Are you smarter than a smart pump?

Smart Infusion Pump History, Implementation, and Monitoring

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Learning Objectives

- Understand the role of smart pump technology in preventing medication errors
- Discuss the development and maintenance of drug libraries
- Describe strategies for monitoring and improving compliance with the use of the drug libraries

Conflicts of Interest

I have no conflicts of interest

History

- “To Err is Human” – 1999 Institute of Medicine Report
- Medication errors make up the highest percentage of non-surgical errors, reported to be approximately 15% up to as high as 44%.
- The most serious medication errors are caused by IV administration of medications and can be three times as likely to cause harm or death when compared to other medication errors. Thrombolytics, narcotics, hormones, and sedatives are among the highest risk for harm.
- Wrong dose IV administration errors are most commonly caused by an error in programming an IV infusion pump.

Reported Medication Errors

- Insulin administered at 1 unit/kg/hour instead of 0.1 unit/kg/hour – missing decimal event
- Nitroglycerin ordered as mcg/kg, infusion programmed as mcg/kg/min – units error

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“Dumb” Pump Capabilities

- Flow rates
  - Large volume pumps 0.1-999 ml/h
  - Syringe pumps 0.01-100 ml/h
  - Epidural pumps 0.1-50 ml/h
- Calibration to tenths of a ml
- Flow accuracy +/- 5%
- KVO rates as low as 1ml/h
- Pause/standby
- Alarms
  - air in line/empty line
  - downstream occlusion line
  - low battery
- Patient weights

“Smart” Pump Capabilities

- DERS (Dose Error Reduction Systems)
  - Pre-programmed initial rates, soft/hard rate limits, concentration limits
  - Drug libraries
  - Easy to read screens that identify infusion drug/rate/volumes infusions
  - Tall-Man lettering
- Reminder alerts
  - “Ventilated patients only”
  - “Requires nurse double check”
  - “Requires telemetry monitoring”
  - “Central line only”
- Program patient (weights, IDs) or user information (nurse ID)

“Wireless” Pump Capabilities

- Unidirectional
  - From server to pump only
  - Can “push” a library update
- Bidirectional
  - From server to pump and from pump to server
  - Can push a library update, and send data back about pump alerts and alarms
  - Enhances infusion safety and provides the ability to perform continuous quality improvement efforts

Dumb Pump Limitations

- Morphine programmed at 99 mg/hour (intended rate 9 mg/hour) – “fat finger” error
- Heparin infused at 26 units/hour (0.5 ml/hour) instead of prescribed dose of 26 ml/hour (1300 units/hour) – “units” error

Smart Pump Limitations

- Do not overcome poor compliance with DERS use or rapid overrides of alerts.
- Do not communicate alarms, alerts, or status of infusions in near-real time.
- Still not “smart” enough to ensure the “Five Rights” of right drug, dose, route, patient, and time, much less right response and documentation

“Wireless” Pump Limitations

- Pumps powered off
- Dead zones
- Mobility of pumps
- Lack of patient IDs
- Lack of clinician IDs
- Rental pumps
- New pumps
- Pumps from patients transferred in
- Pumps lost from transfer out
Next – “Intelligent” Pumps

- Close the loop between CPOE, BCMAs, and EMRs
- Auto-associate pumps and patients
- Auto-associate pumps and clinicians
- Auto-pump programming of medications
- Auto-documentation of infusion activity into EMR
- Patient monitoring
- Infusion status monitoring
- Alarm management
- “Air Traffic Control” integrated surveillance

Vanderdeyne, T. From Smart Pumps to Intelligent Infusion Systems – The Promise of Interoperability. 27 May 2014.

