Wrong-Site Surgery in Pennsylvania During 2015–2019:

A Study of Variables Associated With 368 Events From 178 Facilities

By **Robert A. Yonash**, RN[◆◇] & **Matthew A. Taylor**, PhD[◆◇]

DOI: 10.33940/data/2020.12.2

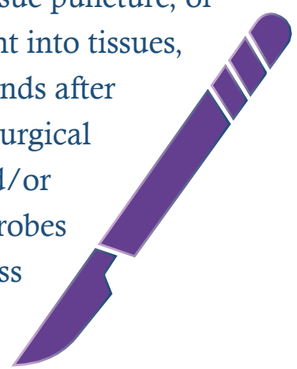
◆Corresponding author
◇Patient Safety Authority

Disclosure: The authors declare that they have no relevant or material financial interests.

Wrong-site surgery (WSS) is a well-known type of medical error that may cause a high degree of patient harm. In Pennsylvania, healthcare facilities are mandated to report WSS events, among other patient safety concerns, to the Pennsylvania Patient Safety Reporting System (PA-PSRS) database. In the study we identified instances of WSS events (not including near misses) that occurred during 2015–2019 and were reported to PA-PSRS. During the five-year period, we found that 178 healthcare facilities reported a total of 368 WSS events, which was an average of 1.42 WSS events per week in Pennsylvania. Also, we revealed that 76% (278 of 368) of the WSS events contributed to or resulted in temporary harm or permanent harm to the patient. Overall, the study shows that the frequency of WSS varied according to a range of variables, including error type (e.g., wrong side, wrong site, wrong procedure, wrong patient); year; facility type; hospital bed size; hospital procedure location; procedure; body region; body part; and clinician specialty. Our findings are aligned with some of the previous research on WSS; however, the current study also addresses many gaps in the literature. We encourage readers to use the visuals in the manuscript and appendices to gain new insight into the relation among the variables associated with WSS. Ultimately, the findings reported in the current study help to convey a more complete account of the variables associated with WSS, which can be used to assist staff in making informed decisions about allocating resources to mitigate risk.

Keywords: *wrong-site surgery, wrong patient, wrong procedure, wrong side, surgical error, interventional radiology, clinician specialty, surgical procedure, WSPE*

> The National Quality Forum (NQF) defines surgery as "an invasive operative procedure in which skin or mucous membranes and connective tissue is incised or an instrument is introduced through a natural body orifice. Surgery begins, regardless of setting, at the point of surgical incision, tissue puncture, or the insertion of an instrument into tissues, cavities, or organs. Surgery ends after counts have concluded, the surgical incision has been closed, and/or operative device(s) such as probes have been removed, regardless of setting."[3]



Introduction

Both ambulatory (i.e., outpatient) and inpatient surgeries are prevalent in the United States. For example, a recent study estimated that 48.3 million ambulatory surgical procedures were performed in the United States during 2010.[1] In a different study, the researchers reported that 30.2 million inpatient surgical procedures were conducted during the same year.[2]

Fortunately, the healthcare community within the United States has observed a high rate of surgical success, as indicated by a relatively low rate of complications and death.[4-6] Nevertheless, the National Quality Forum (NQF), The Joint Commission, World Health Organization (WHO), Agency for Healthcare Research and Quality (AHRQ), American College of Surgeons, American Academy of Orthopaedic Surgeons, and North American Spine Society have all identified wrong-site surgery (WSS) as a concerning and preventable type of error.[7-13]

WSS (e.g., wrong anatomical side, wrong site, wrong procedure, wrong patient) is a well-known type of medical error that may cause a high degree of patient harm and may result in substantial monetary costs due to malpractice claims.[14-19] In an effort to prevent WSS, many clinicians, healthcare facilities, and organizations (e.g., professional societies, government agencies) continue to develop interventions and put resources toward reducing the likelihood of WSS.[8,19-23] Despite the attention given to this topic, there is a dearth of reliable data on the prevalence or frequency of WSS.[7,24-27] The inability to reliably collect data and monitor trends in WSS is often attributed to a lack of infrastructure and mandates that require reporting of WSS and other medical errors.[18,26,28-35]

Pennsylvania is among a relatively small number of large governments or entities that legally mandates the healthcare community to report all near misses and serious events, and has a single database where all events are reported.[26,28,29,31-33,36-41] In Pennsylvania, healthcare facilities report WSS, among other patient safety events, to the Pennsylvania Patient Safety Reporting System (PA-PSRS)* database, which was established in 2004. With a well-established reporting system and relatively mature reporting culture, the WSS events documented in Pennsylvania are a consistent and robust source of data that should be leveraged to generate safety-related insights.

