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Information Overload: Auditing the Clinical Utility of Smart Pump Reporting Tools

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AUDITING THE CLINICAL UTILITY OF SMART PUMP REPORTING TOOLS

by

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ABSTRACT

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AUDITING THE CLINICAL UTILITY OF SMART PUMP REPORTING TOOLS

by

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Under the Supervision of Professor Philip Brummond

Purpose: Smart pump technology provides detailed information about each infused drug and fluid that can be used to examine trends and assist in data set optimization. When smart pumps interface with the electronic health record through interoperability, additional data are available.

Methods: The primary outcomes of this study were to identify the top 10 drugs implicated in smart pump near miss events and to reduce the number of near miss events related to smart pump programming. Interoperability data from April 2017 to October 2017 were assessed for near miss trends. Potential interventions for the top 10 drugs were compared using a risk matrix. Secondary outcomes measured the number of data sets circulating prior to each data set update and the duration of time taken for 80% of pumps to accept the most recent data set.

Results: A total of 291,503 infusions were included in the preliminary analysis. There was a low frequency of near miss events, with 4,440 alerts (1.5%) comprising the top 10 drugs. An evaluation of the number of circulating data sets prior to each bimonthly update demonstrated that 98.87% to 100% of pumps in active circulation were using the most recent data set. The time for 80% of smart pumps in active circulation to accept the newest data set was between day 0 and day 1 following the data set update.

Conclusion: Interoperability data is not ideal for continual monitoring of smart pump metrics but can be useful for identification of workflow optimization opportunities.

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Introduction

Smart pump technology for administration of intravenous (IV) drugs has evolved over the last decade, with many published reports suggesting a reduction in drug errors when pump libraries are optimally used.[1] Approximately 88% of U.S. hospitals[2] use smart pump technology which provides the capability to have highly customized drug libraries to promote safe drug administration practices by setting maximum and minimum parameters for infused doses, concentrations, and rates of infused drugs and IV fluids.[1,3]

The smart pump and electronic health record (EHR) programming interface has also become more advanced with many hospitals utilizing interoperability technology as an attempt to simplify programming by prepopulating infusion parameters from scanned barcode medication administration (BCMA). Interoperability is a two-way interface between the smart pump and EHR that allows both technologies to communicate with one another.[4,5] Interoperability decreases infusion pump programming errors by eliminating the need for infusion parameters to be manually programmed and also reduces the cross-referencing between a drug order and pump programming.[6]

In addition to promoting safe drug administration practices, smart pump software collects detailed information about each infusion that may be used to examine trends and assist in drug data set optimization.[7] Interoperability provides an additional layer of data beyond data collected by smart pump software. There is very little published literature on standardized smart pump metrics and none on interoperability metrics. The Institute for Safe Medication Practices (ISMP) acknowledges the significance of this data, stating that smart pump analysis is essential for

maximizing benefits of this technology.[8] Despite the abundance of published data of various smart pump metrics,[9,10] and access to a variety of reporting tools, standardized metrics and strategies for evaluating this information are not defined by patient safety, pharmacy, or informatics organizations.[8,11-13] This study was done to evaluate the utility of assessing smart pump interoperability reports generated from the EHR to determine the usefulness of data compared with other reporting platforms commonly used to evaluate smart pump metrics.

Methods

Assessment Metrics: Smart pump interoperability was implemented in December 2016 at Froedtert Hospital and the ambulatory infusion clinic setting. Prior to this implementation, current performance indicators utilized were from the Knowledge Portal tool (BD Carefusion, San Diego, CA) to evaluate quarterly adherence to smart pump data set limits and the frequency of soft and hard stop alert limits. To gain a better understanding of interoperability data metrics, an assessment of the 4 reporting tools that our institution has access to were evaluated and included: remote server data (BD, Carefusion, 2018), smart pump specific data (Knowledge Portal, BD, Carefusion, 2016), peer collaborative network data (CatalyzeCare, West Lafayette, IN, 2018), and EHR interoperability reports (EPIC Systems Incorp, 2017). Each of the evaluated tools collectively evaluate various metrics ranging from uptake of data sets to alert frequency of the 1,009 Alaris BD® (San Diego, CA) large volume smart pumps used across the campus. These data tools capture data from our academic medical center consisting of 604 inpatient beds and the 5 infusion clinic settings consisting of approximately 120 outpatient chairs.

