



Lutheran Medical Center

Brooklyn, New York

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Maximizing Technology and Practice to Improve Medication Infusion Safety

Recognizing that 35 percent of all medication errors that result in significant harm are the result of infusion pump errors "primarily due to incorrect programming of the infusion parameter, Lutheran Medical Center, a 476-bed hospital in Brooklyn, New York, decided to implement an institution-wide infusion pump technology upgrade.

We understood that error reduction was, in itself, a goal and that safety required system-wide improvements. We purchased 275 pumps with dose-limiting technology, created a customized drug library specific to our institution's needs and installed new software that would allow us to evaluate outcome data and trends associated with drug dosing, potential errors, and practice-specific events for the first time. After implementation of the smart pump technology from B. Braun Medical Inc in 2006 as well as evidence-based drug protocols, we have experienced a concrete reduction in infusion-related medication events, from seven events in 2005 to one in 2007. So far, we have had no events in 2008" a 100 percent decrease.

Preparing for Change

After gathering support and input for the upgrade from each clinical service line involved in infusion therapy, we created an infusion pump drug library that established dosing limits for each drug and a clinical protocol for verifying overrides or dosing outside the limits. When dosing outside facility-established dosing parameters, the B. Braun infusion pump alerts the clinician, then prompts a change and confirmation step. We chose the smart pump in part because it allows soft stop overrides that is; it allows the clinician to appropriately override the dosing parameters to achieve a desired therapeutic effect or to exceed the limit in an emergency. But we also chose it because it allowed for customization and a more uniform, reliable approach to safety.

Before converting to new infusion pumps, we successfully piloted the software program with three select drugs in the ICU and labor/delivery departments. Because it would take a significant amount of time to extrapolate our initial findings throughout the rest of the organization, we decided to move forward with the full conversion based on the results of the pilot program.

It was during this evaluation period that we realized a one-size-fits-all drug library would not benefit our institution, nor would it help us to improve patient safety to the level of the standards we had set for ourselves. We wanted to be able to gather all relevant data from these pumps, and be able to apply key findings to daily practice within the hospital.

The extent of our success required teamwork among nursing, pharmacy, and prescribing clinicians to determine the drugs most often used and most likely to cause a potential error or concern. We spent more than six months in small working groups to evaluate our needs and decide the best course of action for using these drugs safely in the future.

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The teams included representatives from critical care, oncology, obstetrics, medical/surgical, and pediatrics, all of whom had a professional stake in how medications are administered. We reviewed drug dosing guidelines for each of the 48 infusion-delivered medications included in our library. We used the evidence-based literature to establish our own protocols for each, many of them weight-based. These guidelines, approved by the interdisciplinary team, took into consideration circumstances that require dosing parameters to be altered, including, for example, situations involving pediatric patients.

As we charted new territory with the smart pump, we also took a more critical look at our own staff practices. In response, we developed a protocol that required two nurses at the bedside to verify overrides and a progress note reflecting the override and identifying the ordering physician. Doctors could still prescribe as necessary for the patient, but the addition of a second nurse at the bedside provided much needed verification for entering a high or low dose of the prescribed infusion.

Results

In January 2006, we began using 275 pumps in the designated departments. By April 2006, we had collected data from a random sample of 36 pumps (12 each from critical care, medical/surgical and obstetrics). With the help of B. Braun, we evaluated our first three months of usage to get a complete picture of events including dose alerts (attempts to program outside the limits), overrides (doses outside the limits that were accepted), and potential errors (doses that were rejected).

Of 2,536 total doses, 78 dose alerts occurred. Of these 78 alerts, the majority (78 percent) was overridden; that is, the dose was accepted. This represented a trend of dosing titratable drugs both above and below the published dosing limits to achieve patient therapeutic effect. Sixty-nine percent of our override alerts were below the limit and associated with titrating to patient effect or weaning off the drug.

For example, phenylephrine registered 30 total alerts, but 29 of those were actually below the set limit. Titratable drugs delivered below the limit included phenylephrine, milrinone, amiodarone, diltiazem, nicardipine, and fentanyl. Three drugs revealed trends of programming above the limit: vasopressin, oxytocin, and magnesium sulfate. Oxytocin registered 17 total alerts, all of which were above the limit.

