Using Medication Safety Technology to Prevent Adverse Drug Events - What's the Evidence

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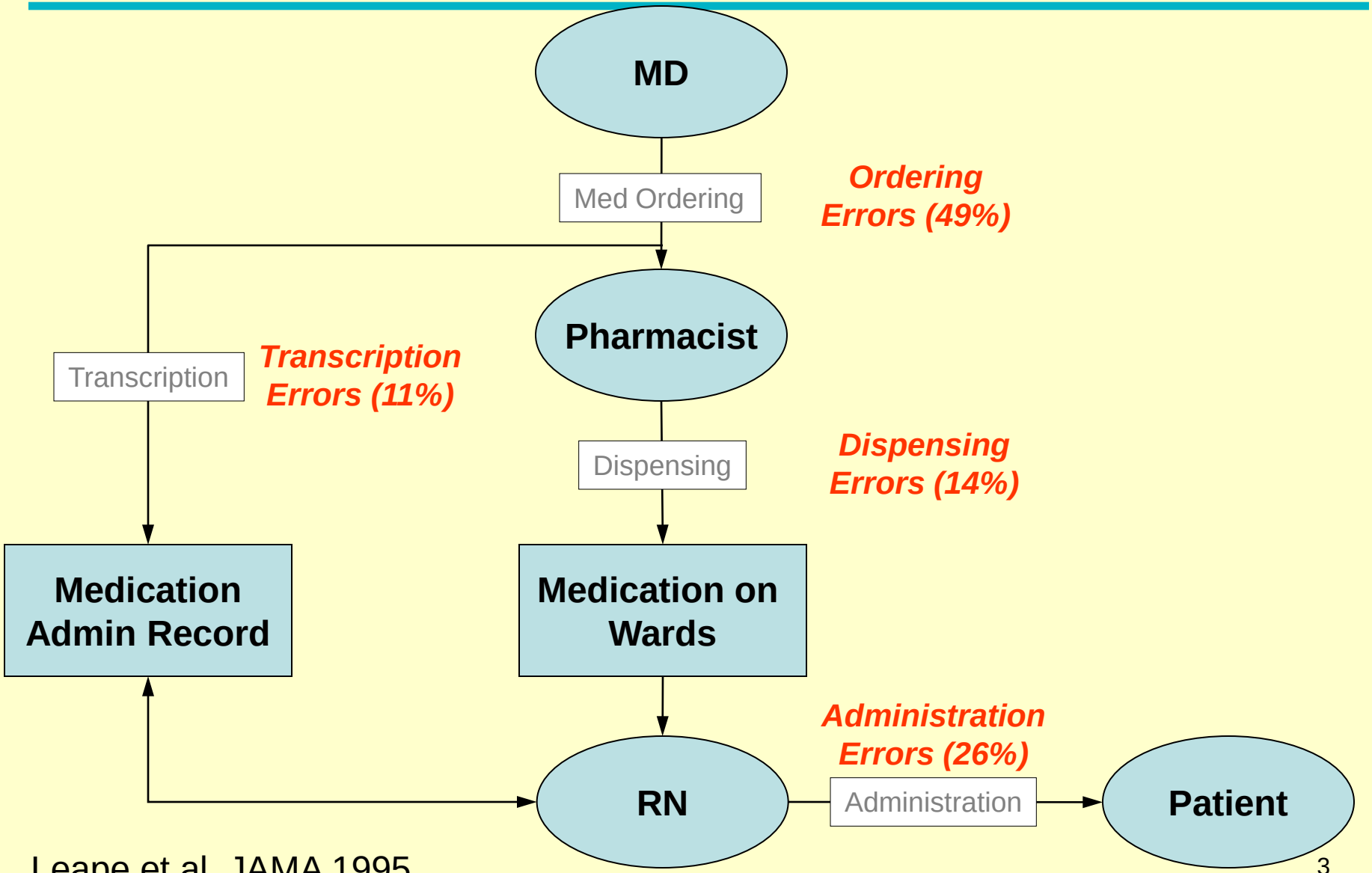
FY 10 Volume Indicators

Indicator	Volume Per Year
Medication orders approved	3.9 Million orders
Inpatient medications	7.2 million doses
IV admixtures	1.5 million doses

