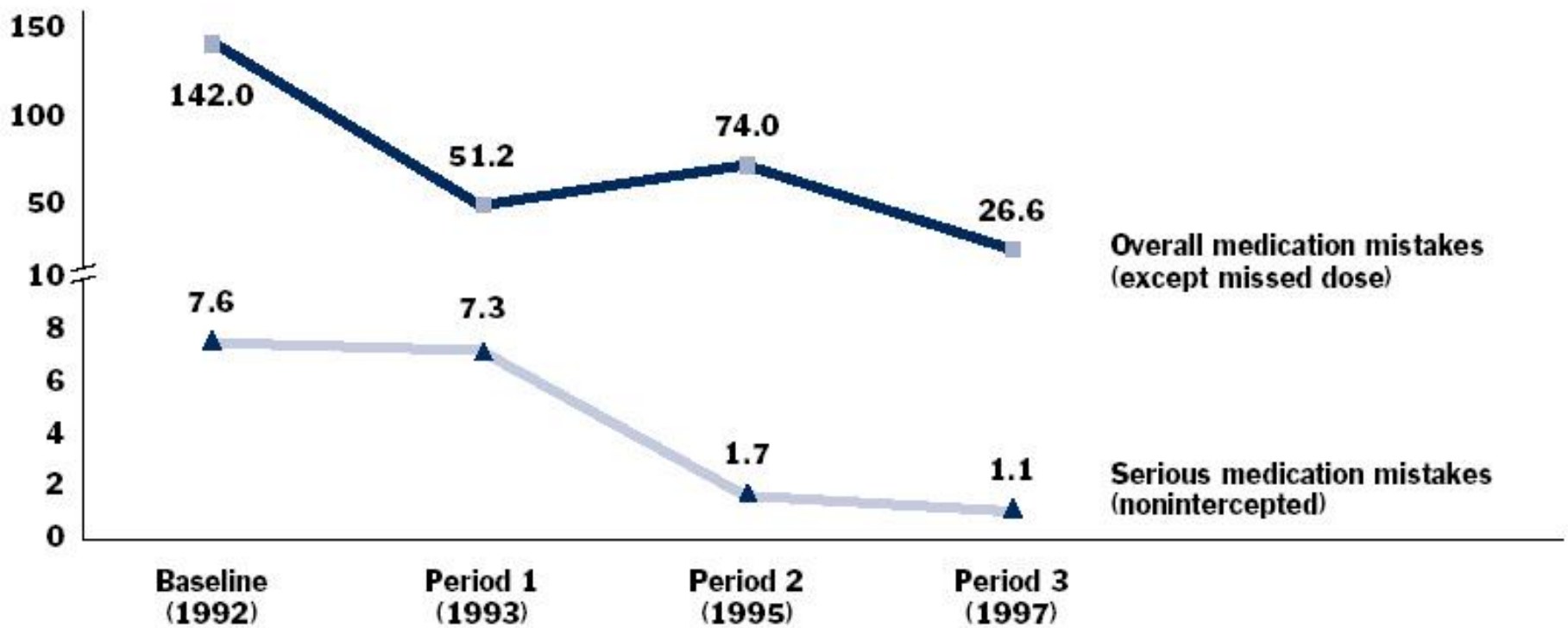


Chart 6-8

Preventing Medication Mistakes

Over 80 percent of medication mistakes (other than missed doses) were prevented by a computerized physician order entry system once it was fully developed at a teaching hospital. Medication mistakes that caused patient injury or had the potential to cause injury (and were not intercepted before reaching the patient) were reduced by 86 percent.

Rate per 1,000 patient-days



Source: Adapted with permission from Bates et al. 1999.

Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors

Ross Koppel, PhD; Joshua P. Metlay, MD, PhD; Abigail Cohen, PhD; Brian Abaluck, BS; A. Russell Localio, JD, MPH, MS; Stephen E. Kimmel, MD, MSCE; Brian L. Strom, MD, MPH

JAMA. 2005;293:1197-1203.

ABSTRACT

Context Hospital computerized physician order entry (CPOE) systems are widely regarded as the technical solution to medication ordering errors, the largest identified source of preventable hospital medical error. Published studies report that CPOE reduces medication errors up to 81%. Few researchers, however, have focused on the existence or types of medication errors facilitated by CPOE.

