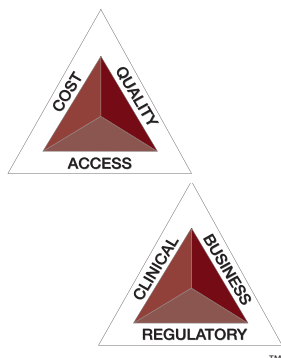


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SUPPLEMENT



## The National Burden of Preventable Adverse Drug Events Associated with Inpatient Injectable Medications

*Proceedings from a Virtual Roundtable  
Program, January 14, 2013*

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# The National Burden of Preventable Adverse Drug Events Associated with Inpatient Injectable Medications

Proceedings from a Virtual Roundtable Program, January 14, 2013

A recent burden of illness study quantified the frequency and costs of injectable drug medication errors that cause patient harm, also called preventable adverse drug events (ADEs).<sup>1</sup> This study focused on injectable medications used in the inpatient hospital setting because of their frequent use, high risk, and potential for targeted prevention strategies.<sup>2</sup>

## Background

Hospitalized patients typically receive a number of different medications during inpatient treatment. Many of these medications are delivered by injectable routes, and these injectable medications are among the highest risk for error and the most severe harms.<sup>3</sup> In a study of inpatient ADEs, 50% of the medications implicated were injectable, including antihypertensive drugs, insulin, and anticoagulants.<sup>4</sup>

Hospitals, third-party payers, and patients incur substantial direct and indirect costs associated with preventable ADEs. In a 1997 study, preventable ADEs were estimated to add \$4685 in adjusted, postevent costs to an inpatient hospitalization, contributing an extra \$2.8 million in annual costs per hospital.<sup>5</sup> Furthermore, the Institute of Medicine estimated that preventable ADEs impact up to 450,000 hospitalized patients in the United States and add \$3.5 billion in extra costs annually.<sup>6</sup> Healthcare providers are not immune from the economic burden of preventable

ADEs. Litigation increases costs for healthcare stakeholders, and provider costs related to medical professional liability are substantial.<sup>7</sup>

For the purposes of this publication, medication errors refer to any error that occurs during the medication use process. An ADE is defined as any injury associated with medication. Not all ADEs are the result of errors or are preventable. For example, there may be no warning that a patient will have an allergic reaction to a medication. When an ADE coexists with a medication error, it is considered a preventable ADE. Finally, injectable medications refer to any drugs that are administered through the skin barrier via a needle, including IV infusion, intramuscular, and subcutaneous routes.

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# Clinical and Process Issues Concerning Preventable Adverse Drug Events Associated with Inpatient Injectable Medications

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*Dr Rothschild, co-author of a recent paper on the national burden of preventable ADEs, discussed his research, emphasizing new insights and practical implications for prevention in the acute care setting.*

More than 7 million serious, potentially avoidable, medication errors occur annually, and approximately 7000 people die annually in the United States as a result of preventable medication errors.<sup>1,2</sup>

Nearly 4 million preventable medication errors take place in the inpatient setting annually.<sup>1,2</sup> According to the US Department of Health and Human Services, approximately 1 in 7 Medicare inpatients have an error that causes either prolonged hospitalization or permanent harm. One-third of those errors are associated with medications.<sup>3</sup> Approximately 50% of harmful adverse drug events (ADEs) are thought to be preventable.<sup>3</sup>

Medication errors can take many forms, including the wrong dose (delivered or prescribed), dose given at the wrong time or via the wrong route of administration, or dose delayed or missed altogether. In addition, a patient may have been given a drug even though they had a known allergy or contraindication to that drug or class of drugs.<sup>4</sup>

There are also myriad causes for medication errors, including but not limited to<sup>5</sup>:

- Inadequate dissemination of drug knowledge to physicians and other clinicians
- Incomplete patient information
- Failure to follow guidelines or established protocols
- Transcription errors
- Lapses in judgment and performance.

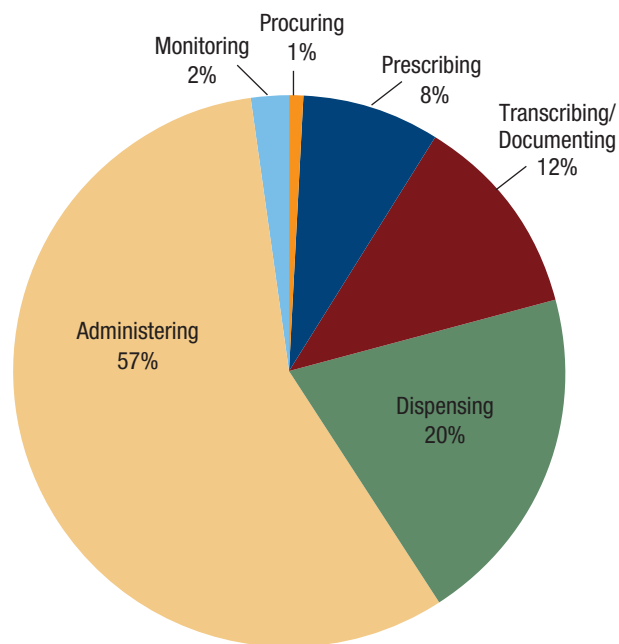
One challenge with interpreting research on medication errors is that unless a rigorous observational study has been conducted, most data contain only errors that are reported. Spontaneous reports indicate that the majority of injectable medication errors occur during the administration (57%), dispensing (20%), transcribing (12%), and prescribing (8%) phases of the process (Figure 1).

The National Coordinating Council for Medication

Error Reporting and Prevention (NCC MERP) provides an index that classifies medication errors into Categories A through I, based on the severity of the outcome for the patient (Figure 2, page S62). It is possible to break down reported errors into the nine NCC MERP categories, noting errors that do and do not reach patients and differentiating which errors cause harm.

