Table B.57: Infusion Pumps, Structured Process Change and Workflow Redesign—Single Studies

Note: Full references are available in the [Section 12.1 reference list](#Section12point1refs).

| Author, Year | Description of Patient Safety Practice | Study Design; Sample Size; Patient Population | Setting | Outcomes: Benefits | Outcomes: Harms | Implementation Themes/Findings | Risk of Bias (High, Moderate, Low) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Biltoft and Finneman, 201810** | Hospital implemented smart pump- electronic medical record (EMR) interoperability to decrease opportunities for errors by reducing manual clinician keystrokes needed to program an infusion.  Conducted workflow analyses prior to implementation.  The team made necessary changes to streamline workflow, such as reconfiguring rooms so that infusion pumps and EMR computers could be accessed at the same time for the most accurate infusion documentation. In addition, implemented a double-check to ensure that all medication identifiers populated the correct drug library and corresponded to those in the EMR. This helps streamline nursing workflow, especially when there are patient transfers between units. | Case study | Hospital (286 beds) within a regional health system. United States | Pre-population of infusion parameters reduced manual keystrokes by 86%.  Compliance with using interoperability technology averaged 70-80% in the first 7 months.  Rate of appropriate entry of patient identification information by pump users increased from 35.5% to 81%.  Mean monthly number of alert overrides decreased by 20%. | Not provided | Pharmacist-led implementation of smart pump-EMR interoperability led to measurable improvements in intravenous (IV) medication safety and improved accuracy, timeliness, and efficiency of IV infusion documentation. | High—case study |
| **Chaturvedi et al., 20199** | Hospital implemented intravenous clinical integration (IVCI), which links EMRs, computerized physician order entry (CPOE), smart pumps, and bar code medication administration systems in order to reduce human errors caused by manual documentation.  During the planning process, hospital leaders discovered significant variation in nursing workflows for IV administration and engaged in multiple efforts to standardize workflows. | Qualitative description of hospital’s IVCI implementation.  Conducted semi-structured interviews with 33 informants: 4 pharmacists, 8 IT personnel, 10 frontline nurses, 4 nurse trainers, and 7 hospital leaders.  Researchers observed nurse IVCI training and nurses on five units. | Large nonprofit academic medical center (886 beds), United States | Hospital leaders viewed standardization as extremely beneficial because it was perceived to reduce the frequency of nursing workarounds that could cause patient harm. | Nurses often forgot to validate infusion completion times, which led to large errors in recorded infusion volumes. Although the EMR automatically enters infused volumes into patients’ charts, nurses are required to manually validate completion times.  IVCI significantly reduced the amount of time required by nurses to program the pumps but did not decrease their workload overall. Many nurses reported that IVCI increased the number of computer steps required to administer medications.  There were challenges gaining buy-in from nurses to adopt workflow changes, and frontline staff expressed concerns regarding safety of workflow changes.  Since not all units had IVCI, moving patients required special procedures. | IVCI implementation is not just a technological intervention, but also requires workflow standardization in order to be successful. | Moderate |
| **DeGraff, 20138** | In response to a shortage of IV pumps and staff members hoarding pumps, the team created a new procedure for cleaning and restocking pumps on floors. This allowed staff to easily see when the supply fell below a set minimum and pumps needed to be restocked. | Case study | Five hundred seventy-bed regional referral center and teaching hospital, United States | New process reduced pump handling steps from 26 to 8.  Pumps were available when needed 94% of the time, compared to 28% before implementation. | Not provided | Hospital dramatically improved utilization of IV infusion pumps by streamlining their workflow. | High—case study |
| **Iacovides et al., 201412** | Survey investigated the extent to which standardization of infusion devices has occurred. | Online survey sent to device managers and trainers within National Health Service (NHS) organizations.  Forty-five respondents participated in study. | Staff were involved within 49 U.K. organizations representing 120 hospitals. United Kingdom. | A high level of standardization was reported. (Only 4% reported there was no standardization at all.) | Reasons for not using dose error reduction software included time required to implement and train staff, and not being able to standardize across the entire site. | To implement technology, organizations need to overcome challenges, including existing device contracts, infrastructure and resources available, required time and investment, and complications related to lack of standardization. | Moderate |