Reporting Tool	Example Features
Server reports	• Device data set uptake data • Data set transfer status • Current connectivity • Device event log • Utilization history
Smart pump software reports	• Compliance data • Soft and hard alert data • Cost avoidance estimations • Alarm reports • Dashboard summary
Interoperability reports	• EHR pump interface failures • Infusion near miss report • Individual patient data • Individual unit data
Infusion pump informatics collaboration network reports	• Soft and hard alert data • Good and missed catches • Time to alert override • Programming benchmarks • Data set compliance • External comparison analytics

Table 1. Comparison of select features from smart pump analytics reporting tools available at Froedtert Hospital.

Data Source Selection and Key Performance Indicators: After evaluation of the capabilities of each reporting tool, the EHR interoperability data was selected for review since this report had never fully been assessed for performance indicator metrics post-interoperability implementation. The report added a new data element surrounding near miss events that was targeted as the primary endpoint.

Evaluation of near miss events described in the EHR report (Epic Systems Incorp, Verona, WI) focused on identifying the top 10 drugs implicated in smart pump near miss events. The EHR Near Miss Report provides infusion near miss details generated through interoperability. The

term near miss in this report refers to differences in the drug, dose, rate, concentration, or patient weight between the EHR and the smart pump.

To minimize near miss events occurring due to outdated data sets in circulation, secondary outcomes measured the number of smart pump data set versions circulating prior to each bimonthly data set update (BD CareFusion remote server, San Diego, CA) and the duration of time until 80% of pumps used for patient care were on the most recent data set (CareFusion Knowledge Portal, San. Diego, CA).

Data was collected over a 6 month time period from April 1, 2017 through October 31, 2017 and compiled in a Microsoft Access™ database. A risk matrix was developed to compare and contrast potential interventions for each of the top 10 drugs identified. Potential interventions were stratified according to their potential patient safety benefits and/or technical benefits (eg, reduction of nuisance alerts) as well as their relative ease or difficulty to implement. A modified Delphi approach was utilized to determine which intervention to implement. A statistician was consulted prior to selecting an intervention.

This study was approved by the Institutional Review Board at the Office of Clinical Research and Innovative Care Compliance at our institution.

Results

Preliminary Data Analysis

A total of 291,503 infusions were administered using interoperability from April 1, 2017 to October 31, 2017 and included in the analysis of the primary outcome. The near miss report during this 6 month period yielded a very low frequency of near miss events at 3.7% (N=10,776) of total infusions. The most common type of near miss event was wrong rate (49.5% of total near misses), followed by wrong drug (19% of total near misses). Wrong rates were either nearly all too fast for a given drug (eg, majority of ondansetron infusions were administered at a rate faster than the EHR rate) or nearly all too slow (eg, majority of albumin infusions were administered at a rate slower than the EHR rate). Only 10.2% (N=1,099) of near miss events identified as wrong drug reflected true alerts of an incorrect drug that was scanned but not ordered in the EHR. For the remaining cases of a wrong drug near miss events (N=9,766) the report indicated a drug order on the pump but an error of "no value from pump" in the drug field. Further investigation identified that these alerts were the result of a nursing action after a patient transferred from a care area not utilizing interoperability (eg, Emergency Department) to a care area within the scope of interoperability with the drug infusing.

Primary Outcome Results and Intervention Selection

The top 10 drugs implicated in near miss events comprised 1.5% of total infusions (4,440 out of 291,253 infusions). Six of the drugs were fluids or electrolytes.