Another limitation when evaluating medication errors is data availability. In the MedMarx 2011 data

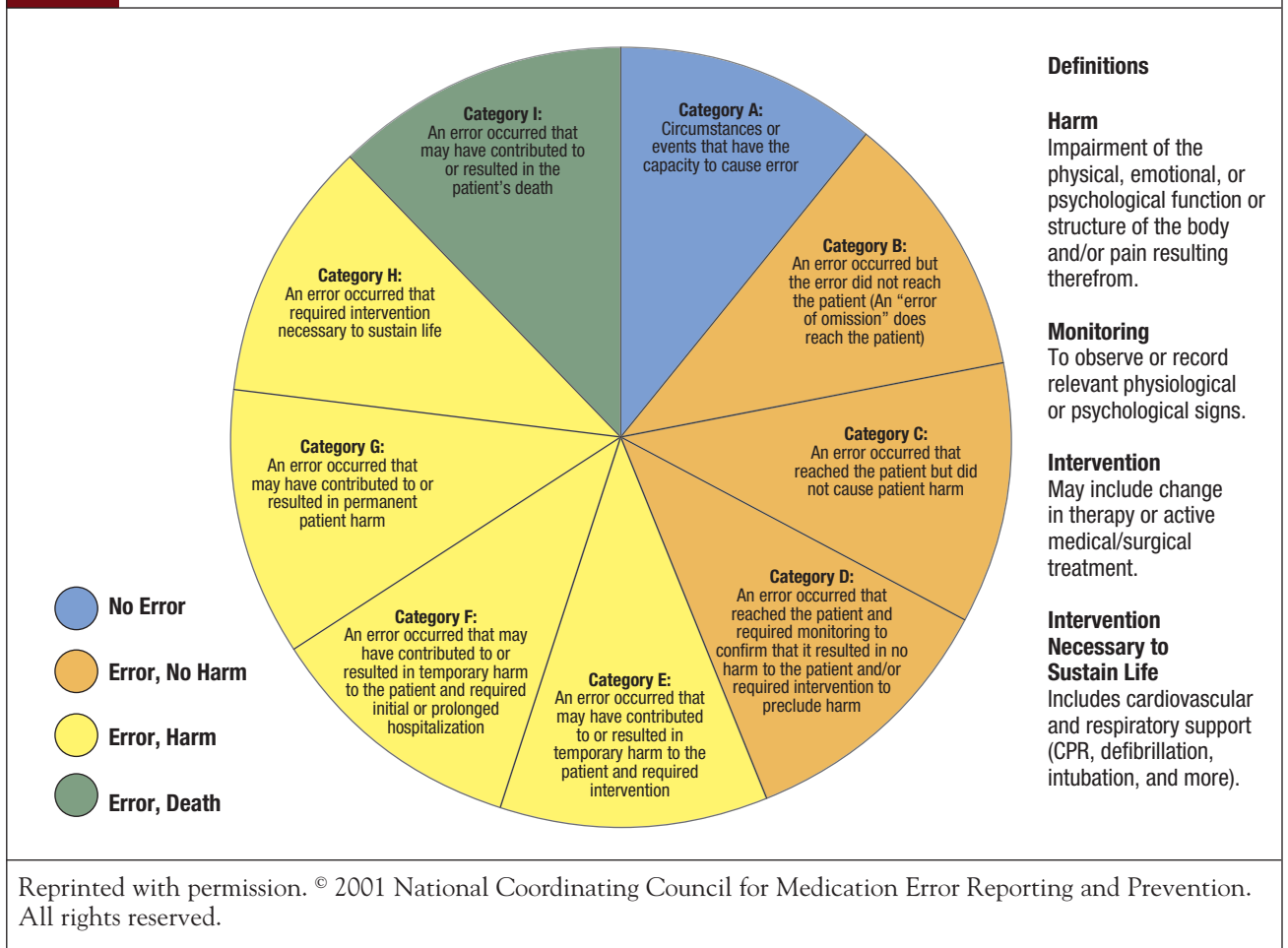
**Figure 1** Error Distribution by Process Node



Source: Inpatient, Injectable (administration route: subcutaneous, intravenous, intramuscular, epidural) drug errors (N=5389, NCC MERP CDEFGH) by Node. Quantros MedMarx, 2011



**Figure 2** NCC MERP Index for Categorizing Medication Errors



files, 184 injectable medication errors caused harm (NCC MERP Categories E–I) versus a total of 5389 errors that reached the patients (NCC MERP Categories C–I). The low sample size of harmful errors makes it difficult to make strong observations about the proportions of harmful errors. Nonetheless, the proportion of error types is similar across injectable medication errors that

**Perhaps most important, injectable medications have greater potential for serious errors causing serious harm than medications administered by other routes, such as oral or sublingual.**

reach the patient regardless of whether harm is caused. **Figure 3** (page S63) shows that among reported errors, those related to dose/quantity, omission, or prescribing make up the majority across process nodes.

For many reasons, the inpatient setting is particularly ripe for medication errors. An overwhelming majority of hospitalized patients receive an injectable medication of some type. We believe that the error rate is higher than reported because error reporting is voluntary in most hospitals, and the choice to report may be influenced by the perceived risk of negative implications for the staff member who made the error. Perhaps most important, injectable medications have greater potential for serious errors causing serious harm than medications administered by other routes, such as oral or sublingual. In the hospital, patients typically do not participate in the preparation or administration of medications, and as a result, they often do not know what they are receiving. In this way, the potential for error (and harm) is magnified in the inpatient setting. Although it is difficult to envision a patient accidentally taking a 10-fold or 100-fold overdose of a tablet, it is not rare to see a 10-fold or 100-fold overdose of drugs administered by injection as a result of incorrect

**Table 1** Probability of Preventable ADEs per Injectable Drug Administered and Administrations of Injectable Drug per Admission

Injectable drug group	Probability of preventable ADE per administration of injectable medication, <sup>a</sup> % (95% CI)	Injectable drugs administered per admission, <sup>b</sup> N (95% CI)	Total admissions receiving injectable medication, in millions, N (95% CI)
Insulin	1.16 (0.43-1.89)	0.74 (0.74-0.74)	6.7 (6.7-6.7)
Cardiovascular	0.50 (0.19-0.82)	0.51 (0.51-0.51)	5.3 (5.3-5.3)
Narcotic/analgesic	0.33 (0.12-0.53)	2.29 (2.28-2.29)	15.4 (15.4-15.5)
Anticoagulant/thrombolytic	0.26 (0.10-0.43)	1.92 (1.92-1.92)	14.2 (14.2-14.2)
Electrolytes/minerals	0.25 (0.09-0.40)	0.85 (0.84-0.85)	5.9 (5.9-5.9)
Anxiolytic/sedative	0.22 (0.08-0.35)	0.63 (0.63-0.63)	12.0 (12.0-12.0)
Anti-infective	0.15 (0.06-0.25)	2.93 (2.93-2.93)	18.5 (18.5-18.5)
Other	0.11 (0.04-0.19)	5.53 (5.52-5.53)	25.7 (25.7-25.7)
Mean	0.25 (0.09-0.40)	15.39 (15.38-15.40)	31.4 (31.4-31.4)

<sup>a</sup>Estimated from Premier Database and Quantros MedMarx.  
<sup>b</sup>Weighted average of all hospitalizations, by Medicare severity diagnosis-related group in the United States.  
 ADE indicates adverse drug event; CI, confidence interval.  
 Source: Reference 6.