The purpose of our descriptive study was to use the PA-PSRS database to identify instances of WSS that reached the patient (excluding near miss events) during 2015–2019. We explored the data set for patterns and trends across the events to learn more about the variables associated with WSS, such as error type, facility type, procedure location, procedure performed, body region, clinician specialty, and demographics of patients involved. Overall, we believe that the data from this study can be used to help the healthcare community better understand current challenges with WSS and reveal variables that may influence the likelihood of WSS.

Methods

Data Source and Sample

Data in this study were derived from event reports that were composed by individuals working in healthcare facilities and submitted to the acute care PA-PSRS database. Each event report consists of responses to many structured fields (e.g., event date, patient age, patient gender, care area, facility type) and several free-text narrative fields, which are used by event reporters to describe the event. Given the unstructured nature of free-text narrative fields, the quantity and quality of the information varies from one report to another.

Readers should note that responses within the free-text fields of some reports are concise and none of the reports include access to patients' medical records or other sources of information. Nevertheless, in many reports the information is sufficient to understand and identify the safety-related variables of interest.

The WSS events included in the study occurred between January 1, 2015, and December 31, 2019. We conducted a two-phase process to select and identify WSS events for inclusion in the study (note: near misses were excluded from the study). The first phase consisted of a database query, where events were extracted if they met one or more of the following inclusion criteria:

- Based on the PA-PSRS taxonomy, events were classified by reporters as "wrong site," "wrong side," "wrong procedure," "wrong patient," or "preparation inadequate/wrong."
- Based on the PA-PSRS taxonomy, events were classified by reporters as "surgery/invasive procedure problem" and at least one of the free-text narrative fields contained the words "incision" and "excision" or "left" and "right."

*PA-PSRS is a secure, web-based system through which Pennsylvania hospitals, ambulatory surgical facilities, abortion facilities, and birthing centers submit reports of patient safety–related incidents and serious events in accordance with mandatory reporting laws outlined in the Medical Care Availability and Reduction of Error (MCARE) Act (Act 13 of 2002). All reports submitted through PA-PSRS are confidential and no information about individual facilities or providers is made public.

Table 1. Definition of Wrong-Site Surgery (WSS) and Examples by Error Type

Wrong-Site Surgery: *Defined as a surgical or other invasive procedure performed on the wrong side, site, or patient, or an incorrect procedure performed on the patient.*[17,43-45]	
Error Type	**Examples**
Wrong Side	• Ureteral stent erroneously placed in left ureter, rather than right ureter • Regional block performed on the left knee, as opposed to the right knee • Patient admitted for surgical arthroscopy of the right knee; the patient's left knee was mistakenly draped and prepped, and an incision was performed
Wrong Site	• Anesthetic block performed on wrong finger of the same hand • Osteotomy erroneously performed on second metatarsal rather than third metatarsal • Spinal procedure on unintended spinal level
Wrong Procedure	• Carpel tunnel performed instead of trigger finger release • Patient had a dialysis catheter placed in error (unnecessary procedure, which was a procedure that was not scheduled, consented, or intended) • Patient scheduled for a tonsillectomy, but instead the adenoids were removed
Wrong Patient	• Peripherally inserted central catheter (PICC) line converted to midline on patient A instead of patient B • Circumcision erroneously performed on patient A rather than patient B

Note: Information in each event example was modified to ensure confidentiality.

- Within PA-PSRS, events classified under the "surgical services" care area (including anesthesia care) and at least one of the free-text narrative fields contained any of the following phrases: "wrong site," "wrong side," "wrong level," "time out," "incorrect side," "incorrect site," "block," or "mark."

In the second phase, one person manually reviewed each report to identify all events that met the definition of WSS (see **Table 1** for a definition of WSS and examples by error type). Based on the aforementioned query criteria and manual review of event reports, a total of 368 events were included in the study.