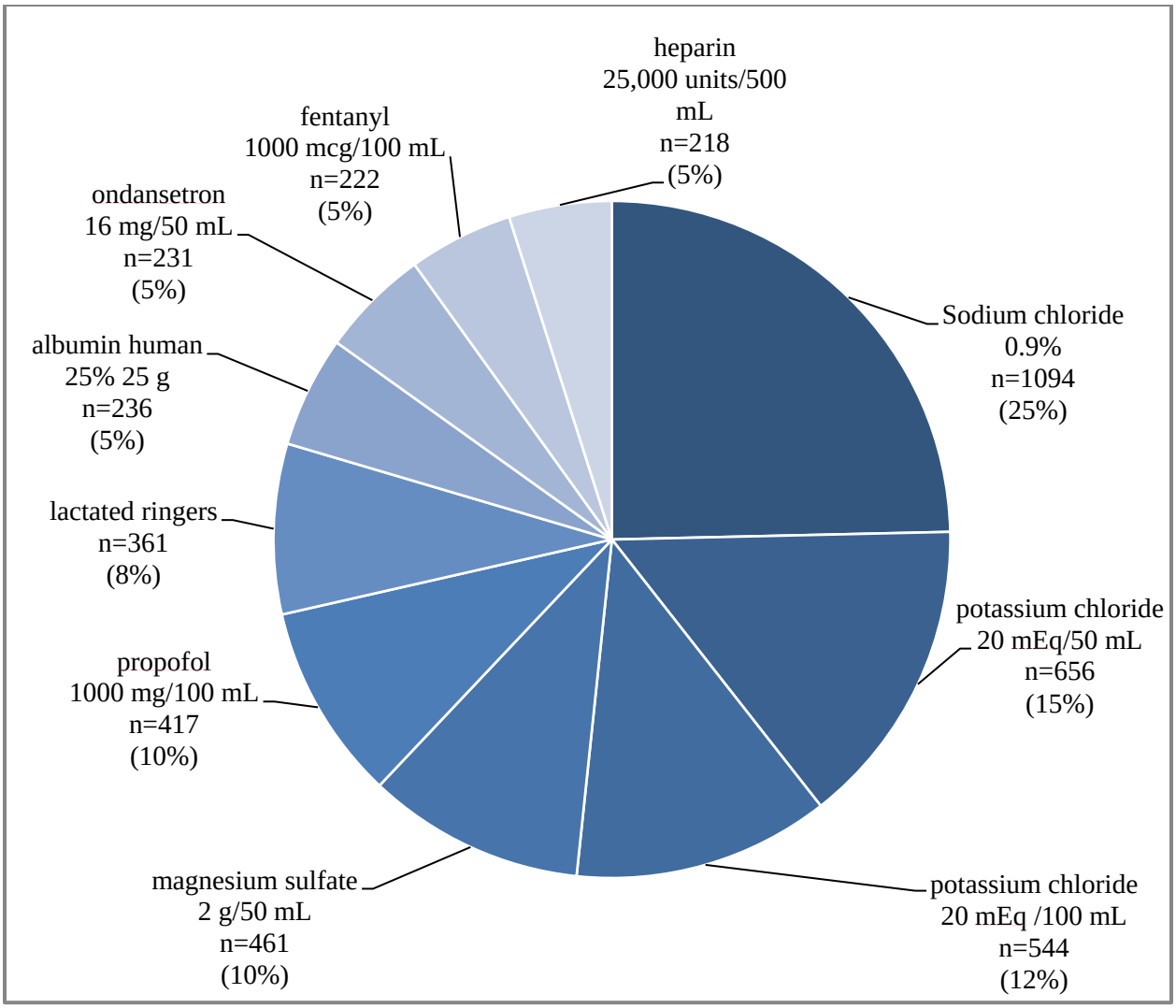

Figure 1. Top 10 drugs implicated in smart pump near misses from April 1, 2017 to October 31, 2017 (N=4,440).

A wrong rate near miss was associated with all of the top 10 identified drugs (N=1,724) and a wrong drug near miss was associated with all of the top 10 identified drugs except ondansetron (N=755). This was consistent with the larger data set as well.

Each of the 10 medications was analyzed to understand the underlying reason for triggering the near miss. This included an assessment of both the quantity, type, and near miss trends for each

drug, as well as retracing nursing workflows, and consulting frontline staff and pharmacy informaticists. Following an assessment of risk matrices for each medication, propofol was selected for an intervention based on safety and regulatory implications. Propofol accounted for 10% (N = 417) of the 4,400 top 10 drugs associated with near miss events. Approximately 16% of near miss events associated with propfol were due to a faster rate as a means to administer a bolus from the infusion bag. This action was being captured as a near miss because there was not an order for the bolus on the EHR. While administration of the bolus may have been clinically appropriate in many cases, it presented both a safety and regulatory concern.

