Mapping a Large Patient Safety Database to the 2005 Patient Safety Event Taxonomy

John R. Clarke, MD; Janet Johnston, MSN, JD; Monica Davis, MSN, MBA;
Arthur J. Augustine, BS; Matthew Grissinger, RPh; Michael J. Gaunt, PharmD;
Hedy Cohen, BSN, MS; William Marella, MBA

Abstract

Objective: To evaluate the Patient Safety Event Taxonomy (PSET) using a large existing database with near-miss reports. **Methods**: Analysts from the Pennsylvania Patient Safety Reporting System (PA-PSRS) mapped 420 reports from PA-PSRS into PSET. **Results**: We evaluated 34 PSET classifications accepting values. For five classifications, data could be translated directly from PA-PSRS for at least 95 percent of reports. For 11 PSET classifications, PA-PSRS data fields were not available for at least 95 percent of reports. Data were predominately unavailable in PA-PSRS data fields for two classifications. For 16 PSET classifications, translation required analysts' reviews of multiple PA-PSRS fields and free-text narratives. Useful data in seven PA-PSRS fields could not be transferred to PSET. **Conclusion**: Mapping an existing patient safety database to PSET would require analysts' interpretation and/or considerable realignment of the existing database. With a large flow of near-miss reports, either effort would require considerable resources.

Introduction

The Federal Patient Safety and Quality Improvement Act of 2005, signed on July 29, 2005, states that the Secretary of Health and Human Services may set standards for the definitions, data elements, and interface for a national network of patient safety databases.[1]

On August 3, 2005, the National Quality Forum (NQF) endorsed a National Voluntary Consensus Standard for the Joint Commission's Patient Safety Event Taxonomy (PSET), in addition to definitions of patient safety terms, data elements for patient safety reporting systems, principles for improving the taxonomy, and recommendations for integrating the taxonomy into the health care information technology infrastructure.[2] PSET (or a modification of PSET) may become the basis for any national network of patient safety databases. The consensus standard stated that the standards were not intended to replace the taxonomy, definitions, or elements of reporting systems already in use, but that existing systems should be mapped to the standards in an evolutionary way.

The NQF standard definitions include:

- "A threat to patient safety," defined as "any event that has harmed patients or could lead to patient harm."
- "A hazard," defined as "anything that can cause harm."

From these definitions, we infer that the NQF-endorsed PSET is intended to be used for reports of near-miss events as well as for the sentinel events for which it was originally designed. We became interested in whether a large existing database with near-miss reports could be mapped to PSET, how difficult it would be to provide information for the PSET classifications, and whether useful information would be left behind.

Under the Pennsylvania Medical Care Availability and Reduction of Error (MCARE) Act of 2002,[3] acute health care facilities in the State are required to report near-miss events (called "incidents" by the Act), as well as serious events involving unanticipated injury, to the Pennsylvania Patient Safety Authority, an independent State agency. The Pennsylvania Patient Safety Authority developed the Pennsylvania Patient Safety Reporting System (PA-PSRS) in order to receive these reports.

Table 1. PA-PSRS event types, primary categories

A. Medication error
B. Adverse drug reaction (not a medication error)
C. Equipment, supplies, and/or devices
D. Fall
E. Error related to procedure, treatment, and/or test
F. Complication of procedure, treatment, and/or test
G. Transfusion
H. Skin integrity
I. Other and/or miscellaneous

PA-PSRS is a Web-based electronic reporting system based on a taxonomy and data fields developed by the University HealthSystem Consortium (UHC) Patient Safety Net (PSN)[4] and modified to meet the requirements of the MCARE Act. The taxonomy, which we will refer to as the PA-PSRS taxonomy, includes information to analyze the reported patient safety events. The main descriptive element is what others might call the "incident type," but which we call the "event type" – given the very specific definition for "incident" in the MCARE law, as noted above.

Nine primary categories of event types (Table 1) are modified by multiple secondary and tertiary subcategories, resulting in 195 distinct clinical event types, classified by the three levels of descriptors (e.g., F, complication; 1, procedure; g, retained foreign body). One of the primary categories is "Other," and 20 of the subcategories within primary categories are described as "other" (e.g., A, medication error; 9, other). These event types drive the collection of information germane to a specific event. The UHC PSN is comparable.

At the end of the first 2 years of data collection (June 2004 - June 2006), PA-PSRS contained 380,000 reports, 96 percent of which were reports of near misses. The total number of reports in the UHC PSN database was of the same order of magnitude.