Background: Serious Medication Errors



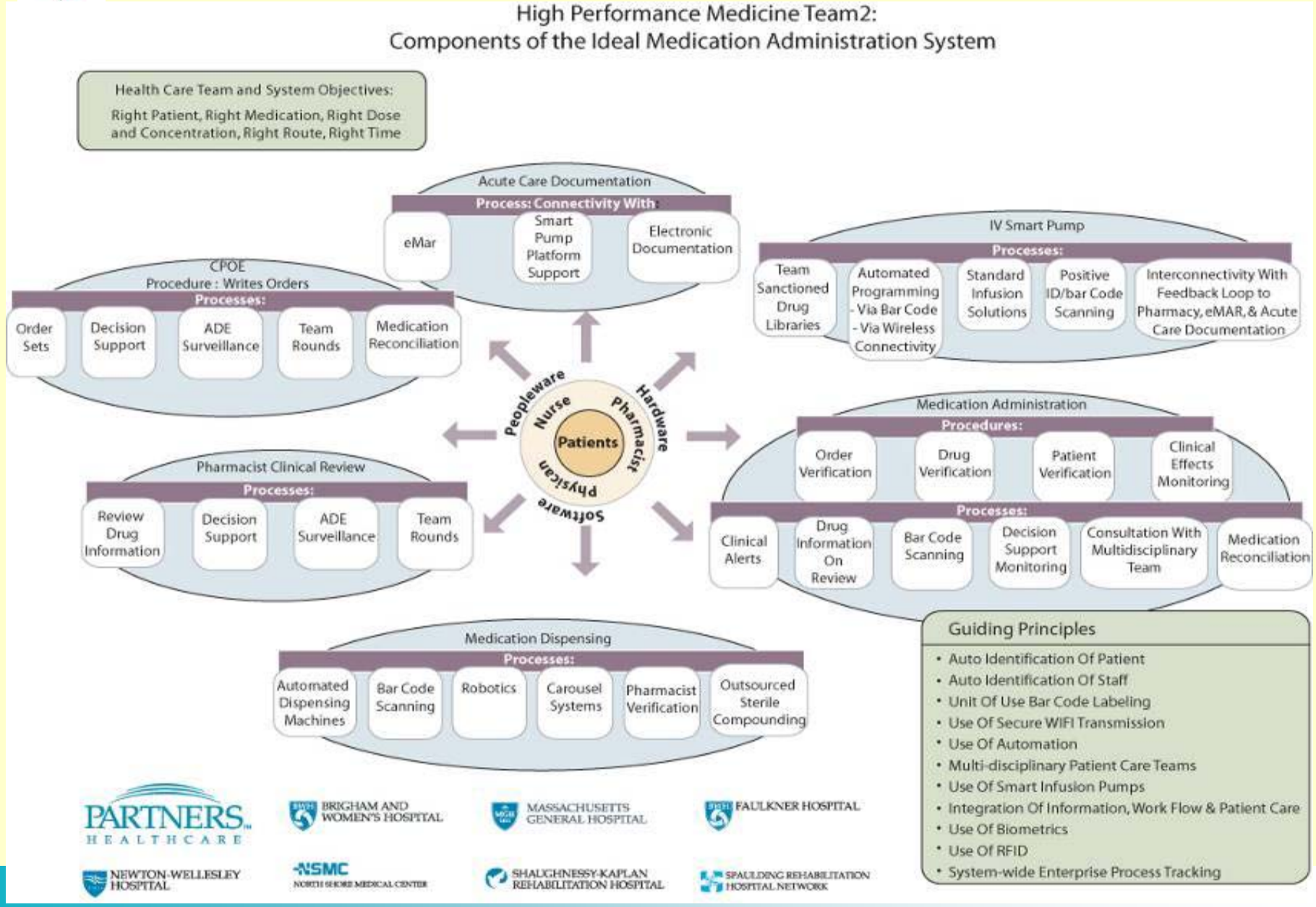
Leape et al, JAMA 1995

Approaches for Improving Inpatient Medication Safety

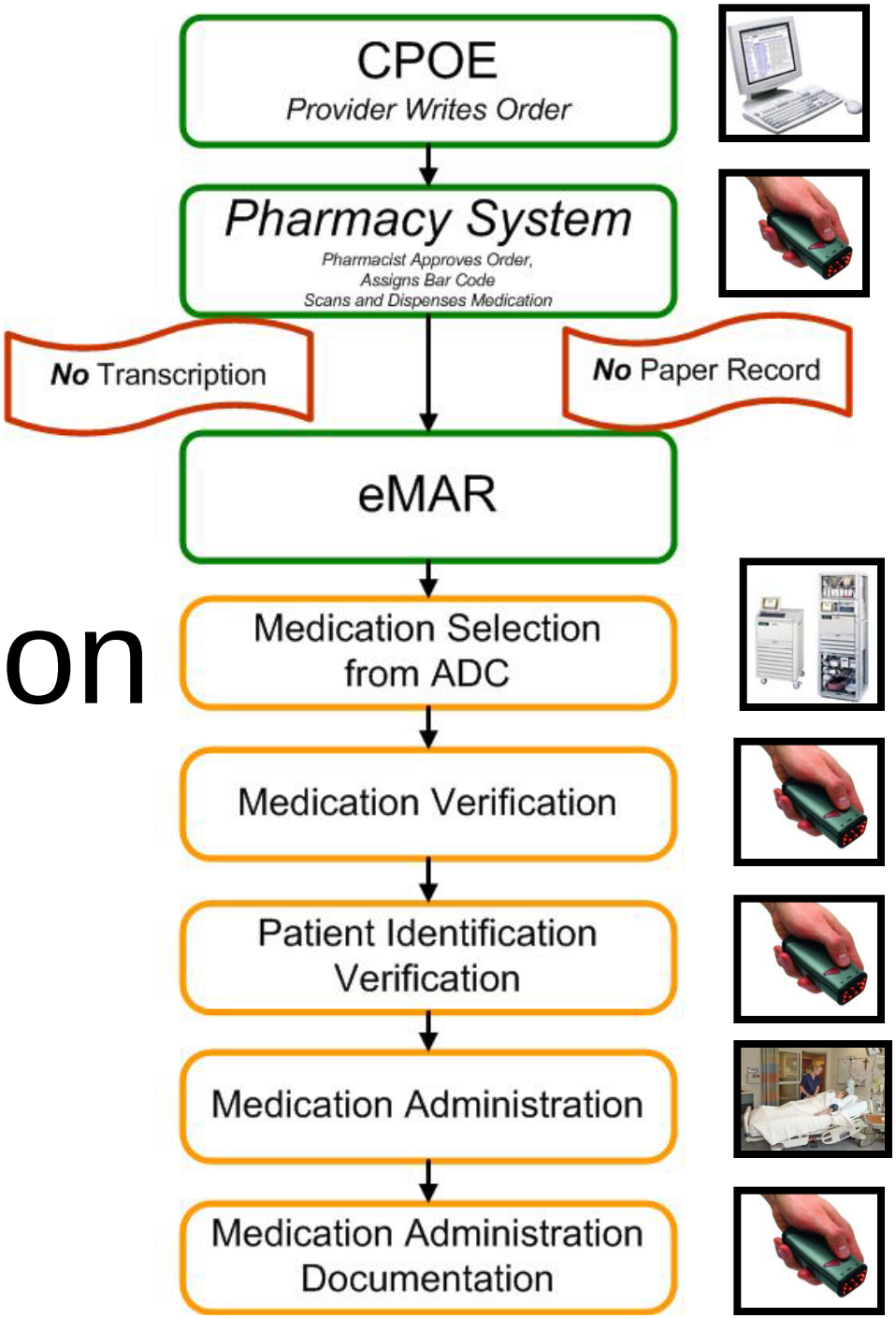
- Computerized physician order entry (CPOE)
  - Completeness and traceability of orders
  - Decision Support
  - Standardization
- Decision support for care providers
- Closed loop medication use process (MUP)
  - Medication bar code verification
  - Electronic medication administration records (eMAR)
  - Smart Pumps
- Clinical pharmacists on the units
- Robotic technology in the pharmacy
  - Inpatient
  - Outpatient
  - Compounded Sterile Products