Variables Coded

In this study, we explored two sets of variables. The first set was coded by the event reporter (i.e., facility-assigned personnel who submitted the event report to PA-PSRS) and consisted of demographic and clinical variables (e.g., patient age and gender, event date, event harm, facility type, bed size). The second set of variables were coded by a researcher, based on manual review of the event reports. While reviewing the events, the researcher coded the events for the following variables: error type (4 categories), clinician specialty (17 categories), procedure group (11 categories), specific procedure (34 categories, as shown in **Appendix A**), body region (12 categories), and body part (41 categories, as shown in **Appendix C**). Each variable was coded to reflect what occurred in the event, as opposed to what was intended. For example, the researcher coded the events for the procedure performed and body region impacted by the event, which may have been different from the intended procedure or body region.

In this study, the procedure group variable was comprised of three categories independent of clinician specialty and anatomical area, and seven categories that were dependent on specialty and/or anatomical area. The three independent categories were biopsy, excision, and injection procedures. During the coding process, if the procedure performed during the WSS event was among either of the three independent categories, then it was coded as one of those categories. However, if the WSS event was not associated with either of the three independent categories, then it was subsequently coded as being among one of the seven clinician specialty and/or anatomical area dependent categories (e.g., ophthalmic, urological, vascular). If the procedure was not aligned with either of the 10 independent or dependent categories, then we coded the event under the other category. During the coding process, each of the WSS events were coded as being associated with one category of the procedure group variable; therefore, the categories are mutually exclusive to each other.

The body region variable consisted of three categories of systems and eight categories of anatomical areas, which included numerous body parts. During the coding for the body region variable, if a WSS event occurred in the digestive, reproductive, or urinary system, then we coded the event as occurring within one of those three systems. However, if the WSS event did not occur within either of those systems, then the WSS event was coded as occurring within one of the eight anatomical areas. If the event report did not identify the body region impacted by the WSS event, then we coded the event under the unspecified category. In this study, the categories within the body region variable are mutually exclusive to each other.

Descriptive Data Analysis

The variables were measured by frequency of occurrence and were subjected to a descriptive analysis. A descriptive analysis is an approach where phenomena are identified and patterns are explored to better understand and explain the conditions in which the phenomena occur.[42] This type of analysis is not used to identify causal relations; rather, it is used to characterize the context of the phenomena, point toward possible causal mechanisms, and generating hypotheses. With a descriptive analysis, data are presented in a manner favoring simplicity with minimal statistical adjustments, as opposed to complex statistical modeling or an unnecessarily complex presentation of the data, to help a broader audience readily comprehend the findings. This type of analysis is often achieved with graphs and tables of the data that will allow a triangulation among various combinations of variables. Overall, our goal with this approach is to analyze and present the data in a manner that is most useful for readers.

Results

Patient Age and Gender

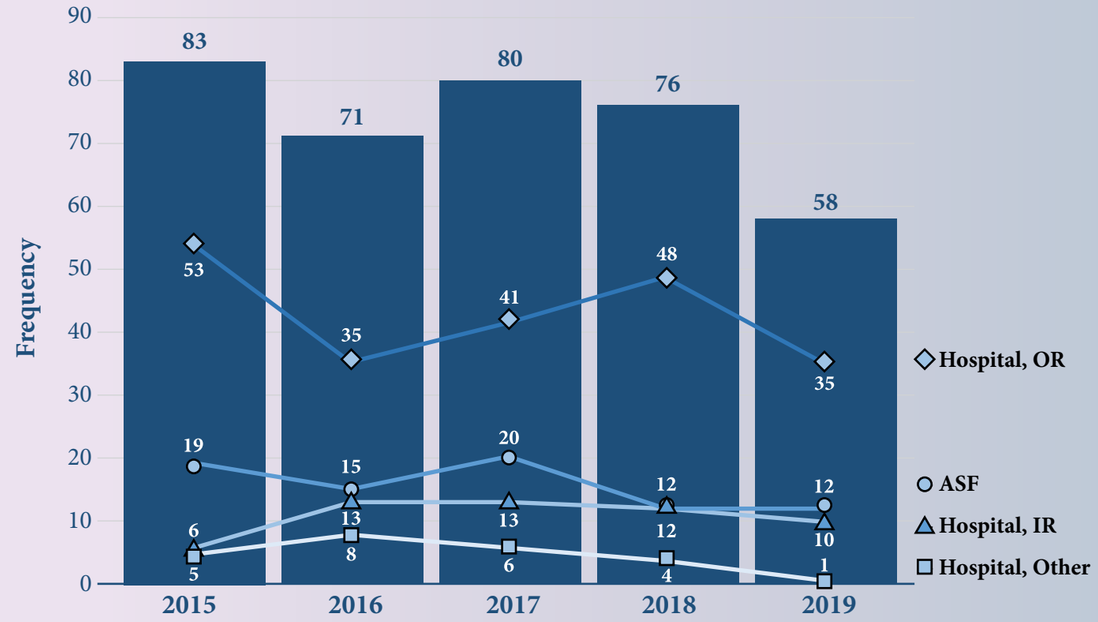
Based on all 368 event reports, patient age was an average of 56 years and a median of 58 years (range of 0 to 99 years). Also, 57% (209 of 368) of patients were reported as female and 43% (159 of 368) were reported as male.[†]