We mapped event reports in the existing PA-PSRS to PSET. We wanted to determine how much information in the PSET classifications could be mapped directly from our electronic system, how much could be mapped at all, and how much effort would be involved to achieve full mapping. We wanted to understand the potential implications of mapping our system, with its large volume of near-miss reports, to any future national network of patient safety databases. We also wanted to determine if any PSET classifications were perceived as essential components of a patient safety database that would add value to PA-PSRS, and whether any PA-PSRS data fields that provided useful information had been missed by the currently endorsed version of PSET.

Methods

We listed the most recent PA-PSRS reports that met the following criteria:

1. The reports were initially entered more than 90 days previously, thus, beyond the time limit for further revisions.
2. The free-text narratives of the event contained more than 200 characters. This threshold was set a priori by the analysts to exclude reports likely to contain inadequate information in free text.

In order to capture an assortment of reports that were not unduly biased by the particular taxonomy of PA-PSRS, but were broadly representative of a variety of event types, we selected reports from that list using the following four strategies (in sequence). Altogether, 420 reports were reviewed. (Whenever applicable, facilities were selected based on which ones submitted the most recent reports.)

1. In order to get a “consecutive sample” without being biased by a select group of large-volume reporters, we selected the most recent report from 100 different facilities.
2. In order to get a “representative sample” of clinical event types, we selected the most recent report from each of the 195 specific event types, excluding the “other’ categories.
3. In order to capture events that might not be well described by PA-PSRS, we selected the most recent reports from five different facilities for each of the 20 “other” event-type subcategories.
4. For the same reason as described in number 3, we selected the most recent reports from 25 different facilities for the primary event type called “Other.”

If an analyst had previously reviewed a report in depth, that analyst did the mapping. If not, the analyst normally assigned to review reports of that event type did the mapping. Prior to mapping the values from PA-PSRS fields into the PSET classifications, a mapping diagram was agreed upon by consensus meetings of all the analysts, linking PA-PSRS fields with appropriate PSET classifications. For each PSET classification, a value was entered to indicate whether:

- The value for that PSET classification could be translated directly from the value for a field in PA-PSRS (direct mapping).

- The value for that PSET classification could be filled in by an analyst from information in PA-PSRS (analyst interpretation).
- The value for that PSET classification could not be entered because there was no information in the comparable field in PA-PSRS (unknown value).
- The value for that PSET classification could not be entered because there was no comparable field and no comparable source for information in PA-PSRS (field absent).

If the value for an individual report did not follow the mapping diagram convention for that PSET classification, the expected value was changed to the appropriate value for that particular report. For instance, if the "age" field, which can be translated from PA-PSRS, had no entry in an individual report, the value assigned to PSET's "age" field would be changed from the expected "direct mapping" to "unknown value." If the place where the report originated was the intensive care unit, but the free-text narrative indicated that the event had occurred in the operating room, the value assigned to PSET's "place" field would be changed from the expected "direct mapping" to "analyst interpretation." If the analyst could find the patient's diagnosis, which had no field in PA-PSRS, in the free-text narrative of the event, the value assigned to PSET's patient "diagnosis" field would be changed from the expected "field absent" to "analyst interpretation."

Errors in coding PA-PSRS fields were not an issue because of numerous error-checking mechanisms in the data entry interface of the electronic reporting system.

Considering the report in its entirety, each analyst then made two further subjective assessments:

1. What information included in the PSET classifications, but not available from PA-PSRS data fields, might have contributed to the understanding of the reported event had it been available?
2. What information in the PA-PSRS report that was useful to the understanding of the reported event would not be captured by the PSET classifications?

Although there was no direct measure of inter-rater reliability, in addition to the consensus meetings of all the analysts to create a uniform mapping diagram, the analysts presented selected reports for group discussion during weekly group analyses.

Results

Of the 420 reports mapped into 34 PSET classifications, 79 percent were reports of incidents or near misses. Table 2 shows the results of our efforts to map information from PA-PSRS reports into the 34 PSET classifications.