| **Lyons et al., 20187** | Observers compared medications being administered against the prescription and local policies/guidance. Recorded any deviations from a prescriber’s written or electronic medication order, the hospital’s intravenous policy and guidelines, or the manufacturer’s instructions. | Point prevalence observational study.  Data were collected on 1,326 patients who were administered 2008 infusions. | 16 NHS trusts, England. | Most (90%) of the observed errors were considered unlikely to cause harm.  One site responded to poor compliance with documentation of medication administration by purchasing handheld computers to allow staff to access electronic records in closer proximity to patients. | Nearly 48% (47.9%) of infusions had at least one procedural or documentation error. Non-compliance with hospital requirements for labeling infusion administration sets was most common.  Discrepancy rates were higher in infusions delivered using smart pumps compared to those without safety features. Differences were linked with policy requirements. Error rates were similar. | Procedural deviations may not always represent poor practice, but rather poor fit between policy and everyday practice. | Moderate |
| **Pinkney et al., 201011** | Conducted 3 experiments to quantify the impact of infusion pump type, smart pump design, and training on nurses’ ability to safety deliver IV medications. | Conducted 3 observational studies. | Usability lab that simulated an inpatient unit, Canada. | Smart infusion systems were found to statistically reduce the rate of medication errors.  Users programmed almost all infusions within a drug library when the pump workflow either defaulted them into the drug library or prompted them to use the drug library. | Soft limit warnings had no impact on preventing errors since nurses simply overrode them. | Smart pumps that rely on users actively engaging the drug library are less preferable to those that encourage/require nurses to enter into the drug library. Supporting and constraining users to follow the preferred workflow is a design-oriented solution that can help ensure users employ the safety features of the smart pump.  Smart pump implementation should be viewed as part of a larger safety initiative, not just technology replacement. Implementation should focus on design of workflows and environments. | Moderate |
| **Russell et al., 20154** | Study examined the impact of a bidirectional interface between CPOE and pharmacy systems on the frequency and types of discrepancies between orders for medication and intravenous fluid (IVF) infusions and pump settings.  Pediatric intensive care unit (PICU) underwent expansion and relocation that caused changes in workflow. | Uncontrolled before and after study using a prospective, observational design.  Compared proportion of discrepancies with results of a study conducted by the authors in 2007. | Children’s hospital, PICU (72 beds), United States | Overall discrepancy rate did not change; however, type of discrepancy changed. Unauthorized medications decreased from 60% in 2007 to 4% in 2010.  Bidirectional interface allowed pharmacist to immediately reconcile verbal orders.  Change in workflow on rounds was likely responsible for decrease in discrepancies for parenteral nutrition subgroup medications. In the new environment, pharmacy and dietary presence on rounds increased, resulting in greater collaboration among pharmacists, dieticians, and the providers responsible for ordering, preventing the number of reorders that previously had occurred. | Fifty-four of 303 (18%) observations of medication infusions revealed order programming discrepancies, while 46 of the 152 (30%) observations of IVF revealed order-infusion pump discrepancies.  There was significant increase in proportion of omitted medications and wrong dose. Change in workflow was suspected to be the reason for the increase. | Analysis suggests that the observed decreases in discrepancies were not solely attributable to the technology. Workflow and other factors had an impact on the observed changes. | Moderate |
| **Schnock et al. 20176** | Objective of the study was to investigate the frequency and types of IV medication errors associated with the use of smart pumps.  Measured policy violations to assess the IV medication administration process. | Prospective point prevalence approach to capture errors associated with smart pump administered medications.  Evaluated 478 patients receiving and/or prescribed IV medications. | Ten hospitals: seven academic medical centers and three community hospitals, United States |  | Violations of IV labeling and tubing change policies were the most frequent error types (60% and 35%, respectively).  Infusion rate errors were the leading type of serious medication error. | High rate of errors was found in the administration of IV medications despite the use of smart pumps, but relatively few were harmful errors.  In reviewing labeling policy, researchers found that some information needed prior to implementation of electronic records is no longer necessary.  Team recognized the benefits of using standardized tubing labels to distinguish when nurse should change tubing.  Results highlight the importance of reviewing existing practices and policies when implementing technologies such as smart pumps. | Moderate |
| **Wiseman et al., 20185** | Implemented clinical pharmacist annotation on medication charts (i.e., completing missing information in infusion medication orders) and adopted smart pump technology.  Smart pump adoption involved a 6-month development phase. | Semi-structured observational study conducted over four periods, pre and post intervention: July 2009, July 2011, April 2012, and June 2014.  Over 5 years, 16,866 patients and 2,599 infusions were observed. | Four hundred fifty bed tertiary referral hospital, Australia. | After implementing pharmacist annotation, errors reduced from 16.6 to 8.1%. Implementation of smart pumps resulted in a reduction from 8.1 to 3.9%. | Not provided | Results suggest clinical pharmacists play a key role in reducing rate of errors. | Moderate |