Event Harm

For each event, the reporter identified the degree of patient harm, which was defined by the 10 categories of harm scores used in PA-PSRS. Based on the harm scores, we found that 76% (278 of 368) of the WSS events contributed to or resulted in temporary harm or permanent harm to the patients and required treatment/intervention or initial/prolonged hospitalization.

> In Pennsylvania, during the period of 2015–2019 there was an average of 1.42 wrong-site surgeries reported each week (368 WSS events during a period of 260 weeks).

Figure 1. Wrong-Site Surgery by Year, Facility Type, and Hospital Procedure Location



Note: The bars represent the total frequency per year, across facility type and hospital procedure location. Each line represents a specific combination of facility type and/or hospital procedure location. OR represents operating room, IR represents interventional radiology, and ASF represents ambulatory surgical facilities that were individually licensed.

Wrong-Site Surgery by Facility Type, Hospital Procedure Location, and Hospital Bed Size

Wrong-site surgeries occurred at individually licensed acute care hospitals and ambulatory surgical facilities (ASF).[‡] **Figure 1** presents the frequency of WSS over a five-year period by facility type and hospital procedure location. The figure shows that the total frequency of WSS was up and down from year to year, with a high of 83 events in 2015 to a low of 58 events in 2019. A closer look at the figure reveals that a majority of WSS events were associated with hospitals, as opposed to ASFs, and were distributed across the following procedure locations: operating room (OR),[§] interventional radiology (IR), and other.[¶] The frequency of WSS was consistently greater in the hospital OR than IR; nevertheless, IR experienced a range of 6 to 13 WSS events per year, over the five-year period. Finally, **Figure 1** also shows that ASFs reported WSS events each year during that five-year period, with a high of 20 events in 2017 and a low of 12 events in both 2018 and 2019.

As shown in **Table 2,** we explored the frequency of WSS by year, facility type, and hospital bed size. The table shows that hospitals account for 79% (290 of 368) of all WSS events and those with more than 300 beds account for 43% (157 of 368) of all WSS events. Also, we found that ASFs

[†]Within the PA-PSRS database, reporting patient gender is a mandatory field, yet response options are binary and only include Male and Female. It is unclear if the reported patient gender matches each patient's self-identified gender.

[‡]The Health Care Facilities Act of Jul. 19, 1979, P.L. 130, No. 48 defines ambulatory surgical facility (ASF) as "a facility or portion thereof not located upon the premises of a hospital which provides specialty or multispecialty outpatient surgical treatment. Ambulatory surgical facility does not include individual or group practice offices of private physicians or dentists, unless such offices have a distinct part used solely for outpatient surgical treatment on a regular and organized basis. For the purposes of this provision, outpatient surgical treatment means surgical treatment to patients who do not require hospitalization, but who require constant medical supervision following the surgical procedure performed."

[§]The category of hospital procedure location labeled operating room (OR) was comprised of events that occurred in the operating room, preoperative area, postoperative care unit, and procedure room (endoscopy/gastrointestinal laboratory, laser room, or dedicated anesthesia block room).