Five PSET classifications could have values directly and accurately translated from PA-PSRS data fields for more than 95 percent of the reports. Another nine classifications could have values directly and accurately translated from PA-PSRS data fields for between 30 and 44 percent of reports. However, for between 10 and 49 percent of the reports, this would require that patient safety analysts extract values, translate values for the PSET classification, or modify the directly translated values for better accuracy, after a complete review of the report. The result was an

accurate transfer of the value for between 43 and 87 percent of reports. For an additional seven classifications, values could be entered following extraction of the information from a complete review of the report by the patient safety analyst for between 10 and 56 percent of reports, despite the absence of a comparable data field or other consistent source of information in PA-PSRS. The analysts were able to find the information by linking information residing in different data and/or text fields.

Two classifications could not have values recorded because the value typically was not available in PA-PSRS, even though a comparable data field was present. Eleven classifications could not have values recorded in over 95 percent of the PA-PSRS reports due to the absence of data fields and any other sources of information in the PA-PSRS reports.

Each review took an average of 5 minutes for an analyst to extract and check values to be mapped into the PSET classifications.

Each analyst indicated information in the PSET classifications that was not present in PA-PSRS but might have contributed to the understanding of the reported event. The PSET domain classifications of staff, patient diagnosis, and coexisting conditions were cited commonly, in about three-quarters of the reviews (Table 3). Four other PSET "type" classifications were cited only rarely.

Each analyst also indicated, for each report, information in the PA-PSRS report that was useful to the understanding of the reported event but could not be mapped to the PSET classifications. The free-text narrative description of the event was most commonly noted as providing useful information not captured in PSET classifications (Table 4). Other data fields commonly cited as useful, but not in the PSET classifications, were identification of the event as a near-miss or "serious event"; the clinical event type according to the PA-PSRS taxonomy used in PA-PSRS; the procedure involved; how the event was discovered; the disposition of the event; and the date of initial contact prior to the event (i.e., a "new" patient vs. a long-standing consumer of care in the venue). Information specific to the clinical event type was occasionally identified as potentially useful.

Discussion

The results of the actual mappings show no anticipated difficulties mapping from the PA-PSRS system (which includes near-miss reports and uses a modified UHC taxonomy) for date, time, patient age and sex, and setting. All five of these PSET classifications, except possibly the last, should be able to be mapped from any robust reporting system.

Currently, 16 of the 34 PSET classifications would sometimes benefit from a review of the report by an analyst with manual entry of missing information or correction of information entered automatically from specific data fields. With regard to the 9 of these 16 classifications currently needing analysts' reviews for mapping from near-miss and "serious event" PA-PSRS reports, the analysts believe that reviews of every report will continue to be necessary to sometimes clarify the values for physical impact. It will also be necessary to critique these values for the types of

communication and patient management and for the organizational, technical, patient, and practitioner causes for any error, plus the indicated prevention.

Table 2. Mapping from PA-PSRS fields to PSET classifications[a]

PSET classifications for which values could be translated directly from the value for a field in PA-PSRS (%)

Domain**:** Date	100.0
Domain: Time	100.0
Domain: Patient – Age	100.0
Domain: Patient – Gender	99.8
Domain: Setting	98.6

PSET classifications for which values were sometimes extracted, translated, or clarified from PA-PSRS data fields by a patient safety analyst's review of the complete PA-PSRS report

A. PSET classifications with comparable sources for information in PA-PSRS (%)

	Directly	By Analyst	Total
Impact: Physical	41.0	46.2	87.2
Type: Patient management	30.5	48.8	79.3
Impact: Economic	44.0	30.2	74.2
Cause: Practitioner	38.3	21.0	59.3
Type: Communication	36.2	21.7	57.9
Cause: Organizational	43.3	10.5	53.8
Prevention: Indicated	41.4	10.0	51.4
Cause: Patient (contribution)	33.1	13.1	46.2
Cause: Technical	31.0	12.4	43.4

B. PSET classifications without comparable data fields or other consistent sources for information in PA-PSRS (%)

Type: Intervention	56.4
Domain: Staff	50.5
Type: Post-intervention	38.1
Domain: Target	36.0
Type: Pre-intervention	29.8
Domain: Patient – Diagnosis	23.3
Domain: Patient – Co-existing Condition	10.5

PSET classifications for which values could not be entered because there was rarely information in existing comparable data fields or other consistent sources for comparable information in PA-PSRS (see text) (%)

Prevention: Selective	8.3
Prevention: Universal	7.6

Table 2. Mapping from PA-PSRS fields to PSET classifications (continued)

PSET classifications whose values could almost never be entered because there were no comparable data fields or other consistent sources for comparable information in PA-PSRS (range 3.6% – 0.0%)