Barcode verification could have prevented Heparin mix-up in Indiana

Ideal Gold Standard Medication Use Process



*M*edication
*A*dministration
*S*ystem



Bar code Verification is Needed Everywhere Not Just for Inpatient Areas!

Smart Pumps

Drug Distribution and IV Preparation

OR Anesthesia and procedural areas

Barcode Verification

ADC

Robotics

Emergency Department

Focus on use of Standardized Premixed Safely Labeled and Packaged Products

- Two dimensional bar code
- Tall man lettering
- Unit dose syringes
- Tamper evident caps

Dispensing Process: Ensuring High Reliability with Barcode Technology

Dispensing Error Measured

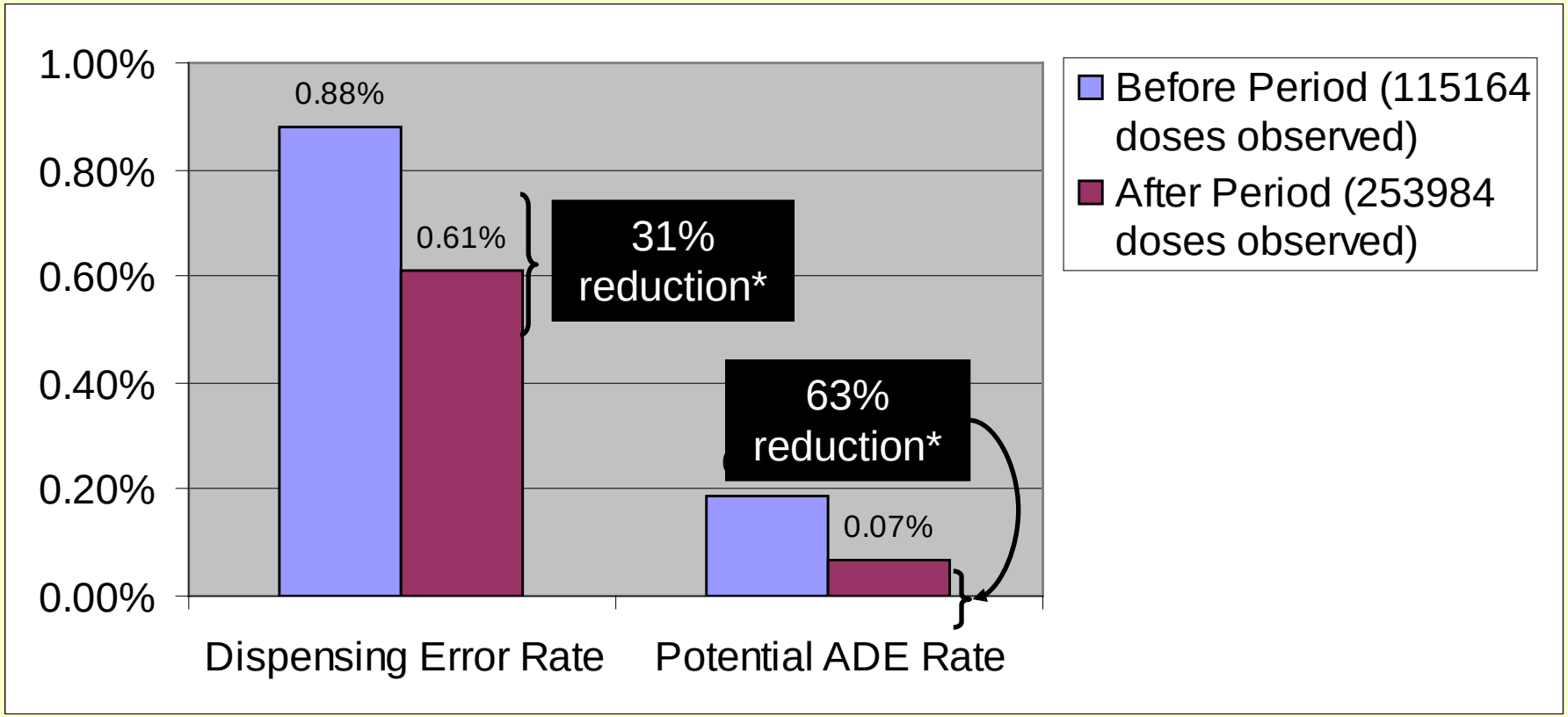
Dispensing Errors Uncovered

Medications Filling by Pharmacy Technician

Checking by Staff Pharmacist

Medications Sent to Patient Units

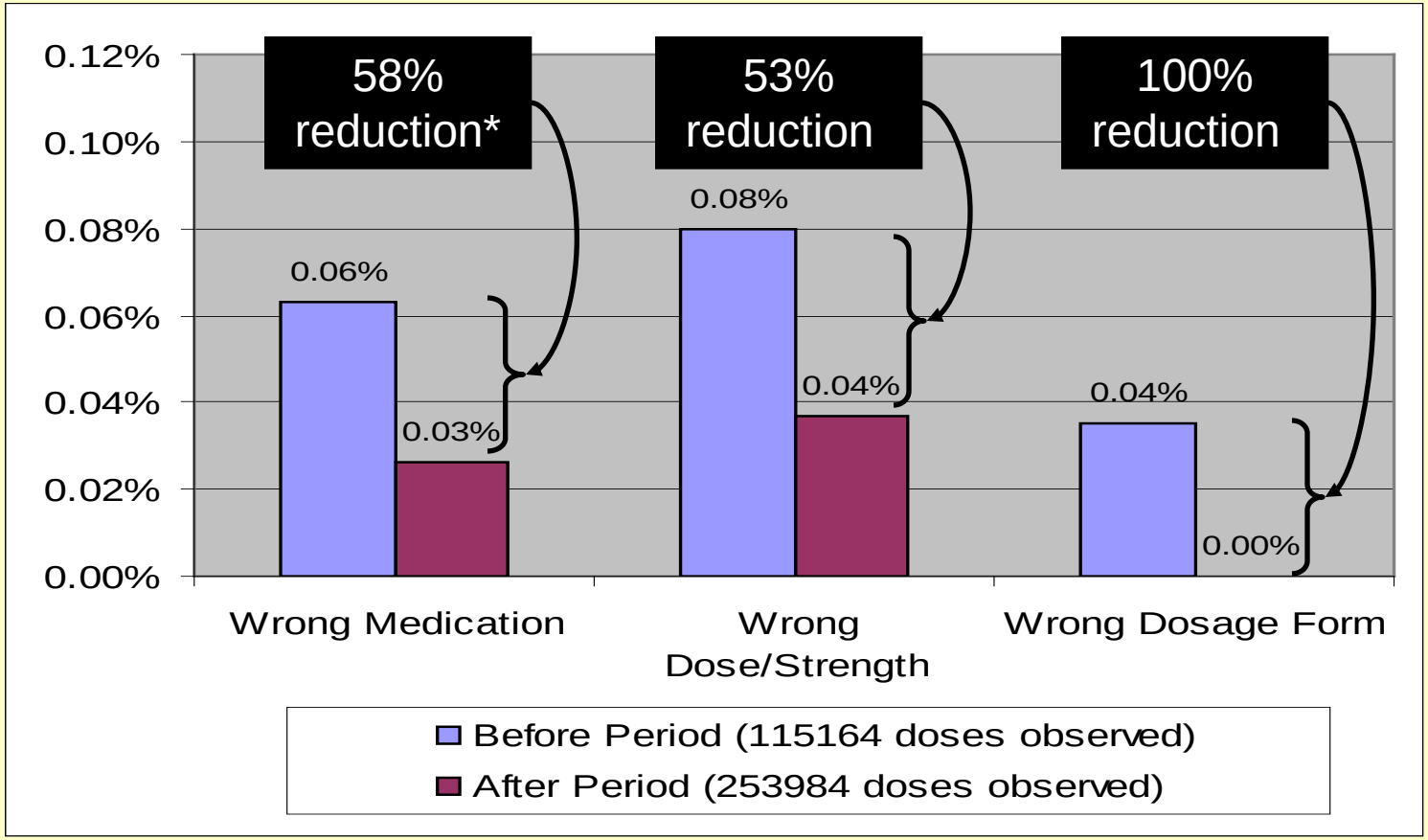
Dispensing Errors and Potential ADEs: Before and After Barcode Technology Implementation



* p<0.0001 (Chi-squared test)