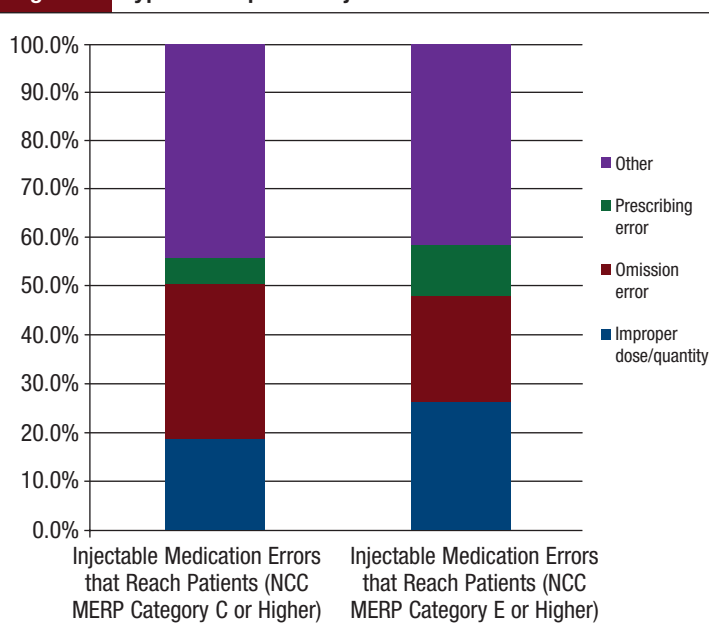
concentrations or incorrect rate settings.

Our study sought to quantify the economic burden of preventable ADEs related to inpatient injectable medications and used the database of reported medication errors to target the frequency of harmful medication errors by drug type. Overall, the results indicated that the likelihood of a preventable ADE in hospitalized patients was approximately 1 in 400 injections, or 0.25%.<sup>6</sup> Furthermore, we estimated that as many as 25 preventable ADEs occur daily in a typical hospital administering 10,000 injections. This frequency translates to approximately 9000 preventable ADEs annually for an average hospital.<sup>6</sup>

Table 1 shows the probability of a preventable ADE for frequently administered injectable drug categories. The per-dose risk of a preventable ADE is highest for insulin (1.16%), followed by cardiovascular agents (0.50%), and narcotic analgesics (0.33%).<sup>6</sup> With regard to volume, the most often administered drugs in the hospital are the anti-infectives, followed by narcotic analgesics and the combined category of anticoagulants and thrombolytics. The data support common knowledge that injectable drugs are widely used in the inpatient setting. Our analysis showed that an average of 15.39 injectable drugs are administered per admission.<sup>6</sup>

When volume and risk data are combined, the

**Figure 3** Types of Reported Injectable Medication Errors



Sources: Inpatient, Injectable (administration route: subcutaneous, intravenous, intramuscular, epidural) drug errors (N=5389, NCC MERP CDEFGH) by Node. Quantros MedMarx, 2011. Inpatient, Injectable (administration route: subcutaneous, intravenous, intramuscular, epidural) drug errors (N=184, NCC MERP EFGH) by Node. Quantros MedMarx, 2011.

**Table 2** Diagnosis-Related Group Families with Greatest Contributions to Preventable ADEs

Description (MS DRGs included in each family)	Proportion of preventable ADEs resulting from injectable medication, %	Proportion of hospitalizations, %	Probability of a preventable ADE resulting from injectable medication administered at the hospital, %
Septicemia or severe sepsis without mechanical ventilation 96+ hrs (871-872)	3.75	1.94	6.3
Major small and large bowel procedures (329-331)	2.71	0.86	10.4
Extracorporeal membrane oxygenation or tracheostomy with mechanical ventilation 96+ hrs (003)	2.57	0.14	59.8
Heart failure and shock (291-293)	2.56	2.18	3.9
Respiratory system diagnosis with ventilator support (207-208)	2.44	0.60	13.3
Major joint replacement or reattachment of lower extremity (469-470)	2.42	2.40	3.3
Cesarean section (765-766)	2.27	3.57	2.1
Coronary bypass (231-236)	2.15	0.41	17.2
Simple pneumonia and pleurisy (193-195)	2.04	2.25	3.0
Esophagitis, gastroenteritis, and miscellaneous digestive disorders (391-392)	1.84	2.52	2.4

ADE indicates adverse drug event; MS DRG, Medicare severity diagnosis-related group.  
*Source:* Reference 6.

total admissions requiring injectable medications can be calculated. Anti-infectives are most frequently administered, followed by narcotic analgesics and anti-

**Our study has yielded data that institutions can use as benchmarks to compare with their developing internal metrics. This approach can help hospitals target specific areas of need within their institutions and initiate new medication safety programs.**

coagulants/thrombolytics.<sup>6</sup> These data are important because they allow hospital safety decision makers to focus their prevention efforts where the errors are most likely to occur.

An analysis of the common diagnosis-related groups (DRGs) associated with preventable ADEs revealed that many of the diagnoses are associated with complex procedures or complicated hospitalizations (Table 2).<sup>6</sup> Sepsis, without mechanical ventilation, has the greatest risk, followed by small and large bowel procedures, extracorporeal membrane oxygenation (ECMO) or tracheostomy with mechanical ventilation, and heart failure and shock. Several surgical procedures are represented in Table 2, including cesarean section, primarily because it is such a frequent reason for hospitalization, as shown in the Table.<sup>6</sup>

Again, the analysis combined volume and frequency data to determine the probability of a preventable ADE associated with injectable medication during hospitalization. The data show that nearly 60% of patients requiring ECMO or tracheostomy with mechanical ventilation are likely to have a preventable ADE.<sup>6</sup> It



should be noted that most of these patients are acutely ill and have been in an intensive or critical care unit for some time. Several other DRGs have a relatively high probability of a preventable ADE, including respiratory failure, coronary artery bypass, and patients with bowel procedures.<sup>6</sup>

As quality-linked payment approaches continue to evolve, it is imperative that institutions collect data for reporting purposes. Our study has yielded data that institutions can use as benchmarks to compare with their developing internal metrics. This approach can help hospitals target specific areas of need within their institutions and initiate new medication safety programs. The data shown in Tables 1 and 2 can serve as a baseline by which progress can be measured as these new safety programs are implemented. In addition, the continuing evolution of quality-linked payment approaches will require benchmarking data and accurate metrics to achieve consensus among stakeholders, and other researchers will have the opportunity to build on this work to better understand progress against this national baseline in the future.