The implemented intervention involved working with the Pharmacy Informatics team to modify 3 common critical care order sets that contain propofol order panels. This change made the order for propofol boluses from the infusion bag more prominent to further promote its use. Additionally, the nursing order for daily sedation interruption with a propofol infusion was paired with the propofol bolus from infusion bag order.

Secondary Outcome Results

The percentage of smart pumps with the most current data set prior to each bimonthly update was between 98.87% and 100%.

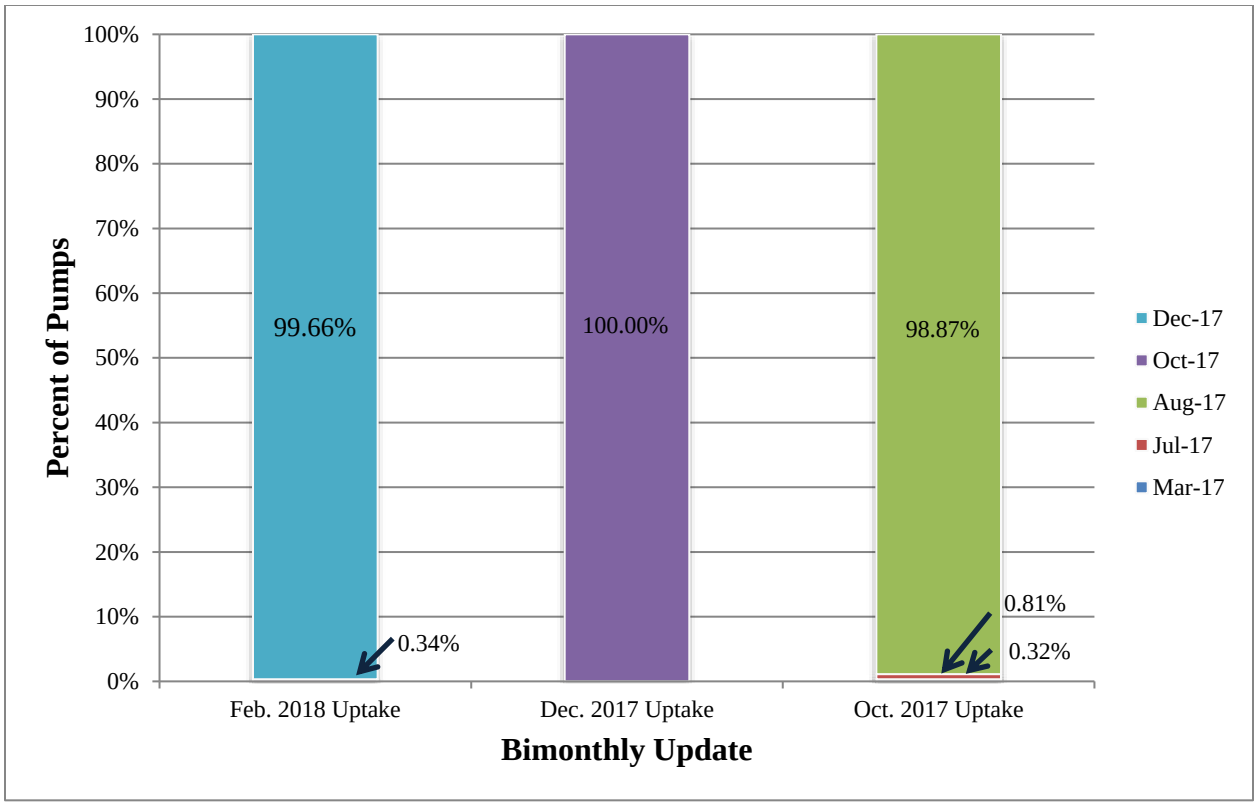

Figure 2. Number of circulating data sets prior to smart pump data set update.

The duration of time for 80% of circulating smart pumps to accept a new data set was between 0 and 1 day, measured from the date of data set replacement to date of first observed alert from the new data set. Interestingly, the February 2018 data set update was taken up at a much faster rate than the October 2017 and December 2017 updates were. Patient census was very high during this month, and may have played a role in these unexpected results.