Poon, et al. Annals of Internal Med 2006

Effect of Barcode Technology on Target Potential ADEs



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Potential Medication Safety Impact at Brigham and Women's Hospital

- The pharmacy barcode verification system currently in use is preventing per year:
  - –>13,500 medication dispensing errors (31% reduction)
  - – >6,000 errors with potential for harm (63% reduction)
- The eMAR bar code verification system is currently intercepting nearly 7700 potential errors per month:
  - – Wrong drug 7107
  - – Wrong patient 192
  - – Expired med 360

Financial Benefits of Barcode Technology in the Pharmacy

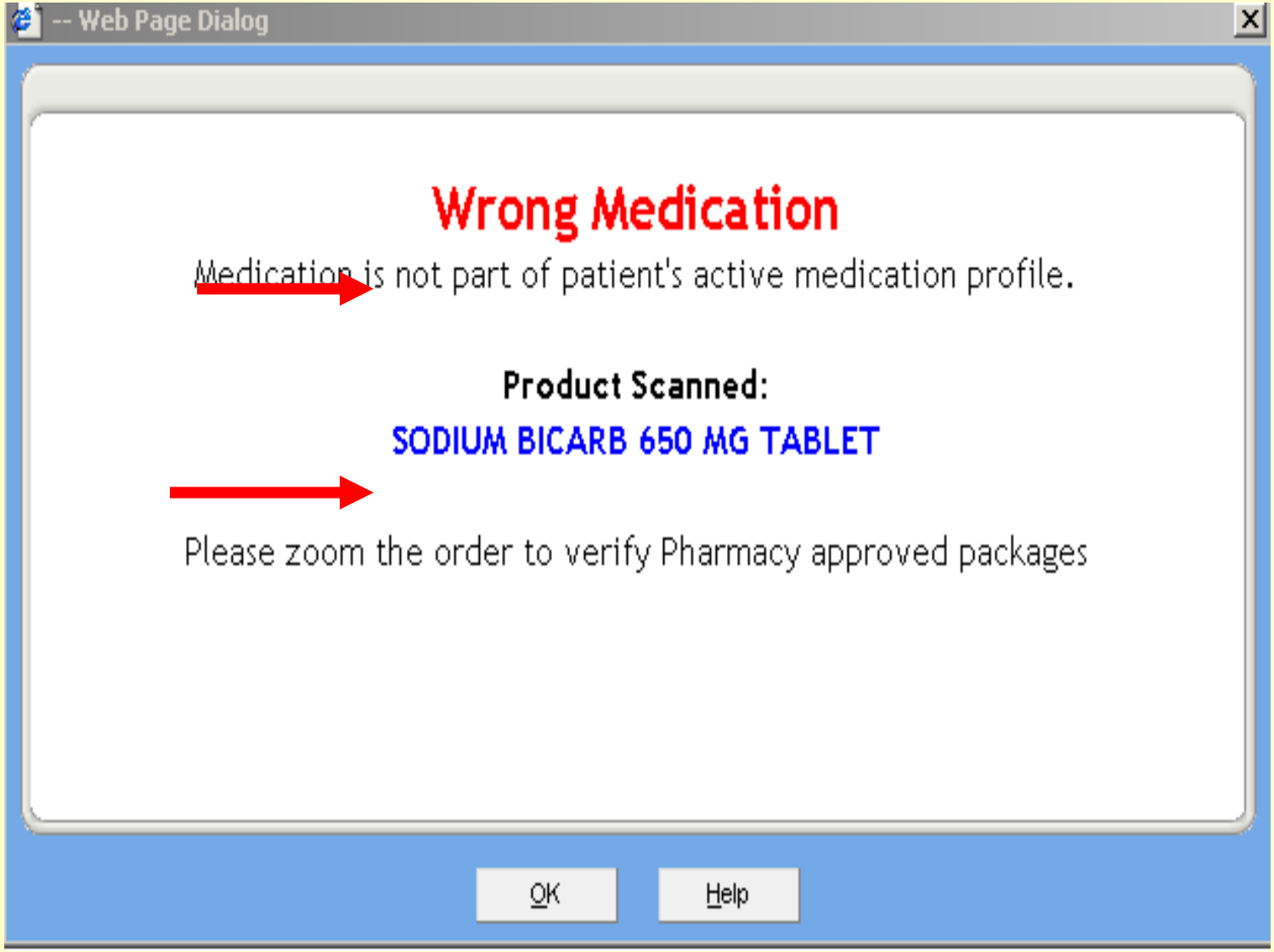
- Medical costs saved through adverse drug event reduction, *per year*
- Increased on-time medication availability on nursing units
- Improved inventory control
- Formal cost benefit analysis showed break-even within first year after go-live
  - 5-year cumulative net benefit = $3.3M