Cause: External
Cause: Negligence
Cause: Recklessness
Domain: Patient – Duration Disease
Domain: Patient – Education
Domain: Patient – Other Information
Domain: Patient – Socio-Economic Class
Impact: Psychological
Impact: Legal
Impact: Social
Impact: Satisfaction

a Full descriptions of the PSET classifications can be found in the NQF report: *Standardizing a Patient Safety Taxonomy*.[2]

Table 3. Percent of PSET classifications, not present in PA-PSRS data fields, identified as potentially useful during the reviews of individual reports

Domain: Patient diagnosis	76.9
Domain: Patient coexisting condition	76.9
Domain: Staff	75.5
For few reports:	
Type: Patient management	1.0
Type: Preintervention	1.0
Type: Intervention	0.5
Type: Postintervention	0.5

Note: Full descriptions of the PSET classifications can be found in the NQF report: *Standardizing a Patient Safety Taxonomy.*[2]

Table 4. Percent of PA-PSRS data fields, not present in the PSET classifications, identified as potentially useful during the reviews of individual reports

Narrative free-text description of event	75.5
Date of admission	37.9
Type (near-miss or serious event)	37.6
How was event discovered	37.6
Event type (modified UHC taxonomy)	37.6
Disposition of event	37.6
Procedure error: Procedure	30.0
Fall: Type-specific information	7.6
Skin integrity: Type-specific information	5.0
Equipment: Type-specific information	4.0
Medication error: Type-specific information	0.2

For the remaining seven PSET classifications, the mapping could be better automated by adding PSET data elements to PA-PSRS. In the analysts' opinion, dedicating data fields to patient diagnosis, coexisting conditions, staff, and target or reason for care could provide consistently useful information. The analysts believe staff classifications would be helpful in identifying groups for interventions, such as team training and education.

For some of the PSET classifications in which information was unavailable in the existing comparable PA-PSRS data fields, the information may not have been entered by the reporter, either because it was anticipated to be included in the narrative field and was not; it was considered unimportant; or it was not required to be entered.

Virtually no information would currently be mapped from PA-PSRS for socioeconomic group and education; psychological, legal, or social impact; patient satisfaction, duration of disease, or "other" patient information; or causes due to recklessness, negligence, or external causes related to human failures beyond the control and responsibility of the facility. Of these 11 PSET classifications, recklessness, negligence, and external causes are excluded uniquely from PA-PSRS by the MCARE Act.[3] The analysts believe that socioeconomic class and education would rarely be recorded, even if relevant. In their opinion, the information about duration of disease present in PSET may be better than the PA-PSRS surrogate, "date of admission." Distinguishing acute from chronic conditions—diagnoses with a single opportunity for error vs. diagnoses with multiple opportunities for error—can be useful.

Adding valuable PSET data elements that are currently not in PA-PSRS, although desirable, would require a significant effort that must be approached as a comprehensive system upgrade. Adding data fields to the reporting system involves adding the fields to the database, changing the data-entry interface, and changing the reports. It would also require facilities that interface their legacy systems with PA-PSRS to change their interface systems. Facilities that collect information internally on paper would need to change their data collection forms as well.

We already spend time critiquing causes and prevention during discussions in weekly group analyses of important reports. We estimate that the additional time to process an individual report to include mapping to PSET with quality control would be approximately 5 minutes. With our current annual load of about 200,000 near-miss and serious-event reports for an estimated population of 12 million people, the additional time to review the mapping of every report would total more than 16,000 hours per year, requiring an additional eight full-time analysts. Even with major improvements in efficiency, extra personnel would be needed. Other patient safety reporting systems capturing large volumes of near-miss reports, such as the UHC PSN system, the Veterans Health Administration National Center for Patient Safety's reporting system, and (internationally) the United Kingdom's National Patient Safety Agency's reporting system, might have similar requirements for additional personnel if they were to map to an American or world patient safety database.

