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Interventions to Improve Patient Safety

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Randomization and Control Groups

Randomization

CONTROL GROUP

High Flying

- Angela Lashoher was a med student in Houston when she first took to the skies. Now the third-year surgery resident says she'd "go crazy without it." Dr. Lashoher typically jumps in New Jersey, though this photograph was taken in the skies over Florida.

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Section A

Evidence-based Safety Solutions

Evidence-Based Safety Solutions

- Inherently difficult to generate evidence for quality improvement
- Many changes made based on common sense
- Safety interventions must be evaluated
- Law of unintended consequences

Hierarchy of Error-Reduction Strategies

- Automation
- Forcing functions
- Process simplification
- CPOE
- Checklist
- Readbacks
- Admonitions

Locus of Intevention

- Patient
- Health care worker
- Workplace
- System

Interventions for Patients

- Thirty-minute pre-discharge medication counseling
- Improved medication accuracy ($p<0.01$), fewer unplanned physician visits ($p<0.05$), fewer hospital admissions ($p<0.05$)
- Al-Rashed et al.

Interventions by Patients

- "Did you wash your hands?"
- Soap usage increased 34% ($p=0.02$) during the program
- McGucklin et al.

Interventions for Health Care Staff

- Education?

- Traditional continuing medical education (CME) often disappointing

Interventions for Health Care Staff

- Randomized trial of virtual reality course for laparoscopic cholecystectomy

- In subsequent live cases, trainee group
  - Faster ($p=0.02$)
  - Fewer errors ($p=0.003$)
  - Greater economy of movement ($p=.003$)

- Grantcharov et al., 2004

Interventions for Health Care Staff

- Crew resource management (team training)

- Before-after study in Swiss multidisciplinary obstetric unit
  - Improved teamwork ($p<0.05$)
  - Improved collective decision making ($p<0.05$)
  - Improved overall hospital safety culture

- Haller et al., 2008

Interventions on Work Conditions

- Do tired doctors make more mistakes?
- Randomized controlled trial of reduced hours and shifts not greater than 24 hours
- Intern reduction in serious errors
  - 35.9% reduction ($p<0.001$)
  - 56.6% non-intercepted
  - 20% fewer medication
  - One-fifth as many diagnostic
- Landrigan, 2004

Interventions on Health Care Worker Tasks

- Poor hand-offs

- Standardized handovers based on Formula 1 pit stops in pediatric intensive care

- Reduction in technical errors
  - 3.15 vs. 5.42 per handover ($p<0.001$)

- Catchpole et al., 2007

Comment: more shifts = more hand-offs

Interventions on Work Conditions

- Pennsylvania study of surgical admissions (n=232,342) linked to nurse surveys in 168 hospitals

- Adjusting for patient and hospital, each additional patient per nurse is associated with a 7% increase in likelihood of dying within 30 days and a 7% increase in failure to rescue

- Aiken et al.

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Section B

IT Solutions

Interventions at the System Level: IT Solutions

- Technology has the potential to reduce many types of error

Technology to Reduce Medication Errors

- Computerized prescriber order entry + decision support
- Automated dispensing devices
- “Smart” infusion pumps
- Therapeutic monitoring systems
- Technology for patient identification

CPOE

- With CPOE, physicians enter orders into computer rather than on paper
- Orders integrated with patient information, including laboratory and prescription data
- Orders automatically checked for potential errors or problems

+ Decision Support

- Systems provide advice or guidance to clinicians at the point of care

- Menu of …
  - Medications
  - Default doses
  - Frequencies
  - Route of administration
  - Appropriate laboratory tests

Theoretical Benefits of CPOE

- Prompts warn against the possibility of drug interaction, allergy, or overdose
- Accurate, current information helps physicians keep up with new drugs as they are introduced into the market
- Drug-specific information that eliminates confusion among drug names that sound alike
- Improved communication between physicians and pharmacists
- Reduced health care costs due to improved efficiencies

Effectiveness of CPOE in Reducing Errors

- Brigham and Women's Hospital (Bates, 1998)
  - CPOE reduced error rates by 55% (from 10.7 to 4.9 per 1,000 patient days)
  - Serious medication errors fell by 88%
  - 17% reduction in preventable adverse events (NS)
  - Resulted in $5–10 million in annual savings over the initial investment

Effectiveness of CPOE in Reducing Errors

- LDS Hospital in Salt Lake City (Evans, 1998)
  - Computer-assisted management program for antibiotics
  - Twelve-bed intensive care unit
  - 70% reduction in antibiotic-related adverse drug events (p=0.02)

Bar Codes

Photo by John. Creative Commons BY-NC-SA.