Maviglia, S et al. Archives of Internal Medicine 2007

Barcode/eMAR at the Bedside

- Orders flow electronically from CPOE through pharmacy to an electronic medication administration record (eMAR)
  - Eliminates transcription entirely
  - Nurses have laptops with eMAR and use this to track what medications need to be given (administered)
- Nurses use barcode scanning of the medication and the patient to verify that the drug they are administering matches the physicians' orders
  - Right drug, right patient, right dose, right time
  - eMAR alerts if any of these is incorrect
  - Potentially reduces administration errors

Real Time Alerts to Nurse



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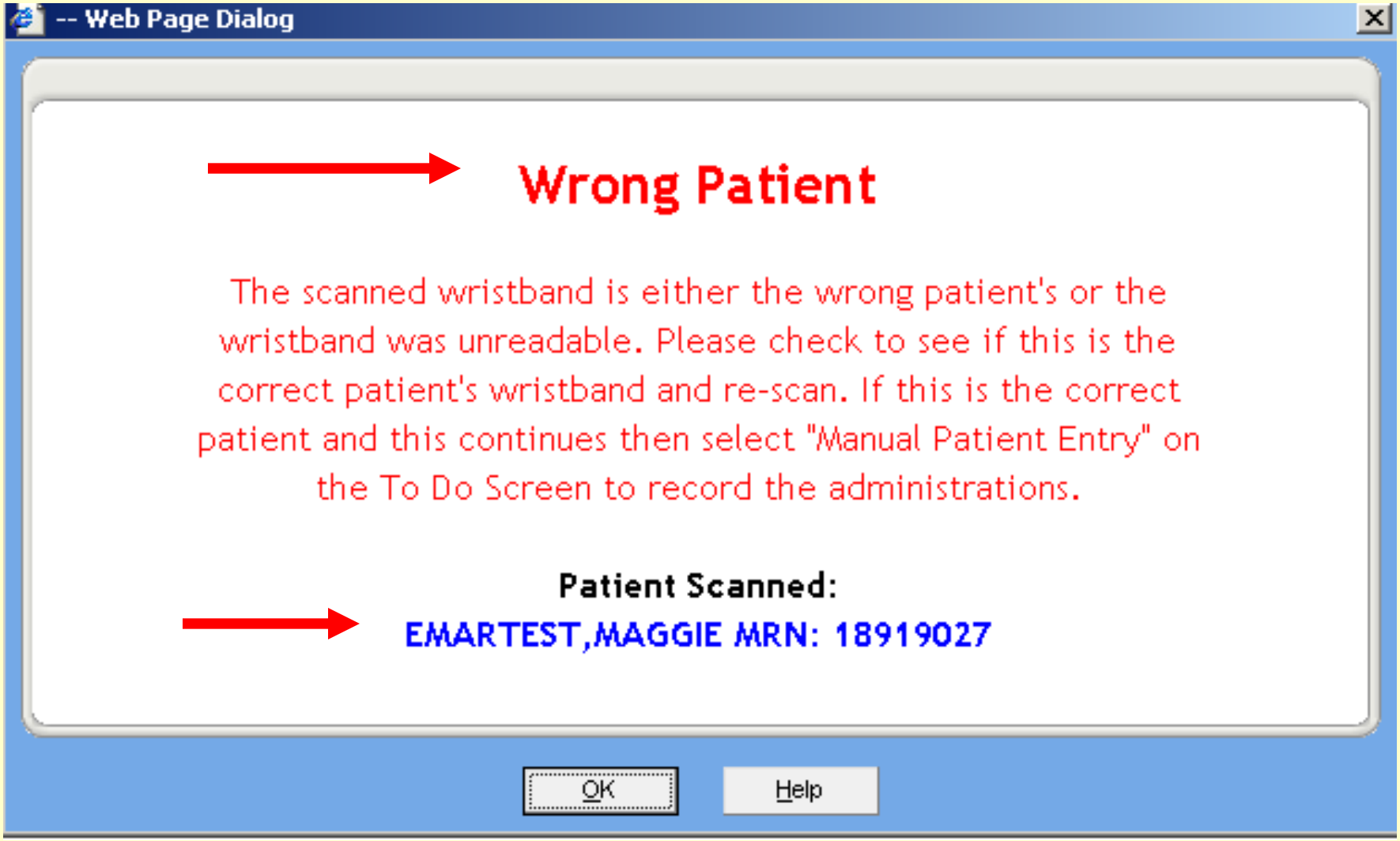