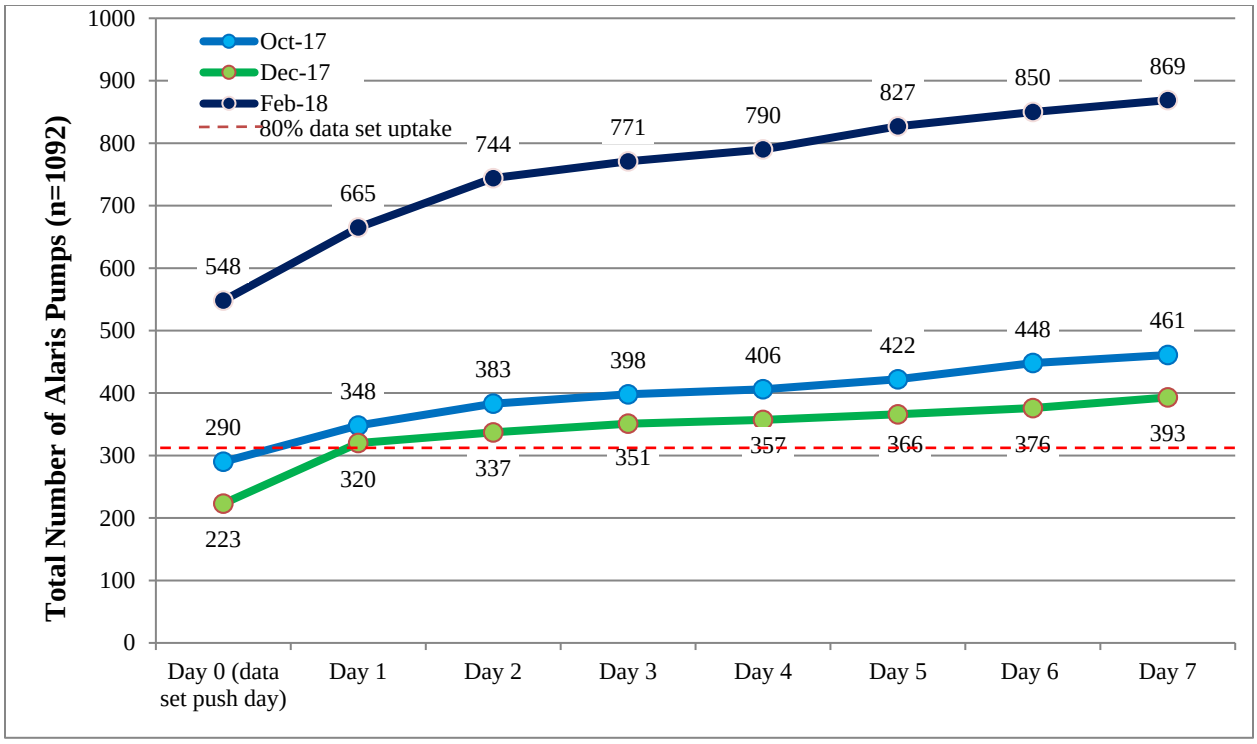

Figure 3. Time to new data set uptake.

Smart pumps that were not in active circulation according to the All Infusion Report (Knowledge Portal, BD, Carefusion) were excluded from both secondary outcome analyses.

Post-Hoc, Post-Intervention Assessment of Propofol Near Miss Events

A subsequent assessment of propofol near miss events was completed 6 months after the modified order sets and order panels were implemented. There was a similar number of near miss events associated with propofol after the April 2018 implementation of the change (N=390 after the change, relative to N=410 prior); however, the number of propofol infusions and boluses ordered correctly from order sets increased significantly from 19.1% prior to the intervention to 43.1% after the intervention (P = 0.0006).