In summary, injectable medications are widely used not only in the inpatient setting but also in rehabilita-

tion centers, outpatient clinics, and, in a growing number, at home as well. There are many steps in the medication process where errors can occur. Errors are more likely to be catastrophic with injectables as opposed to oral medications. Most important, a significant proportion of medication errors can and should be prevented.

#### Author Disclosure Statement

*Dr Rothschild is a consultant to Becton, Dickinson and Company.*

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# Healthcare and Medical Liability Costs Associated with Inpatient Injectable Medication Errors

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*Co-author of a recent paper on the national burden of preventable ADEs, Mr Pyenson discussed his research, emphasizing new insights provided by using various data sources and actuarial data.*

In health economics research, government and commercial administrative claims and financial databases are frequently analyzed to estimate healthcare costs, whereas medical professional liability (MPL) costs (formerly referred to as medical malpractice) are assessed by actuarial professionals using different sets of healthcare data. MPL costs have rarely been included in discussions of health economics.

Much of the work taking place in US healthcare reform is conducted in the context of the “triple aim” concept outlined by Berwick and colleagues in 2008.<sup>1</sup> This concept incorporates improving the individual experience of care, improving the health of populations, and reducing the per-capita costs of care for populations.<sup>1</sup> Medication errors relate to the first two of these aims, perhaps all three, as part of the universe of

Institute of Medicine, The Leapfrog Group, and the US Department of Health and Human Services (HHS). In that study, we estimated that 1.2 million hospitalized US patients experience a preventable adverse drug event (ADE) associated with inpatient injectable medications annually.<sup>2</sup> Direct medical costs to payers account for \$3100 per ADE, or about \$3.8 billion annually in 2013 US dollars.<sup>2</sup> The MPL cost burden of ADEs associated with injectable medications, approximately \$450 million annually, is borne by hospitals and physicians, and ultimately is passed on to their patients and payers.<sup>2</sup>

In terms of the study methodology, cost was examined from two perspectives. Medical payments (revenue to providers) emerge from patient harm, which can be defined as any event that adversely affects a person’s health status, including death. MPL is defined by claims of error and settlement.<sup>2</sup> Some patients who suffer harm due to errors may not choose to litigate, and conversely, some patients may sue even if they have not been harmed by an error. From the medical costs side, we estimated the direct medical costs to payers following an adverse event attributed to injectable medication error. The direct medical costs included inpatient and postdischarge costs to US payers.<sup>2</sup> The analysis of direct medical costs was conducted from the payer perspective, and costs for patients covered by Medicare, Medicaid, and commercial insurance were estimated separately.<sup>2</sup> For MPL, costs included paid medical and professional liability costs for events associated with inpatient medications. Because MPL costs are paid by providers, the MPL estimates correspond to provider cost.<sup>2</sup>

Table 1 (page S67) lists the databases that were used to calculate direct medical cost.<sup>2</sup> The Quantros MedMarx database, which captured self-reported medication errors, was used to identify the medication errors associated with particular injectable medications. The Premier Database was used to assess the use of injectable medications by diagnosis-related group (DRG) at the patient level. Together, these two databases allowed the researchers to calculate the probability of

**Because there are limited opportunities to reverse the macroeconomic factors that are forcing cuts in revenue to healthcare providers, many provider organizations are focusing on building efficiencies to help them live within smaller budgets.**

healthcare errors in general. Within the greater context of healthcare reform, there is tremendous pressure to contain costs. Because there are limited opportunities to reverse the macroeconomic factors that are forcing cuts in revenue to healthcare providers, many provider organizations are focusing on building efficiencies to help them live within smaller budgets. To this end, reducing preventable medication errors is appealing and actionable for healthcare organizations.

The study “National Burden of Preventable Adverse Drug Events Associated with Inpatient Injectable Medications: Healthcare and Medical Professional Liability Costs” by Lahue and colleagues builds on the previous work conducted by others, including the

**Table 1** Databases Used to Calculate Medication Error Frequency and Direct Medical Cost

Database (Owner)	Description	Sample size (years)	Use in study
Quantros MedMarx (Quantros, Inc, Marlborough, MA)	Self-reported medication errors by medication; participating hospitals.	166,498 events (2009-2011)	Identification of particular medications associated with medication errors
The Premier Database – Premier Research Services (Premier healthcare alliance, Charlotte, NC)	Patient level detail of procedures, diagnosis, DRG, and medications in the inpatient setting; participating hospitals	5.6 million discharges (2010 and 2011)	Per patient use of particular medications by patient DRG
Thomson Reuters MarketScan Research Databases (Truven Health Analytics, Ann Arbor, MI)	Commercial insurer administrative data (claims and exposure); contributing payers	40.0 million members in 2009 and 45.2 million members in 2010 (2009 and 2010)	Incremental cost associated with reported ICD-9s indicating inpatient medication errors in commercial population
Medicare 5% Analytic Sample (Centers for Medicare & Medicaid Services)	Medicare fee-for-service insurer administrative data (claims and exposure)	2.4 million beneficiaries in 2009 and 2.5 million beneficiaries in 2010 (2009 and 2010)	Incremental cost associated with reported ICD-9s indicating inpatient medication errors in Medicare population
State discharge database (Milliman assembled)	All payer databases of all discharges by DRG, 17 states (AZ, CA, FL, IA, IL, MA, MD, NJ, NY, OK, RI, TX, UT, VA, VT, WA, WI)	20.7 million discharges (2010)	Standard per capita distribution of DRGs