Evaluating the Impact of Barcode-eMAR on medication Administration Errors

- Study Design
  - Non-randomized, controlled observational study comparing error rates on units with and without bedside barcode scanning
- Primary Study Outcomes
  - Directly-observed *medication administration errors*
  - Directly-observed *potential adverse drug events* (ADEs) due to medication administration errors
- Data Collection
  - Direct observations of medication administrations by trained research nurses
  - All errors detected adjudicated by 2 members of a multi-disciplinary panel

Impact of Barcode Scanning on Administration Errors and Potential Adverse Drug Events

	No Barcode Scanning (n=6712)	Barcode Scanning (n=7314)	Relative Reduction (p-value)
Medication Administration Errors	11.5%	6.8%	41% (p<0.001)
Potential Adverse Drug Events	3.1%	1.6%	50.8% (p<0.001)

N Engl J Med 2010;362:36-45

Impact on Potential Adverse Drug Events of Various Severity

	No Barcode Scanning (n=6712)	Barcode Scanning (n=7314)	Relative Reduction (p-value)
Potential Adverse Drug Events	3.1%	1.6%	51% (p<0.001)
Significant	1.82%	0.94%	48% (p<0.001)
Serious	1.30%	0.60%	54% (p<0.001)
Life-threatening	0.03%	0.01%	54% (p=0.52)

N Engl J Med 2010;362:36-45

Impact of Barcode eMAR on transcription errors

	Manual Transcription (n=1799)	Automatic Transcription (n=1283)	Relative Reduction (p-value)
Transcription Errors	6.1%	0%	100% (p<0.001)
Potential Adverse Drug Events due to transcription Errors	3.0%	0%	100% (p<0.001)
Significant	1.6%	0%	100%
Serious	1.3%	0%	100%
Life Threatening	0.06%	0%	100%

N Engl J Med 2010;362:36-45

Admin Error Study - Conclusions

- Barcode scanning technology can significantly reduce the incidence of medication administration and transcription errors and associated potential adverse drug events
- Significant impact on medication safety
  - ~50,000 potential ADEs prevented per year during transcription stage
  - ~90,000 potential ADEs prevented per year during administration stage
- Errors not completely eliminated
  - Still in learning curve at time of study
  - Possibility of new errors being introduced
  - Incomplete compliance with scanning
  - Need for ongoing monitoring and improvements

Impact of eMAR on Nurse Satisfaction

- Pre and post surveys
- Main Results: Nurses feel medication administration is safer and more efficient after implementation of barcode technology

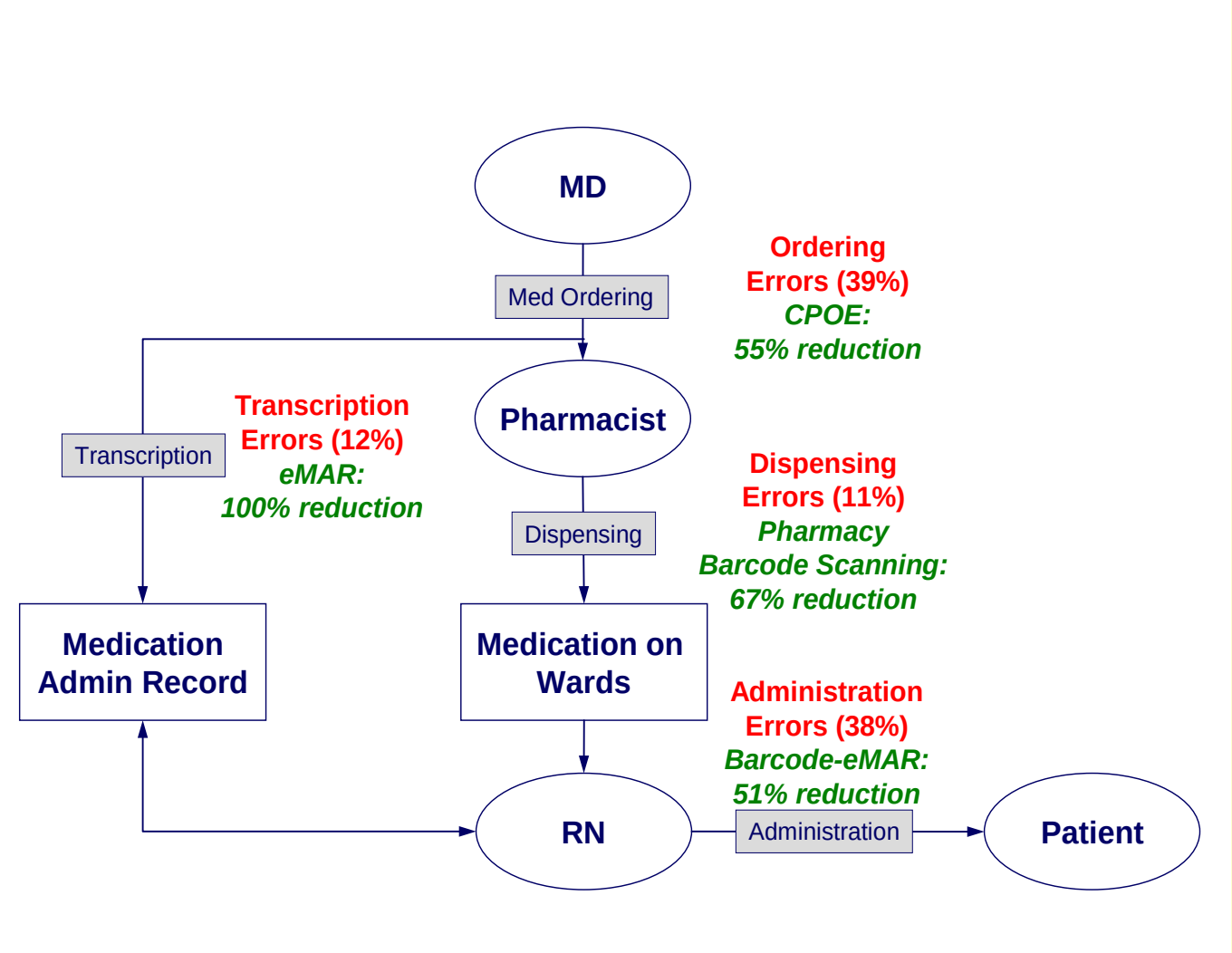
Hurley, A et al. Journal of Nursing Administration 2007