Discussion

This study describes the utility of an EHR interoperability near miss report as a potential tool for identifying smart pump performance metrics. The low prevalence of near miss events, defined as differences in the drug, dose, rate, concentration, or patient weight between the EHR and the smart pump, reflects the overall effectiveness of interoperability at our institution. This finding is consistent with the high nursing compliance with interoperability (90%) at our institution. Analysis of the top 10 drugs implicated in a near miss demonstrated inherent functionalities of interoperability and nursing administration processes (ie, workarounds) as the underlying cause for the near miss event in the majority of instances. Propofol infusions were associated with a wrong rate as a result of bolus administrations not ordered in the EHR. While propofol was not associated with the greatest number of alerts, it was selected for intervention due to its high alert classification[14] and to ensure compliance with The Joint Commission standards related to appropriate documentation of administered medications. Inclusion of bolus from the infusion bag orders within propofol order sets and order panels did not decrease the number of near miss events in a preliminary assessment; however, there was a substantial increase in the proportion of propofol infusions ordered appropriately from order sets and order panels. Though not the hypothesized outcome, this application of a forcing function within the EHR validated the success of a higher power error reduction strategy with the goal of preventing medication errors at the point of medication administration. Vitoux and colleagues published a similar report wherein smart pump data from 42 hospital sites were used to identify and analyze the top 10 drugs implicated in point of administration alerts. Propofol was associated with 15.1% of the 11,485 top 10 infusion alerts. Unsafe use of smart pumps to administer boluses from the infusion bag outside of the enabled functionality was identified as the underlying process generating the

alert. While the authors did not report on subsequent interventions in response to this practice, they emphasize the use of higher order error reduction strategies (eg, hard constraints on infusions likely to be bolused) and the importance of optimizing smart pump data sets to enhance clinical practice.[15]

We documented the proportion of smart pumps on the most recent data set prior to each bimonthly update and the time for new data set uptake to account for any impact of multiple circulating data sets on the results. Nearly 100% of circulating smart pumps had the most current data set prior to each update, with the time for 80% of circulating pumps to update being very low, at no more than one day. While these secondary outcome results are limited by the method of measurement, it is unlikely that the presence of multiple data sets impacted the number of near miss events. While not the initial intent of the secondary outcomes, these results help validate a reliable wireless connection and nursing compliance with proper data set transfer. Our findings differed from those of a recent analysis of smart pump data set update delays across 11 health systems encompassing 49 hospitals. DeLaurentis and colleagues reported median delays of 22 to 192 days. A proposed strategy for reducing the prevalence of delays is decreasing the frequency of data set updates; however, investigators noted that more frequent updates did not always lead to longer update delays.[10] The inclusion of multiple health systems likely contributed to the divergent results in the present study. An in-depth evaluation of data set acceptance delay was not the intent of the present study; however, our results support the variability among facility wireless networks and the importance of understanding this impact on patient safety and interpretation of smart pump data.

This study is the first to describe the process and impact of examining an EHR interoperability near miss report to optimize smart pump metrics. The direct impact of smart pump interoperability on these medication safety outcomes is also being explored. Seven months after interoperability implementation at a regional hospital, nursing compliance with the dose-error reduction software (DERS) increased from 91.8% to 94.4% and alerts and overrides substantially decreased as interoperability led to fewer manual errors for the DERS to capture. Annual reported safety events related to infusion pump programming declined from 3 events to 1 event following implementation.[6] The utility of the EHR interoperability report to directly improve medication safety was outside the scope of this study; however, the results suggest that this report is not the best tool to capture consistent data to draw conclusions on medication error prevention. Further analysis of available smart pump data reports is necessary to understand the best mechanism to directly improve safety outcomes.

As the implementation of smart pump technology and interoperability continues to grow[2], there is a greater need for enhanced understanding and transparency of smart pump data. While smart pump interoperability provides an additional layer of data, health-systems are challenged with insufficient resources to analyze the data and an inability to extract meaningful data to demonstrate performance.[16]

Conclusion

Our results demonstrate the use of an EHR interoperability near miss report to identify unanticipated nurse workflows that have important patient safety and regulatory consequences. The EHR near miss report is not ideal for continual monitoring of smart pump performance

metrics or direct prevention of medication errors but can be a useful tool to help identify opportunities for workflow optimization. This study adds to the growing body of literature on smart pump metrics and validates the need for similar evaluations of available smart pump and interoperability reports as a means of providing meaningful performance metrics at regular intervals to optimize patient safety.

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