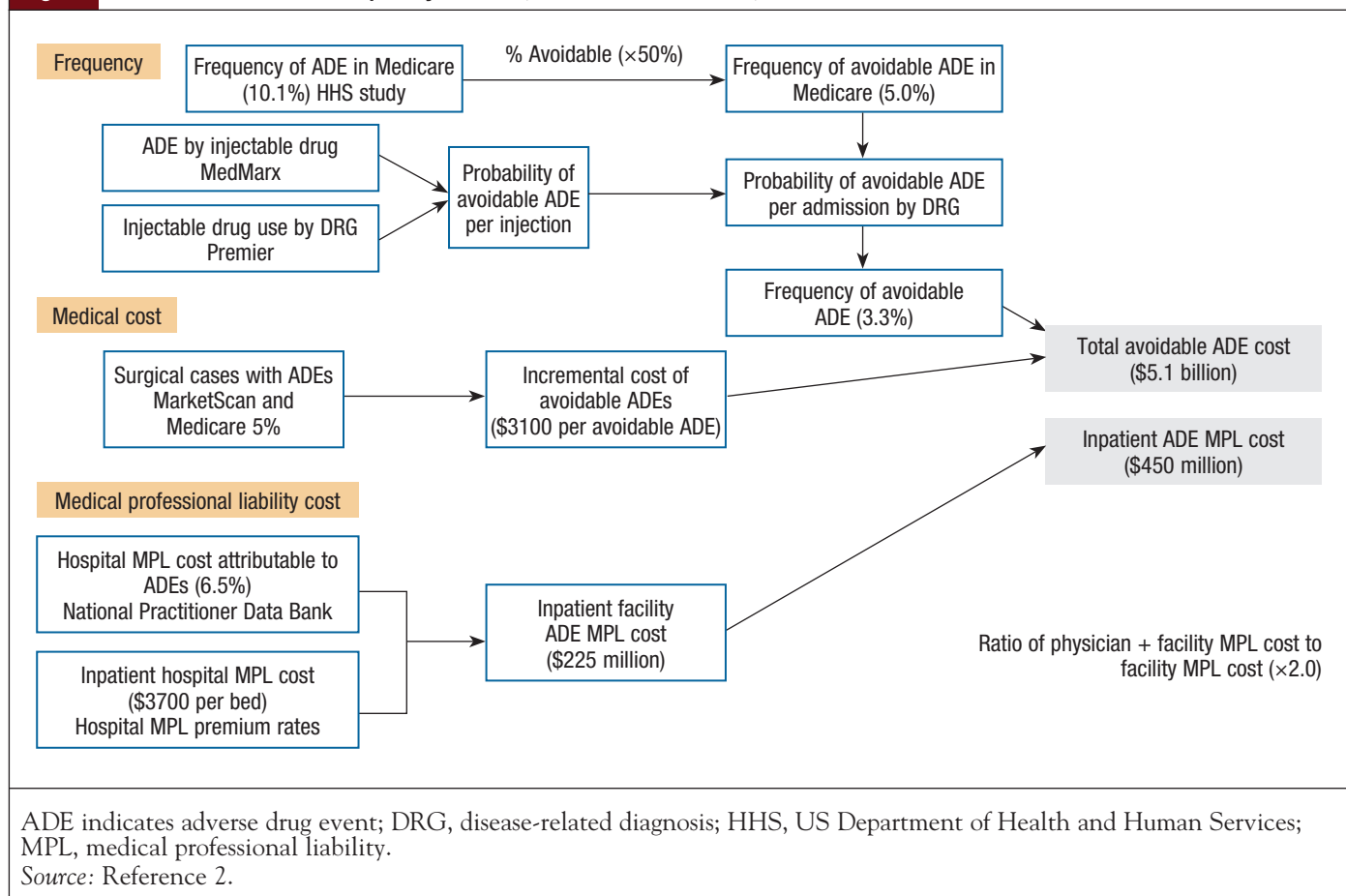
DRG indicates diagnosis-related group; ICD-9, *International Classification of Diseases, Ninth Revision*.  
 Source: Reference 2.

**Table 2** Databases Used to Calculate MPL Frequency and Cost

Database (owner)	Description	Sample size (years)	Use in study
National Practitioner Data Bank (US Department of Health and Human Services)	MPL claims reported by state licensing authorities	864,702 claims (1990-2011)	Size and frequency of claims for inpatient medication errors relative to all MPL claims
MPL insurance filings for states (various MPL insurance companies)	MPL premium rate development filed with state insurance regulators, publicly available	8 filings: CA, FL, LA, MA, NC, OH, PA, VT (2007-2011)	Premium rates for facility portion of MPL
AHA Annual Survey, (American Hospital Association, Chicago)	Operational and financial statistics on individual hospitals	6334 hospitals (2010)	Number of beds by region and bed type, occupancy rates, births, and inpatient procedures
Closed claim database (Florida Department of Insurance)	Chapter 627 Section 912 of Florida insurance laws requires insurance companies, self-insurance funds, and joint underwriting associations to file claim reports for insured entities and individuals	64,469 defendants (1994-2009)	Inpatient professional MPL claim cost for inpatient cases relative to hospital MPL cost for inpatient cases

AHA indicates American Hospital Association; MPL, medical professional liability.  
 Source: Reference 2.

**Figure** Process to Calculate Frequency of ADEs, Direct Medical Costs, and MPL Costs



a particular drug being associated with an inpatient medication error.<sup>2</sup>

The Thomson Reuters MarketScan and Medicare 5% Analytic Sample are standard research databases that were used to calculate the incremental cost associated with reported *International Classification of Diseases, Ninth Revision (ICD-9)* codes indicating inpatient medication errors in commercial and in Medicare popula-

**The numbers of patients involved are alarming, as are the implications about the quality of processes that allow such high frequency of errors.**

tions, respectively. Finally, the researchers assembled state-level hospital discharge data to create a standard distribution per capita of DRGs.<sup>2</sup>

The databases used to estimate MPL costs are shown in **Table 2** (page S67).<sup>2</sup> The National Practitioner Data

Bank, assembled by the HHS, was used to ascertain the size and frequency of claims for inpatient medication errors relative to all MPL claims. This information was then tied to MPL premium rate information from a number of states that have publicly available rate filings. The researchers combined that information with operational information obtained from the American Hospital Association Annual Survey.<sup>2</sup> Inpatient professional and hospital costs were separated using data from the Florida Department of Insurance, one of the few databases to report MPL costs in that manner.<sup>2</sup>

The methodology for combining the data is illustrated in the **Figure**. No single database provided a comprehensive listing of ADE frequency. Although the Quantros MedMarx database contained ADEs that were reported, it is well known that ADEs tend to be underreported. As a result, the HHS data served as an anchor to estimate the frequency of ADEs (10.1%) in the Medicare population.<sup>2</sup> Those data were applied to the commercial and the Medicaid populations with adjustments. The HHS conducted a multiphase chart

review-based data analysis of Medicare claims to identify possible or probable errors. The analysis identified about 50% of ADEs as avoidable.<sup>3</sup> The researchers used this rate to estimate the frequency of avoidable ADEs in the Medicare population.

Our methodology used Bayes' theorem to combine the MedMarx and the Premier data. By doing so, we were able to stratify ADEs by DRG, allowing for calculation of the probability of an avoidable ADE per admission by DRG. In aggregate, preventable ADEs were estimated to affect about 3.8% of the hospitalized patients, adjusted by the 87% of ADEs attributed to injectable medications derived from the MedMarx data.<sup>2</sup> This estimate may be somewhat conservative because ADEs occurring in the emergency department or in observation units were not captured in the study.