Impact on Nurse Workflow

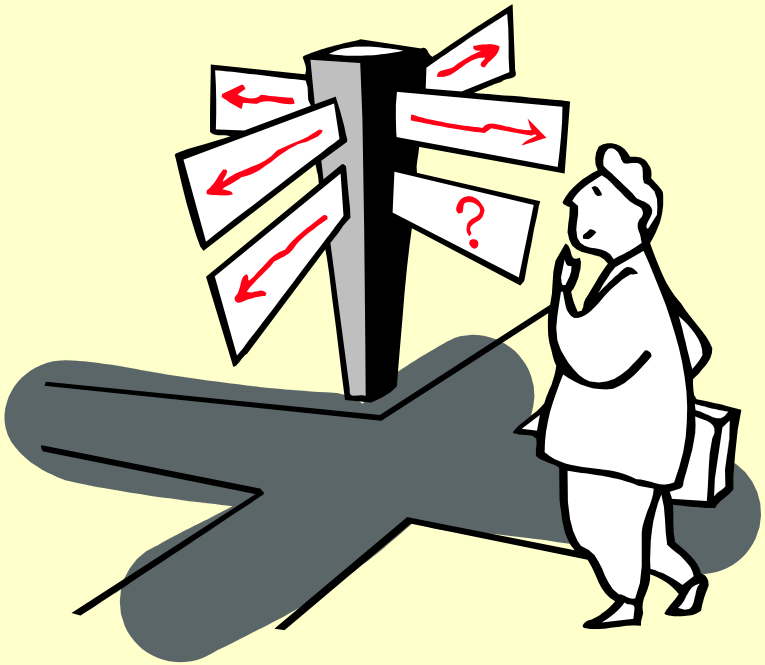
- 232 two hour observation sessions before and after barcode/eMAR implementation
- Primary Result: Proportion of time spent on medication administration did not change after barcode/eMAR implementation
- Secondary Result: Proportion of time spent in presence of patient increased

Poon, et al. Journal of Nursing Administration Dec 2008

What's the Overall Benefit of Medication Safety Technology?

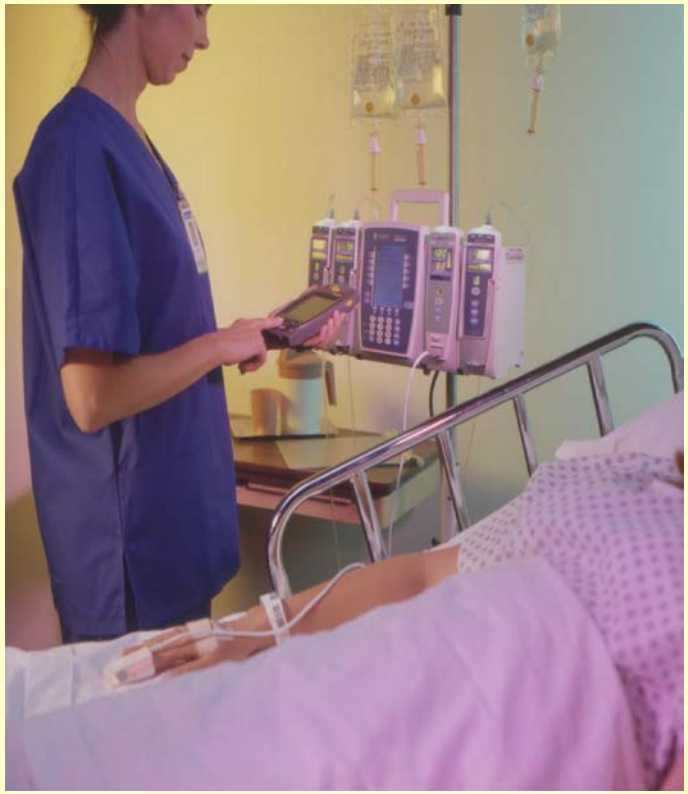


The Future?

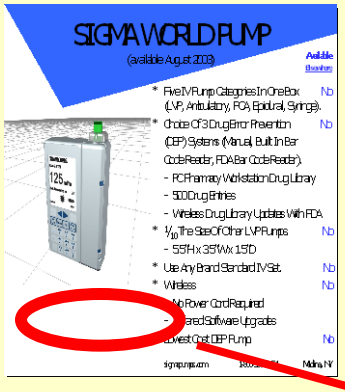


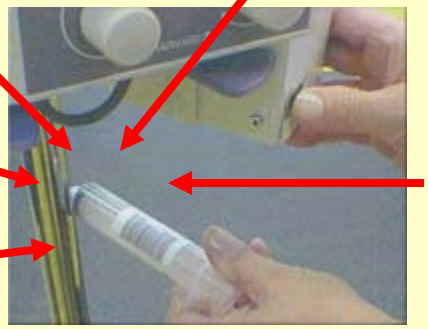
Automating IV Drug Delivery Platform

“Seamless digital pathway from Computerized Provider Order Entry to the patient vein”