Objective To identify and quantify the role of CPOE in facilitating prescription error risks.

Design, Setting, and Participants We performed a qualitative and quantitative study of house staff interaction with a CPOE system at a tertiary-care teaching hospital (2002-2004). We surveyed house staff (N = 261; 88% of CPOE users); conducted 5 focus groups and 32 intensive one-on-one interviews with house staff, information technology leaders, pharmacy leaders, attending physicians, and nurses; shadowed house staff and nurses; and observed them using CPOE. Participants included house staff, nurses, and hospital leaders.

Main Outcome Measure Examples of medication errors caused or exacerbated by the CPOE system.

Results We found that a widely used CPOE system facilitated 22 types of medication error risks. Examples include fragmented CPOE displays that prevent a coherent view of patients' medications, pharmacy inventory displays mistaken for dosage guidelines, ignored antibiotic renewal notices placed on paper charts rather than in the CPOE system, separation of functions that facilitate double dosing and incompatible orders, and inflexible ordering formats generating wrong orders. Three quarters of the house staff reported observing each of these error risks, indicating that

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1: [J Am Med Inform Assoc.](#) 2004 Mar-Apr;11(2):104-12. Epub 2003 Nov 21.

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Some unintended consequences of information technology in health care: the nature of patient care information system-related errors.