How Bar Coding Works

- When it is time for a patient to receive a medication or treatment, the nurse scans both the patient wrist band and chart to ensure they have the proper patient, and then scans the medication to check that it is right for the patient

Features of Bar Coding

- After improving prescribing, addresses administration process
- Positive identification of patient
- Positive identification of medication
- Immediate warnings and feedback to clinicians
- Data available to evaluate and improve processes

IT Reduction in Errors in High-Risk Procedures

- Blood component transfusion still hazardous despite systematization and multiple verification steps
- Bar coding on patient’s wristband and blood product to ensure match (Ash, 2004)
- Significant increase in checking behavior but underpowered to show reduced harm

IT Reduction in Errors in High-Risk Procedures

- Bar-code–assisted medication administration (BCMA) system in ICU
- The medication error rate was reduced by 56% (19.7% vs. 8.7%, $p<0.001$)
- Related to a reduction associated with errors of wrong administration time
- De Young, 2009

IT Itself Can Introduce New Errors

- Can introduce unforeseen errors that may not have existed previously
- Example from the MEDMARX data base
  - CPOE was judged to be the cause of 10% of all medication errors in 2002, and 11% in 2001
  - It is the third leading cause of “wrong patient” errors
- Staff tend to develop workarounds to avoid technology where it makes work more cumbersome (examples of workarounds include the borrowing of meds and wristband removal)

22 “New” Types of Errors (Koppel, 2005)

- Fragmented CPOE display prevent a coherent view of patients’ medications
- Pharmacy inventory display mistaken for dosage guidelines
- Separation of functions facilitates double dosing
- Inflexible order formats generate wrong orders
- In summary, although IT is among the more promising of interventions, it has many other unintended consequences, especially changing workflow and communication (Campbell, 2006)

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Section C

Smart Pumps

Infusion Pumps

- Automated infusion pumps were first introduced in the late 1950s, used to administer IV and epidural medications and fluids

- Allow a wide range (10,000-fold) of acceptable programming parameters
  - Rate from 1 drop per hour to 1 liter or more per hour
  - Dose from 0.1 to 9999 mL

Pump Programming Errors

- Errors can be programmed with a single keystroke

Pump Programming Errors

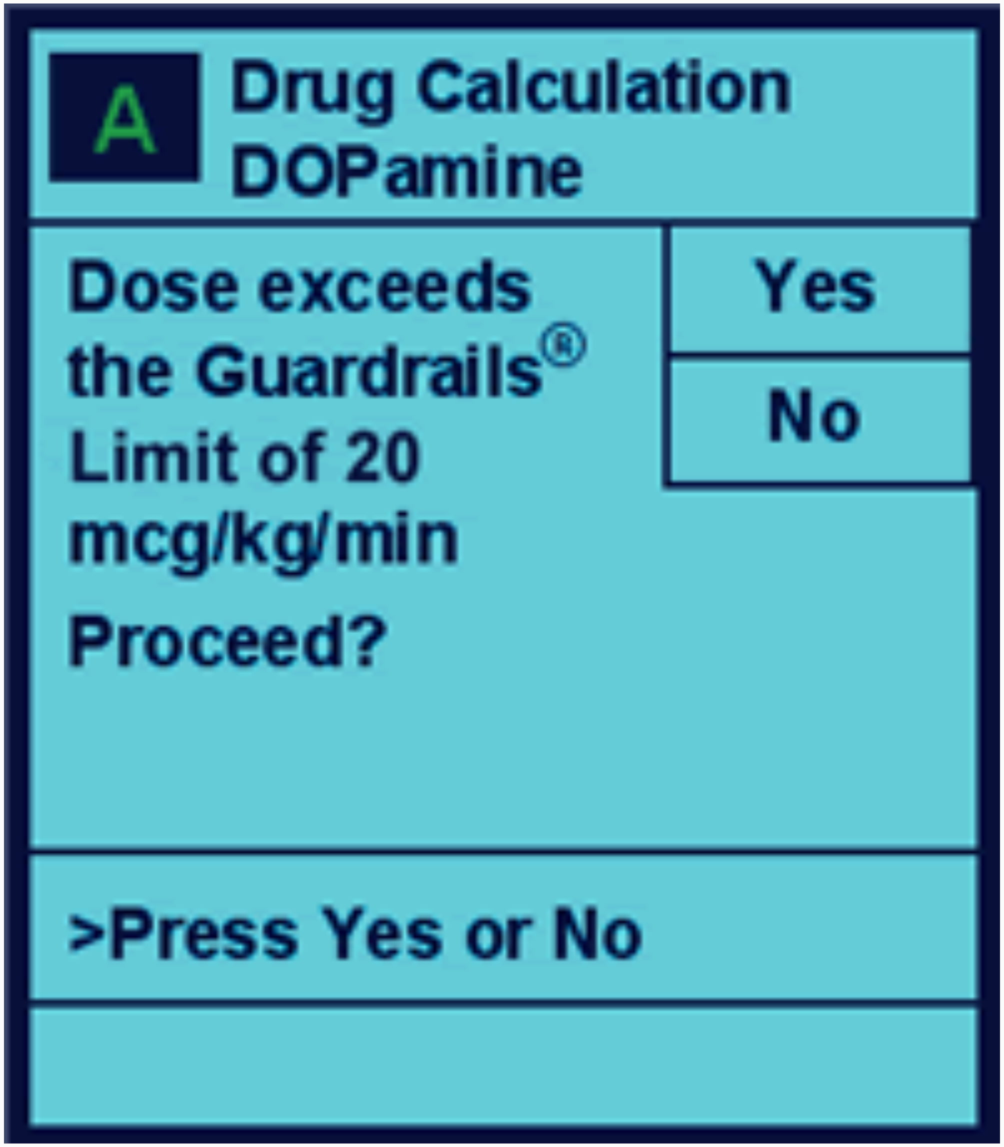
- Morphine entered as 90 mg/hour instead of 9.0 mg/hour
- In a neonatal ICU, an infusion rate intended to be reprogrammed from 3.2 to 3.4 mL/hour was instead programmed to 304 mL/hour
- Nitroglycerin ordered to be administered in mcg/minute was programmed instead as mcg/kg/minute, resulting in a 60x overdose