Smart Pumps – Current Use

Adoptions by Facility Size (in number of beds)

Makes and Models

Care Fusion (Alaris)

Baxter (SIGMA Spectrum)

Hospira (Plum 360)

B Braun (Outlook)

Current Systems in Use

Return on Investment (ROI)

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Phelps, Pamela. Smart Infusion Pumps. American Society of Health Systems Pharmacists. 2011

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Drug Library Development

Considerations for customization:

- Profiles
  - Med/Surg
  - Critical Care
  - Pediatric
- How to handle code medications
- Formulary
- Shortages?
- Standard Concentrations
- Wild-card entries (---mg/---ml)
  - Ensure all wild-card entries have maximum concentration limits
- Standard Administration Criteria (initial rates, max rates)
- Soft vs Hard alerts
- Therapy types (for PE, stroke)
- Clinical alerts (vented patients only, central line only)

Drug Library Development

- Update Medication Concentrations
  - Automated Dispensing Cabinets (Pyxis, Omnicell)
  - Code Carts
  - Electronic Order Entry System (Meditech)
  - Labeling must match what is listed in the library
- *Not only check the concentrations but how the medication is labeled
  - Units: 1500 mg vs 1.5 gm
  - Vitamin K vs Phytonadione

Drug Library Implementation

- Submit list of medication changes to P&T for approval/MEC approval
- Once approved, are new billing codes needed?
- Work with IT Pharmacist to ensure proper build in order entry systems
- ID all areas affected by the changes
  - locations
  - protocols
  - order sets
  - policies - LASA
- Update the areas affected by the changes
- Educate
  - nurses
  - technicians
  - buyer
  - pharmacists
  - anesthesiologists

Drug Library Release

- Determine a go-live date and time
- Identify a team to go room to room and ensure all pumps load the new library
- Monitor that 100% of pumps uploaded new library

Barriers to Compliance

- Inadequate drug library development
- Lack of standardization
- Lack of education and training on proper use
- Accountability
- Alert fatigue
Increasing Compliance

- Build an interdisciplinary team that will provide oversight and engage leadership
- Implicate evidence-based, meaningful limits and monitor their compliance
- Provide ongoing nursing communications via newsletter articles or patient safety posters
- Communicate data analyses ("good catches", "saves")
- Solicit continuing nursing feedback
- Set goals and expectations
- Use data to modify drug library limits and monitor compliance
- Conduct direct observation/compliance rounds


Increasing Compliance

Policy

- Definitions
- Pump Operation
- Anesthesia Mode
- Use of the Drug Library
  - Library development & approval process
  - Frequency of release/updates (quarterly)
  - Profiles
  - Code medications ("zz")
  - Overrides (independent double check)
  - Compliance expectations (90%)

- Management of alarms/alarms settings
- Equipment maintenance (Biomed)
- Documentation
- Cleaning of pumps
- Policy monitoring and auditing

Increasing Compliance

“Audits will be conducted at random in medication administration areas to identify individual compliance with the use of Guardrails. Progressive disciplinary process will be followed for practitioners who bypass use of Guardrails”

The team will review overall compliance to achieve a goal of > 90% use of Guardrails. For profile areas not meeting > 90% compliance, the team will implement action steps.
Increasing Compliance

TJC Sentinel Event (Alarm Safety)

- Tens of thousands of alarm signals throughout the hospital every day
- 85-99% of alarm signals do not require clinical intervention
- 98 alarm related events between January 2009-June 2012
  - 80 deaths
  - 13 permanent loss of function
- Causes
  - Absent or inadequate alarms (30)
  - Improper alarms (21)
  - Inaudible alarms (25)
  - Alarm signals turned off (36)
- Alarm fatigue – the most common contributing factor

Example

Healthcare System:

- 16 Hospital healthcare system
- 15,270 admissions/month/division
- Average 181,853 infusions/month/division (12)
Example

$2,826,250
Estimated cost avoidance for severe harm averted across the 12 hospital system (Q3)

Star Example

Summary

- Smart Pump technology reduces medication errors (when used)
- Drug libraries must be developed with special consideration to hospital formulary, protocols, order sets, standard concentrations, and administration criteria.
- Compliance is dependent on end user involvement in the development and maintenance of the drug library, education, expectation setting, and culture of accountability.

References

3. Star Example

7. Reference Example

9. Reference Example