[Ash JS](#), [Berg M](#), [Coiera E](#).

Department of Medical Informatics and Clinical Epidemiology, School of Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Portland, OR 97201-3098, USA. ash@ohsu.edu

Medical error reduction is an international issue, as is the implementation of patient care information systems (PCISs) as a potential means to achieving it. As researchers conducting separate studies in the United States, The Netherlands, and Australia, using similar qualitative methods to investigate implementing PCISs, the authors have encountered many instances in which PCIS applications seem to foster errors rather than reduce their likelihood. The authors describe the kinds of silent errors they have witnessed and, from their different social science perspectives (information science, sociology, and cognitive science), they interpret the nature of these errors. The errors fall into two main categories: those in the process of entering and retrieving information, and those in the communication and coordination process that the PCIS is supposed to support. The authors believe that with a heightened awareness of these issues, informaticians can educate, design systems, implement, and conduct research in such a way that they might be able to avoid the unintended consequences of these subtle silent errors.

PMID: 14633936 [PubMed - indexed for MEDLINE]

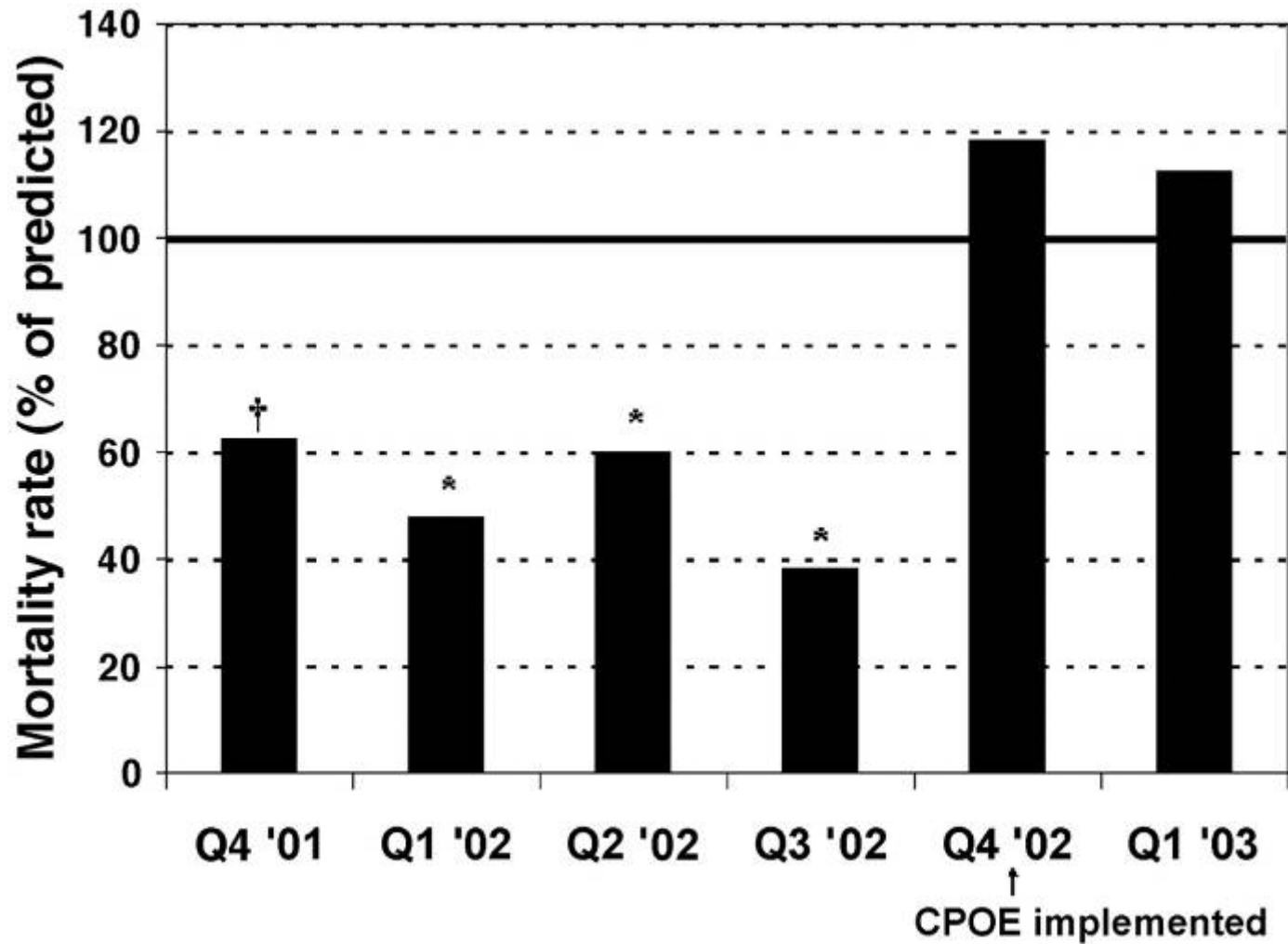
Example error types (N=22)

