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# Pump Alerting Software

## An **Interim Solution** to **Smart Pump** Implementation

Incorrectly programmed infusion pumps pose a serious patient safety hazard. Part of the Intermountain Healthcare system, LDS Hospital in Salt Lake City purchased smart pumps to address these safety concerns, but due to hardware and software incompatibilities our smart pump implementation was delayed in the ICUs. Despite the delay in implementation, we determined we needed a system that would quickly alert the health care team when IV infusion pumps are programmed incorrectly.

LDS Hospital's shock trauma respiratory intensive care unit (STRICU) is a 12-bed, level-one ICU. Our multi-disciplinary safety team, made up of approximately 14 members, was given the task of developing a safer method of programming our Alaris model 7132 volumetric infusion pumps for high-risk medications.

### Interface Development

Intermountain Healthcare has created and evolved their own electronic medical record (EMR) known as HELP (Health Evaluation through Logical Processing). Our device information acquisition (DIA) interface between our current infusion pumps and electronic medication administration record (EMAR) automatically records all pump dosage and rate changes in the EMAR. We determined that, if we could capture the infusion pump changes and filter the information through a database of drug limits, we could use the DIA as a tool to improve infusion pump safety and alert caregivers of excessive initial dosages and incorrect rate increases. By linking our infusion pumps and EMAR, we could create complex and patient-specific parameters for each individual medication in our database.

With the help of the medical informatics department, we created a computer program to identify inappropriate dosages and rate changes. Through a review of past event reports and with a query of the top 100 most-used medications in the trauma ICU, we developed a list of 11 high-risk infusions. These medications were assigned acceptable "dosage limits" and acceptable "rates of change" that generate visual alerts on computer screens throughout the ICU. These rates and limits were derived from unit protocols, such as our continuous insulin infusion and heparin protocols, and are based on percent increases over the last running rates. Alerts are also triggered by decimal place errors that occur during pump programming.