“Smart” Drug Infusion Pumps

- Allow hospitals to enter multiple comprehensive libraries of drugs, usual concentrations, dosing units (e.g., mcg/kg/min, units/hr), and dose limits
- If a dose is entered outside of established limits, the pump alarms, informing the clinician that the dose is outside the recommended range

Photo by Tim Gee. Creative Commons BY-NC.

“Smart” Drug Infusion Pumps: Programmed Dose Limits



Smart Pump Example

- Protocol for heparin
  - Loading dose of 4,000 units, followed by
  - Constant infusion of 900 units/hour

- The loading dose was administered correctly, but the nurse inadvertently programmed the continuous dose as 4,000 units/hour

- Pump limit for heparin as a continuous infusion was set at 2,000 units/hour, so the infusion device would not start until the dose was corrected

Errors Would Result in Alerts

- The 10-fold morphine programming errors would result in "high dose" alerts
- A high rate in the NICU would result in a "high rate" alert
- For drugs where weight is not used in the calculation, the calculator would not allow a weight entry

Ability to Log Alerts

- Can track programming errors, or “near misses”
- Data can be used for quality improvement efforts

Ability to Integrate Monitoring with Patient Parameters

- Some pumps can integrate patient monitoring and other patient parameters, such as age or clinical condition

Too Many Pumps Spoil the …

- Different pumps require different programming

Less Is More?

- Johns Hopkins Hospital replaced about 1,300 IV pumps from multiple manufacturers with a single standardized system

Implementation of New Technology

- New technology must be implemented in a deliberate, careful, and integrated manner
  - Minimizes the opportunity for new types of error
  - Maximizes the ability to provide alerts, safety checks, medication dosage calculations, and decision support

- Ideally, each facility should develop interdisciplinary teams with expertise in content and process re-design to …
  - Prioritize choices of technology
  - Guide implementation in a manner customized to the institution

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Section D

Methodologic Concerns and Conclusions

Methodologic Concerns

- Few randomized controlled trials of safety interventions
  - Difficult to randomize at patient level
- Studies often too under-powered to detect improvements in outcomes
- Denominators often unavailable

Methodologic Concerns

- Most studies from small number of enthusiasts
- Uptake slow
- Many barriers to implementation
- Sustainability rarely measured

Some Conclusions

- There are some promising interventions
  - Forcing functions
  - Computerized order-entry with decision support
  - Checklists
  - Standardized hand-offs
  - Simulation training
- Many interventions lack strong evidence of benefit

Conclusion

- Some innovations can be adopted by individual clinicians immediately with little start-up cost (e.g., readbacks)
- But many others not so much and should be implemented and evaluated carefully *(primum non nocere)*
- Be aware of the dangers of workarounds
- Measure and publish outcomes of interventions