Some conservative decisions were also made in calculating medical costs. There are ICD-9 codes that identify medication errors in the healthcare system; however, the codes do not identify the specific location or the time during which the errors occurred. As a result, it was necessary to remove errors that took place before a hospitalization and resulted in an inpatient stay. To accomplish this objective, the researchers considered only admissions for nonelective surgical cases, then audited several hundred cases (administrative data) to verify that the case history was consistent with medication errors in the inpatient setting.<sup>2</sup> Our algorithm to calculate incremental medical costs was to match the error cases—those discharges selected with an ICD-9 error code attributed to an event during the admission—to controls. Control discharges had similar preadmission resource utilization and were hospitalized for the same conditions. Error cases and controls were compared from admission through 4 months postdischarge for total costs to payers. We calculated incremental payer costs of \$3100 per avoidable ADE compared with control cases. When we extrapolated the data nationally, we estimated that more than 1 million inpatients experience a preventable ADE annually, with a total of as much as \$5.1 billion in payer costs.<sup>2</sup>

Our study found that injectable medication errors account for approximately 6.5% of total annual inpatient hospital MPL costs. After combining frequency and cost data, the researchers estimated that the facility component of the MPL for inpatient injectable medication errors was about \$225 million. Adding the professional services component essentially doubled the MPL costs, yielding a total of approximately \$450 million.<sup>2</sup>

Approximately 37 million inpatient hospitalizations occur in the United States annually.<sup>2</sup> To summarize the key findings of our research, the probability of an avoidable ADE is approximately 3.3%, meaning that

1.2 million inpatients annually have an ADE associated with an injectable medication, at a cost of approximately \$2700 to \$3600 per error, adding approximately \$2.7 billion to \$5.1 billion in payer costs and approximately \$300 million to \$610 million in liability costs annually.<sup>2</sup> The majority (57%) of the cost of these ADEs takes place in the commercially insured population.<sup>2</sup> Of course, the actual rate and cost of preventable ADEs will vary by institution.

Given that the United States is spending approximately \$3 trillion on healthcare,<sup>4</sup> these cost figures imply that reducing these ADEs will not, by itself, lead to dramatic reductions in spending. However, the numbers of patients involved are alarming, as are the implications about the quality of processes that allow such high frequency of errors. We expect that the problem is not uniform across hospitals and is likely much more significant in some organizations.

### Limitations

The study had a number of limitations, some of which are inherent in any analysis where national projections and claims data are combined. For example, there are always some coding inaccuracies in claims data, and clinical detail is not present aside from the codes recorded.<sup>2</sup> We also assumed that the characteristics of reported medication errors are similar to those that are unreported.<sup>2</sup> In addition, one of the data sources, MedMarx, relied on voluntary reports of medication errors.<sup>2</sup>

With regard to costs, the estimated costs for ADEs did not differentiate between injectable and oral medications; therefore, the researchers assumed that they were equivalent,<sup>2</sup> but this may not be true. With regard to MPL, data for MPL costs tend to be less recent than medical healthcare costs, and therefore may not completely represent costs in 2013 dollars. Also, MPL data tend to be less granular, and it can be difficult to ascertain whether awards were granted for preventable injectable medication errors.<sup>2</sup>

### Author Disclosure Statement

Mr Pyenson is a consultant to Becton, Dickinson and Company and Premier healthcare alliance.

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## PANEL DISCUSSION

# Reducing Injectable Medication Errors: Challenges and Opportunities

A panel discussion was held in January 2013 after a review of the study on preventable ADEs to gather insights across health-care perspectives on how to prevent injectable medication errors.

Participant name	Perspective/role	Affiliation
Richard Safeer, MD, FAAFP	Moderator	Staying Healthy Advisors, LLC, Columbia, MD
Bruce Pyenson, FSA, MAAA	Consulting Actuary/Presenter	Milliman Inc, New York, NY
Jeffrey M. Rothschild, MD, MPH	Provider/Associate Professor/Presenter	Brigham and Women's Hospital/Harvard Medical School, Boston, MA
John Bulger, DO, MBA	Provider/Integrated Delivery Network/Associate Professor	Geisinger Health System, Danville, PA
John Clark, PharmD, MS, BCPS	Pharmacist/Assistant Professor	University of Michigan, Ann Arbor, MI
David Bates, MD	Quality/Professor	Brigham and Women's Hospital/Harvard Medical School, Boston, MA
Cora Vizcarra, RN, BSN, CRNI, MBA	Nursing	MCV & Associates Healthcare Inc, Indianapolis, IN
Leslie Schultz, PhD, RN, NEA-BC, CPHQ	Best Practices, Safety	Premier healthcare alliance, Charlotte, NC

In the context of quality improvement, a number of technological interventions have demonstrated success in reducing injectable medication errors, including Computerized Physician Order Entry (CPOE) with decision support and bar code technologies to verify correct drug dosage and reduce transcription errors.<sup>1</sup> In addition, prefilled syringes<sup>2</sup> and smart infusion pumps<sup>3</sup> have both shown promise in reducing medication errors.

Care coordination, improving communication among physicians, pharmacists, and nurses, is also fertile ground in the effort to reduce medication errors.<sup>1</sup> Other areas of opportunity include pharmacist participation in patient care, patient engagement, family engagement in patient care, and improvements in medication reconciliation. Postdischarge follow-up is another area that is critical to reducing medication errors, and the Centers for Medicare & Medicaid Services and other policy organizations have developed evidence-based practices, with accompanying financial incentives, to improve performance in this area.<sup>1</sup>

While technological innovations and improved communication have demonstrated success in reducing injectable medication errors, to date there has not been a coordinated national effort to address this issue. In the

following dialogue, the roundtable panelists share their perceptions of the barriers and opportunities to reduce injectable medication errors.

**Richard Safeer (Moderator):** *What is your reaction to the data presented today? Is there something that you would do differently in your line of work, based on any of the information you learned today?*

**John Bulger:** I think the data are quite compelling, and can be used to provide the big picture, at both the high level and the front lines, to help people to understand the impact that injectable medication errors have on individual patients and on the healthcare system from a population-based perspective. In this way, the data can help overcome the inertia for change.

I am struck by the big difference between injectable medications and non-injectable medications. We have discussed changing the ratio of injectable vs non-injectable medications. We know that injectables are often more expensive, but this point helps make the case that they may not necessarily be the best option for another reason. For example, there seems to be a substantial difference in the safety ratios between oral and inject-

able narcotics. I think we have an opportunity to standardize doses and decrease the unjustified variability within the system.

**John Clark:** I was struck by the thought processes in approaching the very complex patients that were shown to have more adverse drug events (ADEs) that were preventable. I think we need to look closer at the complexity of those patients and try to develop focused interventions specific to those patients.