Smart Pump Technology and Bar Code Verification

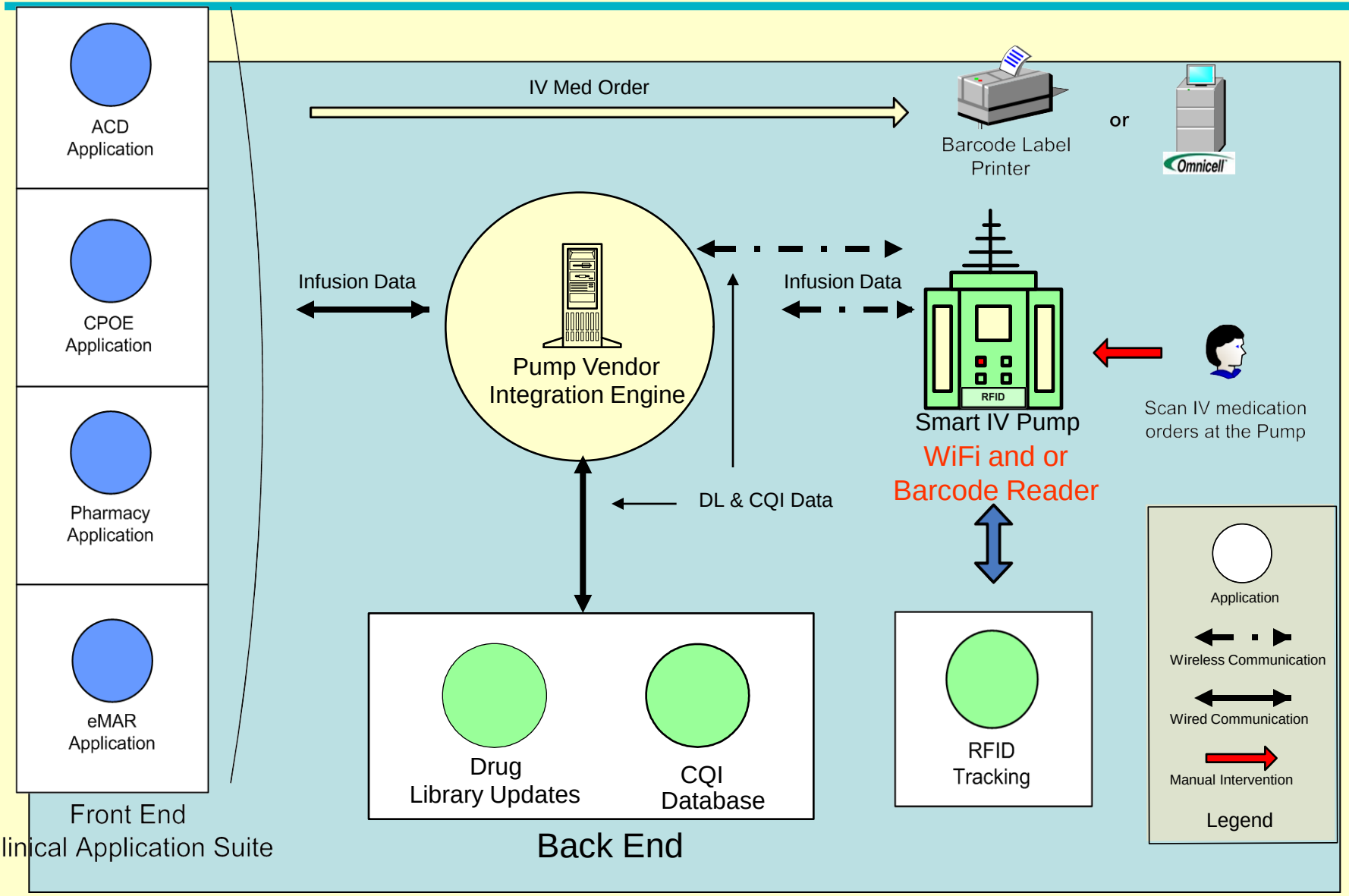




BAR CODE LABEL CONTENT per HIBCC labeling standard

- **The Pump Recognizes Drug Name & Concentration in 2D Bar Code**
- **Calls up correct Drug Library entry**
- **Critical for PCA !!!**

IV Medication Delivery via Wireless Network or Barcode Scan



BWH Strategic Vision for Compounded Sterile Products

- Minimize the number of IV admixture and syringe preparation errors by eliminating human preparation of these products both in the pharmacy in in patient care areas.
- Prepare medications in house that were previously prepared and compounded by outside vendors.
- Utilize the quality and safety features of IV robotic devices to insure that all products are made with the highest degree of accuracy, sterility, and safety.

Action Plan: Equipment

- The Cytocare Robot is designed for preparing chemotherapeutic agents
- The Intellifill syringe robot is designed to prepare bulk batches of ready-to-use syringes for Anesthesia and Nursing staffs.
- The IV Station robot is designed to prepare patient specific IV bags and syringes or batch filling.
  - This can be centrally located or in high volume hospital areas for on-demand access such as the Emergency Department.

IV Station Robotic Devices for On-site, On-Demand IV Admixture Preparation

- Integration with Pharmacy and eMAR information systems
  - Real time bi-directional interfaces
- Remote verification capability for checking pharmacist
- Medications prepared in under 2 minutes in ISO class 5 environment
- Documentation available for central data warehouse

Some Final Thoughts…

- ✓ No one intervention (bar coding, eMAR, CPOE, robotics) will solve all of our problems in the Medication Administration System. We need them all!
- ✓ Technology can never replace the critical thinking of clinicians
- ✓ Beware new sources of error and user initiated work arounds!

Be careful what you wish for….

“To err is human but to really mess things up… you need a computer”

Anonymous