Cost-effective alternatives to having patient safety analysts do manual reviews of all reports and assign or critique values to PSET classifications by hand include the following:

- Radically change the PA-PSRS data fields to mimic essentially all the PSET data elements. This option would require a wholesale system overhaul of the current reporting system to make it into an electronic front-end entry system for a PSET database. This presumes no universal quality control. This solution would also make future data incompatible with the 380,000 reports already collected in PA-PSRS and a comparable number collected by UHC PSN.
- Automate the mapping done by the analysts, who bring together multiple data fields and free-text narrative fields. PA-PSRS currently prioritizes and distributes reports for analysts' queues using Bayesian classification predictors of importance and type of problem. PSET mapping could theoretically be done using more Bayesian classification predictors and, optimally, natural language processing. The inevitable rate of misclassification using automation might be offset by better consistency compared with human review. Resources, ideally in the form of research funding, would be needed to develop appropriate Bayesian classification programs, have them learn classifications from the analysts, and perform validation studies.
- Use a risk assessment index or other criterion to select a subset of important reports for mapping to PSET. This strategy would transmit salient information but would preclude epidemiologic studies based on complete sampling.
- Map only key indexing fields, such as "setting," "physical impact," "patient diagnosis," and "coexisting conditions," and organizational, practitioner, and technical causes.

Either radically changing an existing reporting system or accurately mapping reports would require a significant expenditure of resources. Any decision to do so would have to be justified by its value in providing significantly more information. For small-volume reporting systems with limited extra workloads and synergy from participating in an aggregated network of databases, the extra work may be worthwhile. For large-volume systems that can generate their own metrics, the significant extra work may not be justified.

If the difference in value of fully integrating a large, existing near-miss patient safety reporting system, such as PA-PSRS, with PSET is not perceived as adding enough information to justify the expenditure of resources, one or more partial solutions may be possible:

- Use a "free" unspecified field to link disparate patient safety database systems with a single joint index field. The usual index field for linked, or relational, databases—identifiable information in the report—may not be appropriate because of confidentiality concerns. We feel that a field describing the provider-reported descriptive event type (or incident type as understood by others) would be most appropriate because, in our opinion, it drives the most search strategies.
- Continue to improve the current PSET as existing reporting systems evolve toward PSET standards.

There are some general similarities between PSET and PA-PSRS. Most notably, both divide data elements into two levels: (1) those that are entered initially after an event occurs and (2) those that are entered after followup and analysis. This division is particularly valuable when near-miss reports are added to sentinel event reports, since the former do not always have followup and analysis, although information of similar value may be present in the recovery action.

There also are some differences:

- PSET has five primary parts to the classification of an event: one, the type of failure; two, the domain (setting, providers, and patient characteristics); three, the cause; four, the impact; and five, prevention or mitigation. Each primary classification is subdivided into subclassifications, with up to four designated levels: primary, secondary, tertiary, and quaternary. The type of failure has three secondary classifications, with a total of 21 possible data entries.
- PA-PSRS uses a modification of the UHC taxonomy of event types, which classifies the failure into one of nine primary event types (Table) with subtypes up to a total of three levels, including 20 embedded "other" categories, resulting in 195 distinct clinical event types at the terminal secondary or tertiary level, plus the 21 "other" categories. General information about domain, cause, and impact is collected by separate data elements.
- Whereas the PA-PSRS event types are mutually exclusive (either/or), the PSET classifications and subclassifications are mostly all yes/no (and/or), with possible entries in 115 different data fields in 34 primary, secondary, and tertiary classes and subclasses overall, most of which would be in the default "no."
- The PSET classification of the type of event is based on an assessment of the cause; the PSET "type" classification within its taxonomy does not describe the cause, which is a separate part of the event. However, it requires an evaluation of the event to document the possibility of specific communication failures, specific problems with patient management, and the correctness of the patient's diagnosis.

Alternatively, the event type (or incident type as understood by others) used by PA-PSRS is a description of the observed process error or adverse outcome devoid of analysis. Instead of being an evaluation of the event, it is the "chief complaint"—the problem as perceived by the provider or others involved with the event. As such, it requires no assessment to be accurately recorded. Furthermore, this "chief complaint" of a patient safety event then drives the electronic reporting system interface to ask more detailed type-specific questions as part of the examination of the problem.

Of the standard initial data elements for PSET, most of the basic "who, what, when, where, and how" can be found in PA-PSRS, but the following have no comparable data fields in PA-PSRS: who was involved (i.e., those involved in the event, described by role), diagnoses, and coexisting conditions. Of note to States or patient safety organizations planning to develop patient safety databases, procedures are not found in PSET, nor are they found in PA-PSRS, except within the primary event type "Error Related to Procedure."

Also of possible interest to States or patient safety organizations planning to develop patient safety databases, PA-PSRS records whether a reported event was a near-miss or "serious event," how the event was discovered, and its disposition, all of which are considered useful by the PA-PSRS analysts but are not found in PSET. PA-PSRS also includes a narrative field, which the analysts regard as the most valuable of all.