When it comes to some of the systems, I'll continue to advocate for even smarter CPOE systems, broad implementation of smart IV pumps, scanning on preparation of product to ensure that the product was made correctly from the beginning, and product testing, as it relates to the preparation of IV products.

**David Bates:** In the studies of smart pumps that Dr Rothschild and I conducted, we found many errors that nobody even realized were associated with the injectables. Some of these errors caused significant harm. I believe that the overall problem is much larger than the estimates we have seen today. Investing in solutions to prevent them will make a big difference.

Given today's economic and policy landscape, institutions are best served by making these investments. At the same time, hospital decision-makers are faced with many competing demands and priorities. I'm hopeful that information like this will be helpful to organizations in making hard investment decisions that are likely to reduce medication errors.

**Safeer:** What are some of the major barriers to reducing injectable medication errors in your respective institutions?

**Cora Vizcarra:** I agree that the numbers seem quite conservative, and that medication errors are underreported. For nurses, there are two primary reasons why they don't report. First, they're confused as to what they're supposed to report, and second, they're afraid to report because they fear for their jobs. Among many nurses, the perception is that when they do report, they will be subject to a punitive response by the hospital. I believe this perception must change so everyone will be more open to reporting and improvement.

**Clark:** I agree that organizational cultures can be a barrier to achieving that goal. In my institution, we've grown as a system and taken on opportunities to change culture. In trying to effect change, we've certainly found that the underlying culture of the organization is a major factor. When organizations have a very strong nursing, physician, and pharmacist culture, being able to have some self-governance, I think, can make it easier to get buy-in from all stakeholders.

In our system, we faced a barrier several years ago, when the hospital introduced an electronic health record system that did not interface effectively with

our pharmacy information system. As a result, we were forced to change the electronic health record and purchase a pharmacy system that did interface with the electronic health record. Currently, we are transitioning to a new electronic health record to enhance interoperability. I am quite sure there are many hospitals and health systems that have encountered a barrier of incompatibility between their pharmacy system and their electronic health record.

Another barrier is that we haven't fully implemented bar coding, which helps on the product preparation side and on the administration side, throughout our hospitals. From a cultural leadership perspective, we've found that some individuals are reluctant to make other safety changes when they know that bar coding, which will be implemented in 8 months, will address the issue. That type of thinking tends to decrease the momentum you have to promote change.

**The ability to purchase ready-to-use products such as prefilled syringes has been beneficial, and I believe that standardizing concentrations across health systems has been effective in improving safety.**

**Safeer:** Thank you. We would now like the panel to provide feedback on the injectable medication process **Figure** (page S72).

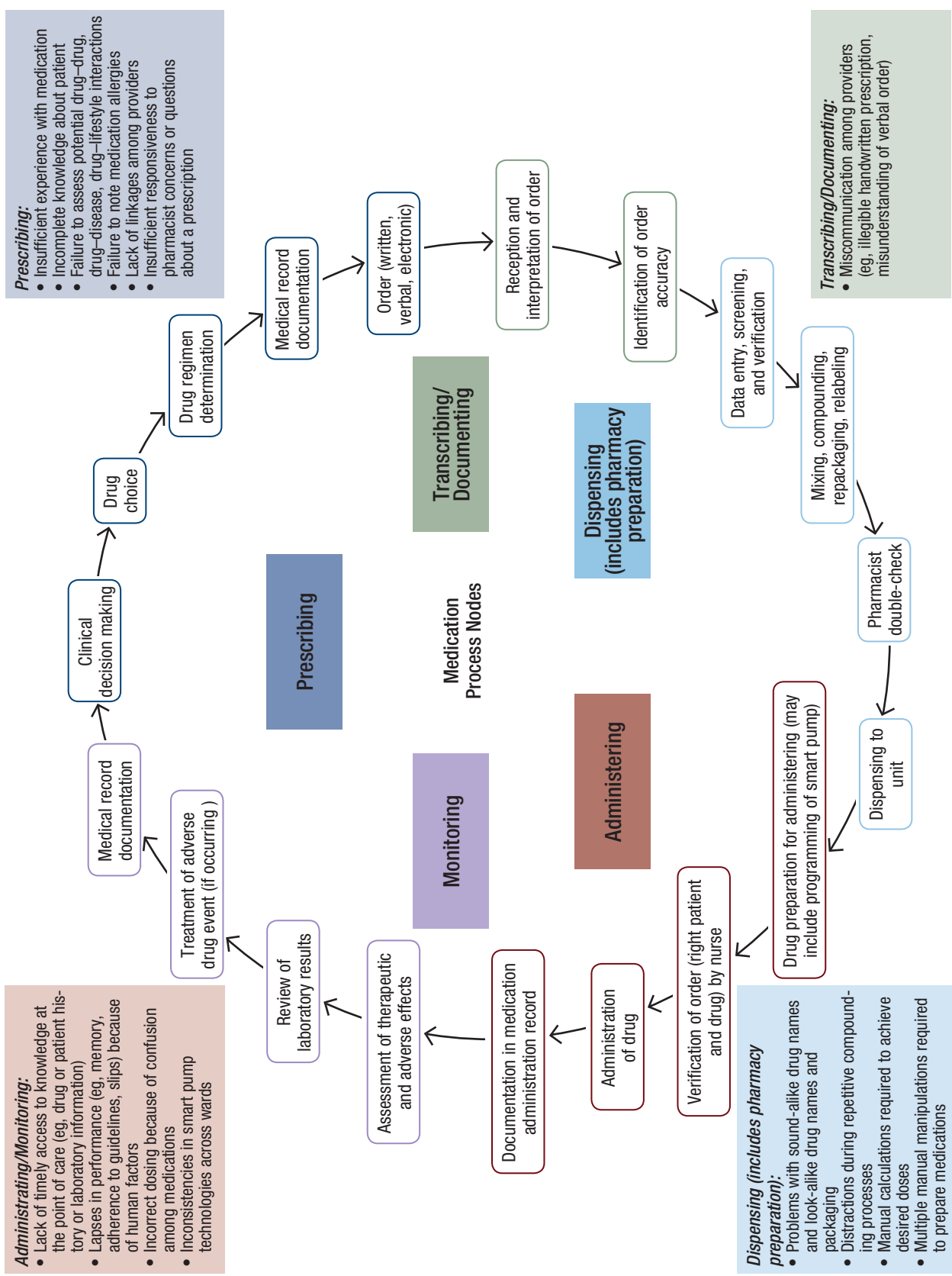
**Leslie Schultz:** I can envision adding depth to this diagram and making it 3-dimensional. For example, when considering drug choice and drug regimen there are processes behind determining the optimal route of administration or duration of a therapeutic regimen. Perhaps a 3-dimensional construct would allow more detail to be added to the diagram.