- Entering order for wrong patient due to interruption or display problems
- Delays in orders when patients not yet entered into system, CPOE crashes
- Incorrect default dosing or protocol
- Overloading users with alerts and reminders for completeness, leading to ignoring or overriding
- Medications discontinued without clinicians being aware (after surgery, antibiotics)

Koppel et al. Role of CPOE in facilitating medication errors. *JAMA* 2005

Ash J et al. Unintended Consequences of IT in Health Care *J Am Med Inform Assoc* 2004

Fig 1. Observed mortality rates (presented as a normalized % of predicted mortality) during the 18-month study period are plotted according to quarter of year



Han, Y. Y. et al. *Pediatrics* 2005;116:1506-1512

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What went wrong?

- “Order entry was not allowed until after the patient had physically arrived to the hospital and been fully registered into the system...”
- “The physical process of entering stabilization orders often required an average of ten "clicks" on the computer mouse per order... 1 to 2 minutes per single order...”
- “Because the vast majority of computer terminals were linked to the hospital computer system via wireless signal, communication bandwidth was often exceeded during peak operational periods...”
- “...while 1 physician continued to direct medical management, a second physician was often needed solely to enter orders into the computer during the first 15 minutes to 1 hour...”
- “...bedside nurses were no longer allowed to grab critical medications... because as part of CPOE implementation, all medications... became centrally located within the pharmacy.”
- “...because pharmacy could not process medication orders until they had been activated, ICU nurses also spent significant amounts of time at a separate computer terminal and away from the bedside...”
- “...because order entry and activation occurred through a computer interface, often separated by several bed spaces... the opportunities for face-to-face physician–nurse communication were diminished.”

Search Results: **City:** Sacramento **State:** CA

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* This hospital has submitted data to the Leapfrog Hospital Rewards Program™. [Click for more information.](#)

Time to first antibiotic dose <4 hours for community-acquired pneumonia

- Two “seminal” studies of Medicare patients showed associations between TFAD and death
 - Meehan et al. (1997) studied 14,069 CAP patients aged ≥ 65 years, reported 15%↓ in 30-day mortality with TFAD ≤ 8 hrs
 - Houck et al. (2004) studied 18,209 CAP patients aged ≥ 65 years, reported 15%↓ in 30-day mortality with TFAD ≤ 8 hrs (but no ↓ among those with prior antibiotic treatment, and 16%↓ for TFAD ≤ 6 hrs)
- Smaller studies (including one involving 38 UHC hospitals) showed no association with mortality, but significant associations with adjusted LOS