For each of these drugs, the doses were corrected to within range only four times, indicating that it was the protocol and drug library limits that may have needed adjustment, rather than clinician or prescriber action. In fact, this prompted a reassessment of protocol and dosing parameters for the drug phenylephrine.

Phenylephrine represented an interesting challenge to us because of its beneficial hemodynamic properties at a variety of dosage ranges, but relatively little evidence-based literature to support its high dose prescribing, which had led to our original, lower dosing parameters. Based on the dose alert data, however, we re-evaluated these parameters and eventually modified our policy to incorporate an intensive review and approval to pharmacy for any high therapy. We will also modify the pump setting to include the newly accepted dosing range.

Further analysis of the dose alert data also revealed two of the 78 alerts represented averted dosing events that could have lead to a significant patient event:

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Phenylephrine was programmed at 1,747 mcg/min, which was 385.3% above the limit (dose range 40-360 mcg/min), but after receiving the alert, was reprogrammed at 80 mcg/min.

Oxytocin was programmed at 166.5 milliU/min, which was 732.5% above the limit (dose range 0.25-20 milliU/min), but after receiving the alert, was reprogrammed at 8 milliU/min. These potential medication events were averted by the software and dosing parameters we put in place proving the efficacy of the dose-limiting technology. With clinical analysis and interpretation of the dosing alerts, we were able to classify the different types of overrides and corrections so that we could identify medication events and adjust practices for best outcomes.

Repeat Study

At 27 months post-implementation, we again analyzed the data logs, this time with a 27 percent random sample of pumps. Of 898 dose mode infusions, there were 52 alerts with six potential averted adverse drug events, representing an error rate of only 0.67 percent. Averted errors were associated with midazolam, propofol, vasopressin and amiodarone. We were pleased to find no dosing errors associated with heparin or insulin and 100 percent compliance with the dose limiting technology.

Discussion

The data we retrieved from the dose-tracking software validated our hospital's decision to convert to the new dose limiting technology. We were able to better understand our institution's needs and help ensure no dosing event would result in an adverse patient event. We could assess whether the dosing overrides were necessary and appropriately verified, and present the data to our colleagues for legitimate discussion and action, instead of solely relying on anecdotal reports.

As data became available regarding significant below limit overrides, we made adjustments to the library settings, further enhancing the effectiveness of our dose alert system and avoiding alert fatigue. The process of utilizing the pumps and new protocols causes us to continually review our practices and make necessary changes, including a re-evaluation of our new phenylephrine protocol.

We were pleased to find only two of the 2,536 doses in the first study and six out of 5,028 doses in the second study represented averted medication events. This was fewer than we expected, indicating a very low incidence of manual programming error associated with this infusion device. Our results gave us confidence in the smart-pump technology, our dosing protocols, and the clinical practices of our clinicians.

We were also encouraged to discover a concrete reduction in infusion-related medication events at Lutheran Medical after our initial implementation of the smart-pump technology and evidence-based protocols from a total of seven events in 2005 to only one in 2007 or an 86 percent decrease. As of today, there have been no events in 2008, which is a 100 percent decrease.

In the process, we also learned that the success of any large technology conversion rests not only on the teamwork and commitment of internal staff, but also on the commitment of the vendor to provide comprehensive services and programs.

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In this case, these included round-the-clock education and technical support, customized training materials, continuing education, and data analysis support. With staff buy-in from across the hospital, we were pleased that all departments experienced the benefits of this technology specific to their practice area.

Conclusion

Smart pumps help to ensure patient safety and encourage better outcomes. But simply booting up a program or recording data is just the beginning. By customizing our drug library system to best fit our institutions needs and by using our vendors thorough expert data analysis and clinical interpretation service, we were able to use this technology to bring about continuous improvement. The smart-pump technology significantly reduced our infusion-related medication events and, just as importantly, the data analysis helped us identify key areas for further improvement. The results of our commitment to combine technology implementation with clinical process improvement initiatives were measurable patient safety improvements today and a system designed to expand with the future.

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