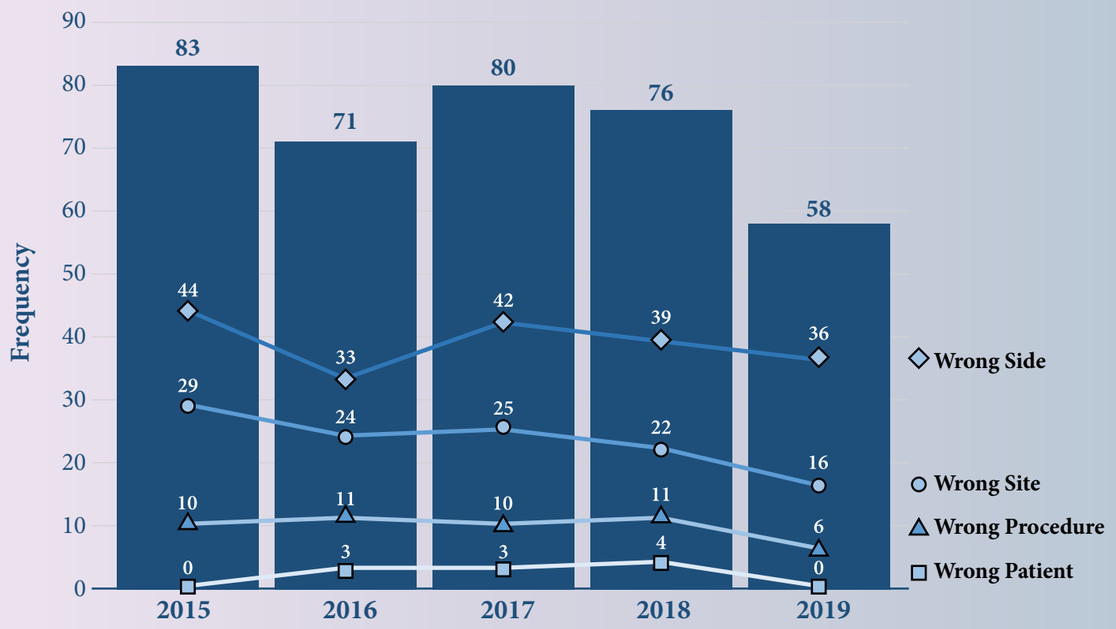
[¶]The category of hospital procedure location labeled other consisted of events that occurred in radiation oncology, rehabilitation unit, short stay unit, invasive cardiology, emergency department, electrophysiology laboratory, intensive care unit, newborn nursery, and nursing care unit (medical/surgical, neurology, medical oncology).

Table 2. Frequency of Wrong-Site Surgery by Year, Facility Type, and Hospital Bed Size

Facility Type	Unique Facilities	2015	2016	2017	2018	2019	Grand Total
ASF	**62**	**19**	**15**	**20**	**12**	**12**	**78**
Hospital	**116**	**64**	**56**	**60**	**64**	**46**	**290**
Acute Care Hospitals - 1 to 100 beds	29	13	7	11	10	2	**43**
Acute Care Hospitals - 101 to 200 beds	28	4	10	10	12	9	**45**
Acute Care Hospitals - 201 to 300 beds	26	8	5	11	11	10	**45**
Acute Care Hospitals - over 300 beds	33	39	34	28	31	25	**157**
Grand Total	**178**	**83**	**71**	**80**	**76**	**58**	**368**