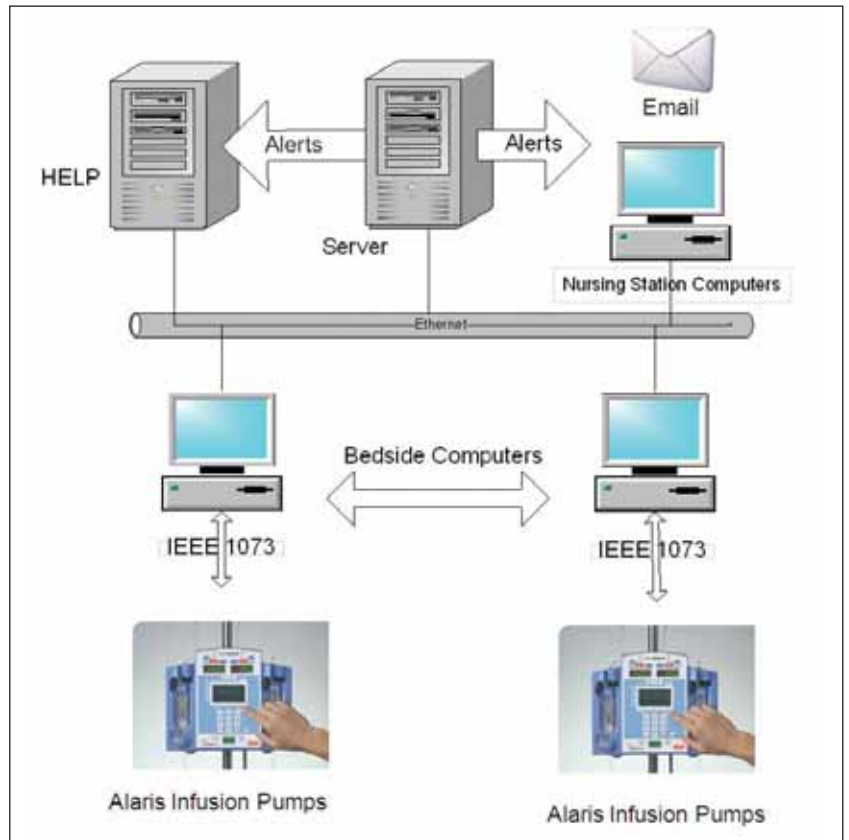


**Diagram of LDS Hospital's enhanced pump alerting system**

### The Solution in Use

When a nurse sets up an infusion pump, he or she must "associate" it, using its established number, with a particular order in the EMAR. The EMAR then electronically captures all dosage changes and charts the infusion. When the nurse programs a dose or rate outside the limits for a particular medication, the program identifies the error. If the dose or rate is not fixed within 30 seconds, the program sends a visual alert, displaying the room and pump number, to each computer screen in the ICU, including those in the patient rooms. To inactivate the alerts, the nurse can either correct the erroneous dosage or rate at the pump, or, if the user feels the infusion rate is appropriate, override the alert. If the alert is overridden, the user is prompted to enter their user name before the screen will clear. Either option will restore the computer screens in the ICU to their previous state within three seconds.

Each alert also sends an e-mail to the computer programmer and the unit pharmacist, showing the room number, the intended infusion rate and the rate that caused the alert, the pump number, and the medication name. E-mails are also sent with information on overrides, rate corrections, and user names. The nurse and pharmacist from the medication safety team use this information to respond to and evaluate the alerts.

### Results

Alert analysis has resulted in changed infusion limits (either making them less stringent or less conservative) and nurse education regarding the safe use of medications and/or proper programming of infusion pumps. The alert program has been live in the STRICU since October 16, 2005. In the first 13 months, we had 657 alerts, 56 of which were directly linked to improved patient safety. Of those 56 alerts, 28 alerts were for insulin, 25 for fentanyl, and one each for lorazepam, heparin, and propofol. Admittedly, there were many false positives during that first year, but they led to adjustments in the programming logic, which have since minimized our false alerts.

We were also able to assess why clinicians deviated from specific unit protocols

# Why Didn't I Think of That...?

and, subsequently, adjust our alerting limits and educate clinicians on the proper use of the high-risk medications. We have also improved the accuracy of our medication charting. For instance, if a pump had been associated with insulin in the EMAR, but was next used to infuse a vancomycin dose without being re-associated, it would electronically chart an insulin infusion, such as 250 units/hour for one hour. The software's alerts now prompt the nurse to correct the pump association, thereby maintaining the accuracy of our charts.

We also programmed a "keep vein open" (KVO) alert into the software in response to the following patient incident: A patient was on a norepinephrine drip at a high rate, and the bag ran out. The unit was busy, and the audible alert from the pump was not heard. The patient began to decline and additional measures were needed to restore the patient's blood pressure. Initially, we programmed a KVO alert for all medications, but because it produced too many unneeded alerts, we now include only cardiac medications and propofol. A visual alert is now seen around the unit, and patients' medication needs can be more quickly taken care of. This enhancement has helped us improve patient safety.

The pump alerting system provides sophisticated alerts for many different parameters. Instead of establishing only soft or hard limits, we can alert for percentage increases over the last running rates, tie the alerts into unit protocols, and alert for any piece of data tied to the EMAR. With enhanced alerting, we have created a smart system – not just a smart pump. Clinician approval rates have been high, and we have installed the alerting software in three other ICUs at LDS Hospital, as well as all five ICUs at Intermountain Medical Center. Currently, 22 medications are screened in our alerting database. A patent describing this process and software was filed with the United States Patent and Trademark Office November 8, 2007.


**Alerts are displayed on every computer in the unit. The screen color alternates from blue to black.**

## Looking Ahead

Our future goal for our "smart system" is to issue alerts based on vital sign trends, age, gender, co-morbid disease states, concurrent drug therapies, and potential drug interactions. The next steps for our software include alerting a rapid response team member, via a pager, when vital signs trend in the wrong direction, or paging a charge nurse when a patient's oxygen saturations trend in the wrong direction. ■


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