Recent concerns/problems with TFAD

- Final ED dx may not be CAP in 20% of patients (especially without abnormal CXR)
- 22% of patients may have “appropriate” delays due to atypical presentations and diagnostic uncertainty
- Factors beyond hospital control may influence adherence (e.g., number of ED registrants)
- In one 608-bed teaching hospital from 2003 to 2005:
 - CAP with normal CXR findings increased from 21% to 29% ($p=0.04$); CAP with “clear infiltrate” dropped from 55% to 41% ($p=0.002$)
 - Patients receiving antibiotics within 4 hours of triage increased from 54% to 66% ($p=0.007$)
 - Final dx of CAP among pts with admit dx of CAP decreased from 76% to 59% ($p<0.001$); non-infectious dx increased from 16% to 30%

Lessons learned for QI research

- QI interventions are heterogeneous
 - CPOE systems are not all the same (user interfaces and capabilities differ)
 - Proprietary systems have many different modules, potential functionalities (order sets)
- Implementation and context matter
- Don't be seduced prematurely by surrogate markers
- Look for unintended consequences

Threats to validity in QI research

■ Internal validity

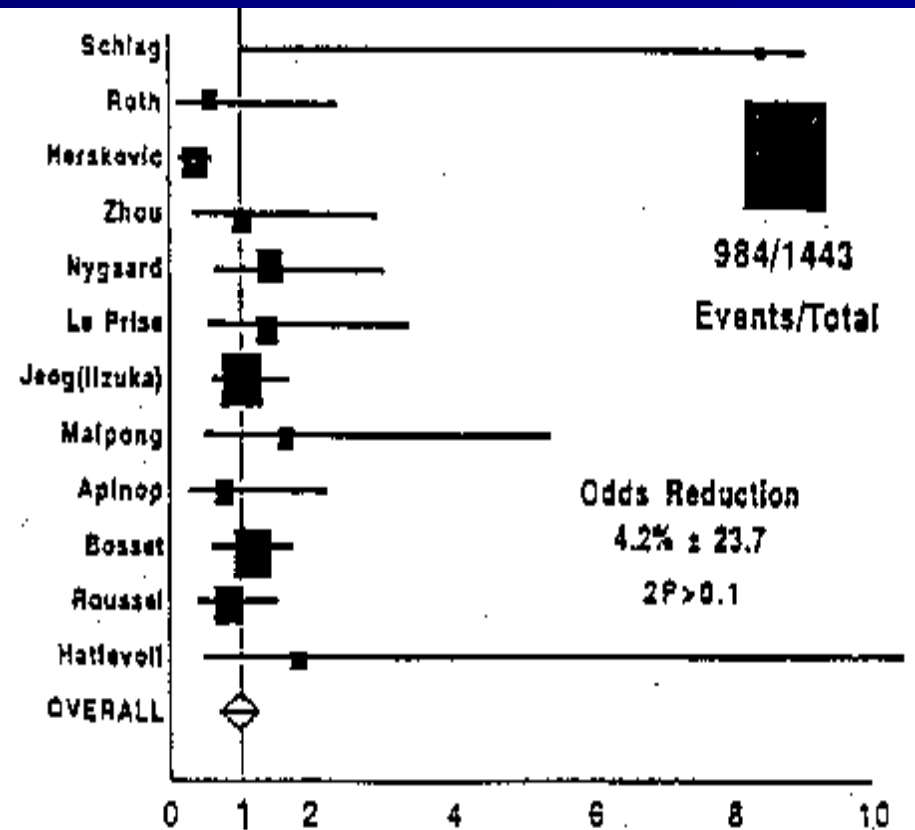
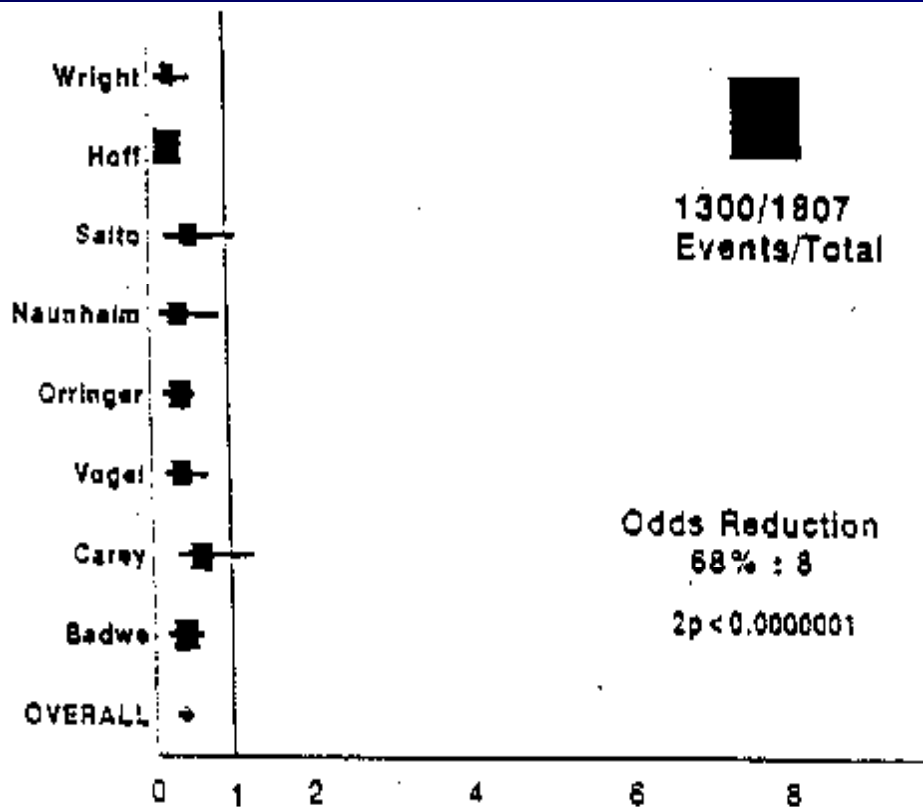
- Confounding bias
- Ascertainment/information bias
- Selection/attrition bias