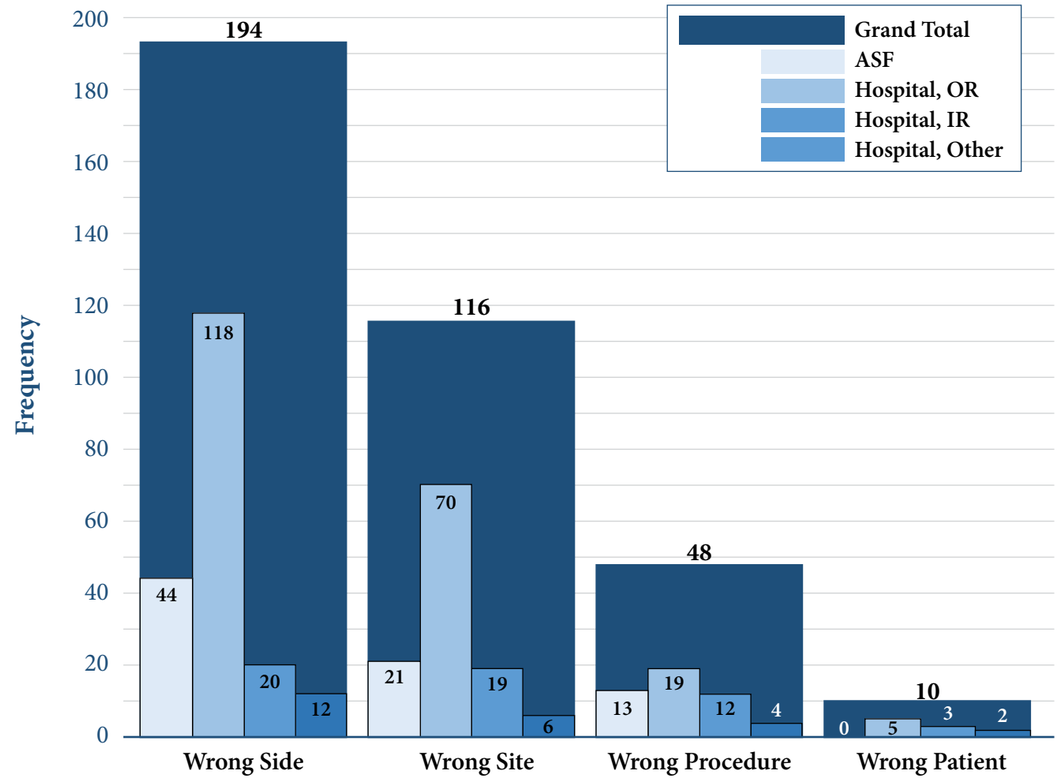
Note: The category of acute care hospitals includes children hospitals, critical access hospitals, and long-term acute care hospitals. All ASFs were individually licensed ambulatory surgical facilities. The numbers under the Unique Facilities column represents the count of individually licensed facilities that had at least one WSS during the five-year period.

Figure 2. Wrong-Site Surgery by Year and Error Type



Note: The bars represent the total frequency per year, across all error types. Each line represents the frequency per error type.

Figure 3. Wrong-Site Surgery by Error Type, Facility Type, and Hospital Procedure Location



Note: The figure shows the frequency of WSS across a five-year period (2015–2019). The primary bar per error type represents the grand total of events across the four sub-categories of bars. OR represents operating room, IR represents interventional radiology, and ASF represents ambulatory surgical facilities that were individually licensed.

were associated with 21% (78 of 368) of all WSS events, which is a greater portion of the sample than hospitals with a bed size of 1–100 (12%, 43 of 368), 101–200 (12%, 45 of 368), or 201–300 (12%, 45 of 368).

We also explored the frequency of unique facilities that reported at least one WSS event during 2015–2019. We found that a total of 62 ASFs and 116 acute care hospitals reported at least one occurrence of WSS during that five-year period. Across the 62 ASFs that reported a WSS event, there was a range of 1–3 events reported per facility (mean of 1.26, median of 1, and only one facility reported 3 WSS events). Across all 116 acute care hospitals that reported a WSS event, the range of reports per facility was 1-16 throughout the five-year period (mean of 2.5, median of 1, and 39 facilities reported having 3 or more WSS events). For the count of unique facilities with at least one WSS event by hospital bed size, see **Table 2**.

Wrong-Site Surgery by Error Type and Related Variables

Figure 2 shows the frequency of WSS by error type and year. Wrong-side errors were the most common type of error, when compared with the other error types (wrong site, wrong procedure, and wrong patient). The figure reveals that the frequency of wrong-side, wrong-procedure, and wrong-patient errors were variable and without a clear trend over the five-year period. In contrast, the frequency of wrong-site errors decreased from 29 events in 2015 to 16 events in 2019.