**Safeer:** If you showed this diagram to a group of nurses, do you think it would be well received or is it something that you might change a little bit to better serve your peers?

**Schultz:** I think my nursing colleagues would say, "It is difficult when you've got multiple versions of pumps. In every place I go, it's a different pump and I have to learn how to program it."

**Vizcarra:** The other thing to remember is that nurses are very good at doing work-arounds if they encounter a problem with technology, and there may be a way to capture that in this diagram. Nurses don't necessarily work around technologies because they don't want to use them. Frequently, there is a system problem or a design problem. For example, with the smart pumps, if the (drug) libraries have not been updated or if there is a dose-limiting function and a pharmacist is not avail-

**Figure** Injectable Medication Use Process and Challenges in Acute Care



Adapted from Medication Use Process Steps and Key Provider Problems: IOM Quality Chasm Series, 2007. Virtual Roundtable on Injectable Medication Errors Feedback, January 2013.

able to help, nurses may bypass the full capability of the technology and revert to the regular infusion pump feature, just calculating the rate and volume.

**Clark:** I recommend putting tornado signs with specific challenges at the points in the process flow where those challenges have an effect. I think that having the challenges separate from the process obscures the impact those challenges have on the system. If they were integrated into the way the system is drawn here, the impact these challenges have on the system would be clear.

**Safeer:** OK. Where do you see prefilled syringes fitting into this schematic?

**Clark:** There are examples of medications that the nurse would draw up for administration. Sometimes the nurse could be pulling those medications from the unit-based cabinet. In some situations, the nurse may be using only part of that product, out of a vial, which is definitely not optimal from a safety perspective. In many larger institutions, most medications are prepared ready-to-use when delivered to the floor. There is purchasing of some prefilled syringes from companies associated with the operating rooms—that simplifies their processes. In other instances, such as in intensive care units, systems vary among hospitals. Some hospital systems administer antibiotics from prefilled syringes, whereas others use them from IV bags. That determination is often made from a systems perspective, with the physicians, nurses, and pharmacists working together to decide what works best for their hospital.

**Safeer:** Recent findings from an observational study conducted by researchers at the Barnes-Jewish Hospital in St. Louis (presented at the Society of Critical Care Medicine's Annual Congress) show that adoption of prefilled syringes improved labeling and preparation practices for drugs used in anesthesia medicine.<sup>4</sup> In your opinion, what is the potential for prefilled syringes to decrease injectable errors in the areas across the acute care setting?

**Clark:** If the prefilled syringes are for drugs such as antibiotics that can be given via IV push, and even IV push using a pump, I think there is an opportunity to improve safety and realize efficiencies, as long as it is cost-effective. The ability to purchase ready-to-use products such as prefilled syringes has been beneficial, and I believe that standardizing concentrations across health systems has been effective in improving safety. I also believe that the preparation of product concentrations that have been standardized for CPOE has been effective.

**Safeer:** What changes can be made in the nursing segment of the healthcare system to reduce medication errors?

**Schultz:** We need nurses to be more vocal about the issues with smart pumps, and to explain why they sometimes must work around problems. The technology developers can then perhaps redesign the systems to

begin minimizing these issues.

**Vizcarra:** Some of the smart pumps can generate a report. These reports can shed some light on when the work-arounds were done, why the library was bypassed, and which medications were involved. I do not believe that most organizations are using the reports to learn why work-arounds are happening. Although it's cumbersome to compile the reports, they could be used as part of the monitoring process to detect potential for errors.

In 2009 our institution began using a double-check process for all high-alert IV infusion medications. Although it was somewhat burdensome for some of the nurses, and delayed some of the administration time, it was a good way to catch some of the potential errors.

**If we could better quantify the harm and then make a business case for eliminating harm as the right thing to do, it would really help to build consensus among the key stakeholders, including the hospital chief financial officers, who want to see the business case for tackling this issue head-on.**

**Safeer:** John, what are the critical points for dispensing, and the barriers to reducing ADEs? Also, what are your thoughts about pharmacists working alongside other parts of the healthcare system?

**Clark:** The pharmacy technician has a critical role in the dispensing process. Often, we don't provide them with the technological support they need to do the best job they can. Pharmacy technicians would benefit from education about bar code preparation of IV products.

The pharmacist check of a product, before it leaves the pharmacy, is another risk point. This part of the process is dependent on good communication between the pharmacist and the pharmacy technician, which doesn't always happen effectively.

Communication with other members of the treatment team is critical. Hospital pharmacies are often located a substantial distance from the physicians and nurses. We have to be careful not to let that space hinder effective communication. For example, nurses may sometimes have difficulty identifying the exact contents of an IV bag after it leaves the pharmacy. When questions arise, the pharmacist may be called upon for clarification. In this regard, a multidisciplinary approach to treatment is beneficial, with physicians, nurses, and pharmacists working closely together to coordinate patient care.

## Closing Commentary

**Safeer:** *Before we conclude, what are your final thoughts on improving medication safety in the hospital setting?*

**Vizcarra:** I think we need to ramp up our efforts to achieve a national standard for preventing medication errors. Many institutions and health systems have developed best practices, but they are all different. We need to bring the key stakeholders together and reach a true consensus around medication safety.

**Schultz:** We also need to consider the economic ramifications of medication errors. If we could better quantify the harm and then make a business case for eliminating harm as the right thing to do, it would really help to build consensus among the key stakeholders, including the hospital chief financial officers, who want to see the business case for tackling this issue head-on.

**Clark:** Our responsibility is to pass information from healthcare professional to healthcare professional. It's the ability to use technology and leverage it in a way that allows the patients to be supported the best way possible, incorporating the talents of all members of the treatment team. Everyone needs to understand their role in improving safety and they need to communicate effectively with one another.

**Bulger:** I think the multidisciplinary team approach will be the key to getting this done. It's the communication between those teams—making sure the teams understand the perspectives and abilities of the other people on the team. We need to eliminate some of the turf wars that we've had in the past and get everyone working together to move this forward.

**Bates:** The advancement of technologies will be critical to improving medication safety. Some of them are ready to be rolled out nationally. There are strong incentives now for organizations to implement CPOE and bar coding. I also think there are some new technologies that will help us go to the next level. One example is a technology that can tell us what drug and dose are in a medication preparation. At the end of the day, the value from these technologies is in implementing them well and reducing variation. That is an area in which we must improve.

**Safeer:** *Thank you very much. I want to thank all of you for your participation in today's roundtable program.*

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