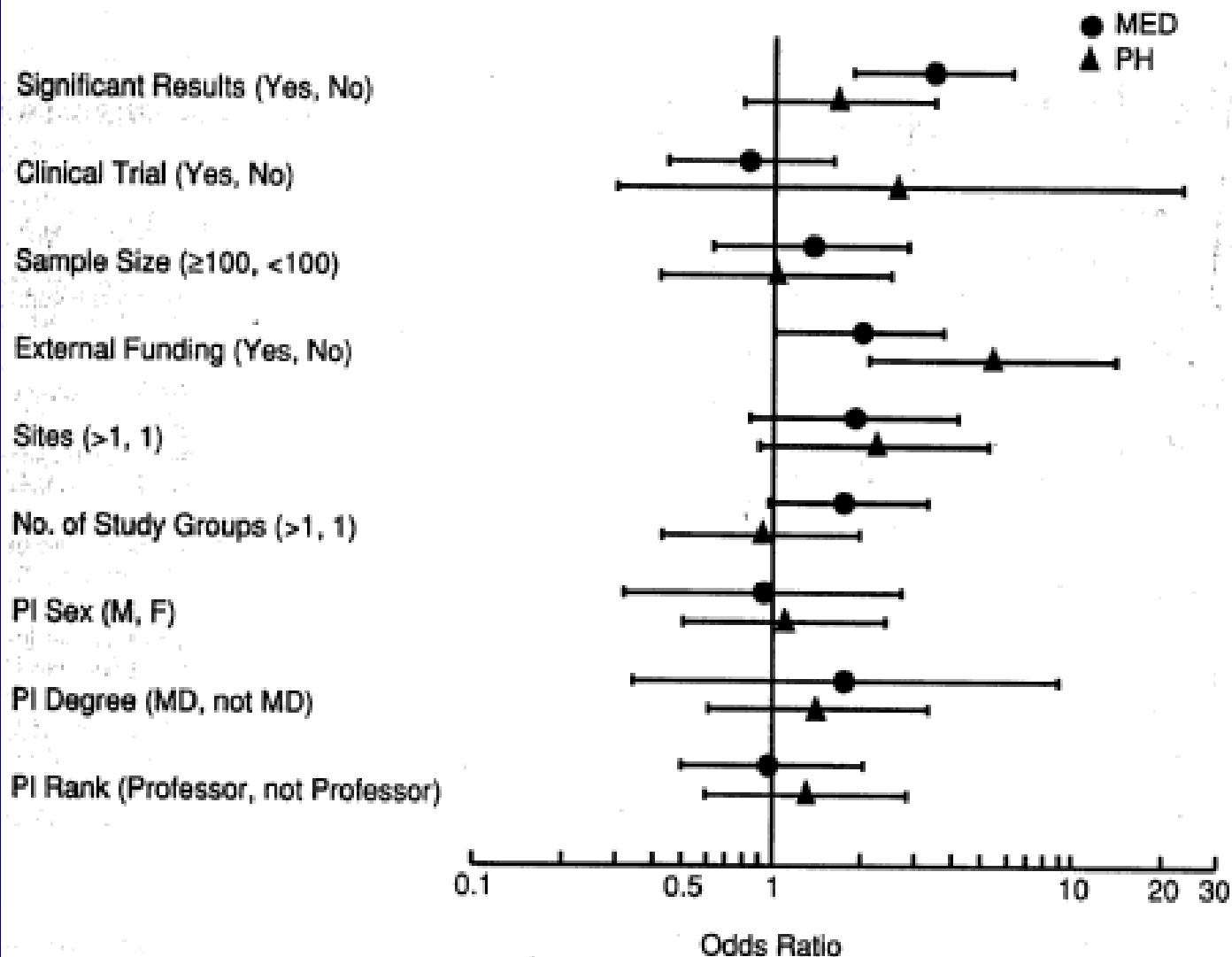
■ External validity

- Generalizability to other regions, other settings of care, other facilities, other demographic or clinical groups
- Related to publication bias

Meta-analysis of historical control studies for cisplatin based chemotherapy in esophageal carcinoma

Meta-analysis of RCTs for cisplatin based chemotherapy in esophageal carcinoma





Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for the association between selected characteristics and publication (ORs and CIs were obtained by using multiple logistic regression separately for each institutional review board [IRB]). See "Methods" section of text for explanation of MED and PH; PI indicates principal investigator. Final models using backward stepwise regression, with P indicating publication proportion, were for MED: $\text{logit } P = 0.3001 + 1.1473 (\text{significant results}) + 0.8336 (\text{external funding})$; for PH: $\text{logit } P = -0.9651 + 1.9815 (\text{external funding})$; and for combined: $\text{logit } P = -0.9889 + 1.0576 (\text{IRB}) + 0.9301 (\text{significant results}) + 0.7464 (\text{No. of sites}) + 1.0864 (\text{external funding})$.

Minimizing confounding

- Experimental designs with random allocation
 - Cluster randomization
- Quasi-experimental designs
 - Pre-post design with concurrent control group(s): “difference in differences”
 - Multiple pre and post observations: interrupted time series

Minimizing other biases

- Blinded and/or unobtrusive ascertainment of “soft” outcomes
 - Errors, potential ADEs
- Measure process of QI program implementation
 - What really happened?
 - How and why did it happen?
- Measure short-term outcomes, but keep watching for long-term outcomes
 - Don't declare victory (or give up) too fast

Improving generalizability

- Involve multiple institutions – ideally different regions, different types
 - Practice-based research networks
 - Multi-hospital systems/networks (Premier)
- Careful identification of targeted groups (inclusion and exclusion criteria)
- Data systems that allow ongoing evaluation of the impact of QI interventions
 - Clinical disease/procedure registries
 - Error reporting systems
 - Administrative data (AHRQ QIs)

What's needed: Infrastructure

- Cross-institutional studies
 - Registries (AHRQ's "Registries for Evaluating Patient Outcomes: A User's Guide")
 - Research consortiums/learning networks
- Multidisciplinary studies
 - Conceptual frameworks from social sciences
 - Analytic methods from biostatistics, econometrics
- Ongoing training
 - VA National Quality Scholars, AHRQ T32, HRSA
 - What about non-physicians? Specialists?