Figure 3 conveys the frequency of WSS by error type, facility type, and hospital procedure location over the entire five-year period (2015–2019). This figure shows that there were some observable differences in

Table 3. Frequency of Wrong-Site Surgery by Error Type and Procedure Group during 2015–2019

Procedure Group	Wrong Side	Wrong Site	Wrong Procedure	Wrong Patient	Grand Total
Biopsy	8	16	3		**27 (7%)**
Excision	2	10	1		**13 (4%)**
Injection	96	16	3	1	**116 (32%)**
Ophthalmic	11	1	2		**14 (4%)**
Orthopedic, Upper Extremity		12	5		**17 (5%)**
Orthopedic/Podiatry, Lower Extremity	13	2			**15 (4%)**
Other	14	14	13	4	**45 (12%)**
Spinal	4	36	1		**41 (11%)**
Thoracic	11	2	2		**15 (4%)**
Urological	28		2	1	**31 (8%)**
Vascular	7	7	16	4	**34 (9%)**
Grand Total	**194**	**116**	**48**	**10**	**368**

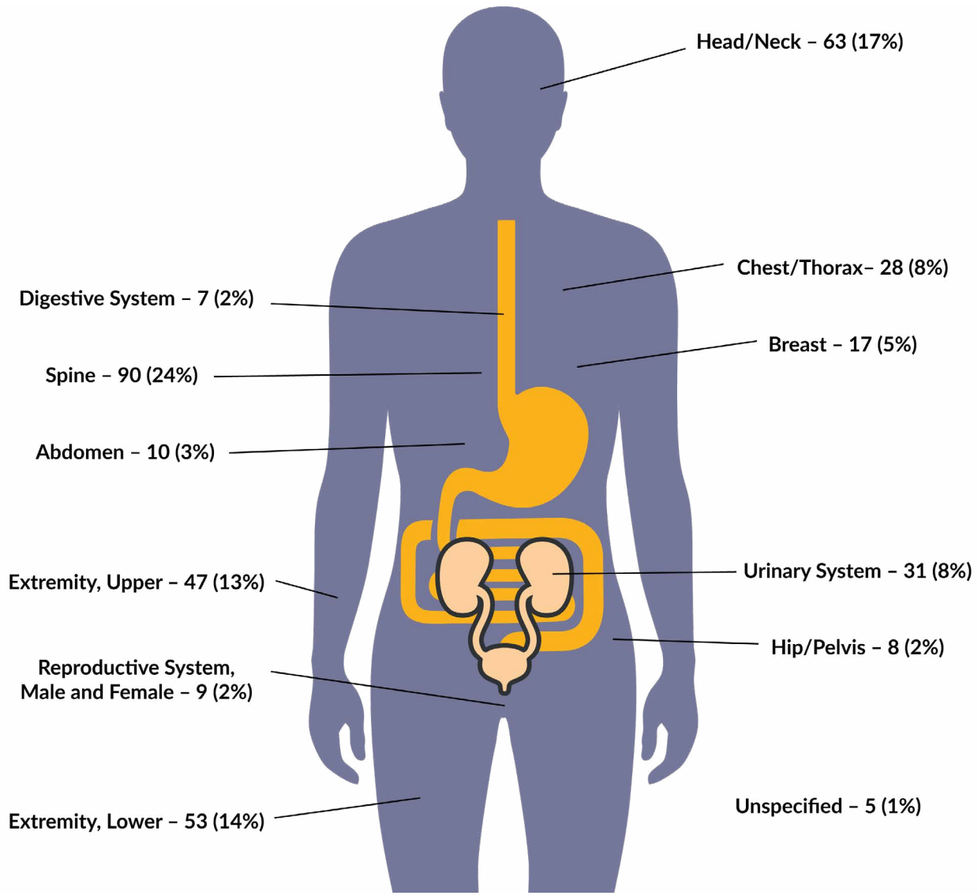
Note: The data reflect the procedure performed, which may have been different from the intended procedure. The "Other" category under Procedure Group consisted of 29 specific procedures, which were each associated with 4 or fewer WSS events. Within each variable, the frequency of events per category are mutually exclusive to other categories. For example, the frequency of events related with the Injection category exclude events associated with the Ophthalmic category and vice versa. Blank cells represent a zero frequency per combination of categories.