Qualitatively, the PA-PSRS analysts also perceived some weaknesses in the current PSET that could be improved:

- The PSET event-type classification presumes prior evaluation. We believe a descriptive event type, or incident type, based on process of care or clinical outcome would be more successful in initiating the evaluation process. This is especially true for data fields for which values do not just sit in a database but are used during the data entry process to drive coherent electronic collection of specific relevant data for that event through the data entry interface.
- Despite the Institute of Medicine's emphasis on errors of commission and omission,[5] errors of timing and technique,[6] such classifications are not available in PSET. PSET also focuses the assessment of clinical performance on the diagnosis rather than on the process of care, which, along with the context in which it is given, relates to the outcome. The PA-PSRS analysts find the reports most helpful when the processes and outcomes are specific, so that the clinical story can be reconstructed: e.g., diagnosis Q in a patient with comorbidity R, treated with process S by a provider type A in environment B, complicated by process error type T, corrected with action U by provider type C in environment D, gets (or is prevented from getting) complication X.
- Despite emphasis in the patient safety community on the components of a high-reliability organization[7] with a system for providing reliable care through standardization and teamwork, important elements of such variables are not collected. For example, institutional and personal factors are captured, but team factors are not.
- The recovery and mitigation responses, which result in events being "near misses" when successful, could be improved to lead to discoveries about how systems can change to prevent errors from harming patients.

Why did some reports in this mapping exercise, but not others, have comparable PA-PSRS data fields for mapping values to the PSET classifications? The PA-PSRS data entry interface is interactive; different details are requested depending on the PA-PSRS event type. For instance, a procedure data field is only available for the event type of "error related to procedure."

With specific reference to the study methodology, the following are emphasized:

- Not all of the 458 acute health care facilities, or even 238 hospitals, reporting to PA-PSRS were included.
- The sample was not random or a sample of consecutive reports. Instead, it was an assorted sample of the variations possible across facilities and event types, with special emphasis on reports of event types not specifically classified by the taxonomy used in PA-PSRS. We attempted to minimize the multiple biases of selecting consecutive reports (over-representing large-volume reporters and common event types) and reports that fit into our existing taxonomy.
- The reports were intentionally a distribution of "near misses" and what PA-PSRS calls "serious events." The difference between the percentage of near-miss reports in this study (79 percent) and PA-PSRS as a whole (96 percent) is due to the intentional sampling of a set number of reports from each event type, some of which (e.g., adverse drug reactions and complications) always presume harm.

- The analysts may have had a bias, based on familiarity with PA-PSRS, in favor of the usefulness of PA-PSRS data fields for understanding reported events. Others may be encouraged to map their patient safety systems to the current version or future iterations of PSET.

Conclusion

Different reporting systems and taxonomies have different conceptual premises that make mapping between them not just a programming exercise. There are some data elements in PSET that were identified in the mapping exercise and were considered worth adding to our existing patient safety reporting system. However, adding these data elements is not trivial. Mapping all reports without total alignment of the reporting system to PSET could double the workload of a large volume near-miss reporting system.

The value of changing existing reporting systems, laborious mapping of all reports, or developing sophisticated software to map them automatically would have to be justified by the net value added by doing so. In our opinion, PSET has weaknesses and strengths, compared with other established patient safety reporting systems. PSET may be most appropriate for new patient safety reporting systems or small systems for which changes or mapping would not be a burden.

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Any opinions in this manuscript are those of the authors and not the institutions with which they are affiliated.

Author Affiliations

All authors are affiliated with the Pennsylvania Patient Safety Reporting System, Harrisburg, PA. ECRI Institute, Plymouth Meeting, PA (Dr. Clarke, Ms. Johnston, Ms. Davis, Mr. Augustine, Mr. Marella); Institute for Safe Medication Practices, Huntingdon Valley, PA (Mr. Grissinger, Dr. Gaunt, Ms. Cohen); Department of Surgery, Drexel University, Philadelphia, PA (Dr. Clarke).

Address correspondence to: John R. Clarke, MD, Clinical Director, Pennsylvania Patient Safety Reporting System and Clinical Director for Patient Safety and Quality Initiatives, ECRI Institute, 5200 Butler Pike, Plymouth Meeting, PA 19462; Telephone: 610-825-6000 ext. 5035; fax: 610-834-1275; e-mail: jclarke@ecri.org.

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