What's needed: Money

■ Sources

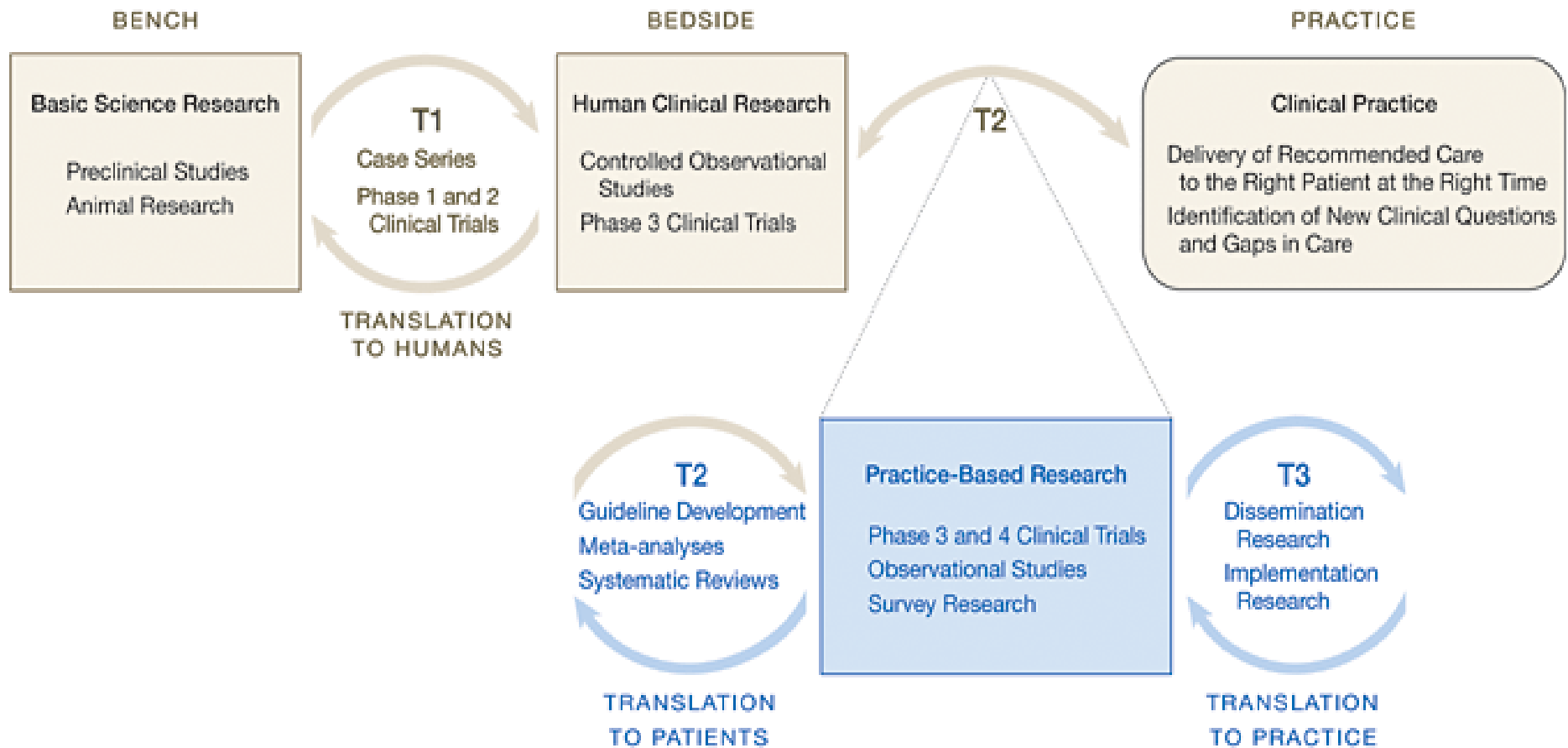
- Federal leadership: AHRQ, VA, NIH, CMS?
- **State/local government**
- Foundations: RWJ, Commonwealth, Diseases
- Accreditors: JCAHO, NCQA
- **Industry: EHR vendors, QI consultants**
- **Payers/purchasers (where ROI exists)**
- Professional organizations
- Healthcare systems
- Partnerships to leverage resources

What's needed:

Linking money with infrastructure

- NIH Roadmap (Re-engineering the Clinical Research Enterprise): “To improve human health, scientific discoveries must be translated into practical applications. Such discoveries typically begin at “the bench” with basic research—in which scientists study disease at a molecular or cellular level—then progress to the clinical level, or the patient's bedside.”
- What about the second translation: from the clinical level to the population or community level (“trench”)?
 - CTSCs, GCRCs, NIH training programs

"Blue Highways" on the NIH Roadmap



Westfall, J. M. et al. JAMA 2007;297:403-406.