Table 4. Frequency of Wrong-Site Surgery by Error Type and Body Region during 2015–2019

Body Region	Wrong Side	Wrong Site	Wrong Procedure	Wrong Patient	Grand Total
Abdomen	3	2	4	1	**10 (3%)**
Breast	2	14	1		**17 (5%)**
Chest/Thorax	17	5	6		**28 (8%)**
Digestive System		2	4	1	**7 (2%)**
Extremity, Lower	43	6	4		**53 (14%)**
Extremity, Upper	12	23	9	3	**47 (13%)**
Head/Neck	39	12	12		**63 (17%)**
Hip/Pelvis	6	1	1		**8 (2%)**
Reproductive System, Male and Female	2	1	3	3	**9 (2%)**
Spine	39	48	2	1	**90 (24%)**
Unspecified	3	2			**5 (1%)**
Urinary System	28		2	1	**31 (8%)**
Grand Total	**194**	**116**	**48**	**10**	**368**

Note: The data reflect the body region involved in the WSS events, which may have been different from the intended body region. The "unspecified" category of body region represents the WSS events where the report did not identify the body region. Within each variable, the frequency of events per category are mutually exclusive to other categories. For example, the frequency of events related with the Urinary System category exclude events associated with the Abdomen category and vice versa. Blank cells represent a zero frequency per combination of categories.

Figure 4. Frequency of Wrong-Site Surgery by Body Region During 2015–2019



the distribution of WSS across facility types and hospital procedure locations from one error type to another. For example, although events were most frequent in the hospital OR, relative to the other locations, the proportion represented by the hospital OR varied from one error type to another. Within the wrong side type of error, the hospital OR represents 61% (118 of 194) of the events and within the wrong procedure type of error, the hospital OR accounts for 40% (19 of 48) of the events. As another example, hospital IR was associated with 10% (20 of 194) of the wrong-side errors and 25% (12 of 48) of the wrong-procedure errors. Overall, these two examples indicate that the type of error might be more or less likely depending on the facility type and hospital procedure location.

Table 3 provides insight into the relation between error types and procedure groups. Overall, we found that the following procedure groups were most frequently associated with WSS: injection (32%, 116 of 368), spinal (11%, 41 of 368), and vascular (9%, 34 of 368). Injections cited in this study include blocks (anesthetic/pain), steroids, and radiation (tracer/therapy). The table reveals that some procedure groups were associated with several types of errors while others were predominantly related with a single type of error. For example, vascular procedures were associated with all four types of errors. In contrast, almost all urological procedures were associated with a single type of error (wrong side). Additionally, the table indicates that certain procedure groups might be more prone to certain error types than other types. For example, orthopedic/podiatry lower extremity procedures were largely associated with wrong-side errors and orthopedic upper extremity procedures were primarily associated with wrong-site errors. Last, the table shows that wrong procedure errors and wrong patient errors were the most infrequent among the four types of errors. Interestingly, we found that 33% (16 of 48) of the wrong procedure errors and 40% (4 of 10) of the wrong patient errors were as-

sociated with vascular procedures, which is the procedure group most frequently associated with those two error types.

To gain further insight into the WSS events associated with each of the procedure groups, we tabulated the frequency of specific procedures (unique), which are summarized in **Appendix A**. Across all 368 event reports, we found that 10 reports did not provide adequate information to identify the specific procedure performed (i.e., unspecified). Among the 358 event reports that identified the specific procedure, we found that there were a total of 97 different procedures associated with the WSS events. Within the four procedure groups most frequently associated with WSS, we found that there was one category of specific procedure within each that was associated with at least a quarter of the WSS events. For example, urological endoscopy with a stent was related with 58% (18 of 31) of the urological WSS events. The findings indicate that some procedures might be more prone to a WSS event than other procedures.

Table 4 shows the frequency of WSS by error type and body region. The table reveals that the spine (24%, 90 of 368), head/neck (17%, 63 of 368), lower extremity (14%, 53 of 368), and upper extremity (13%, 47 of 368) were the body regions most frequently related with WSS events. Additionally, the data indicate that certain body regions might be prone to multiple types of error, while others are primarily related with a single type of error. For example, the spine is frequently associated with both wrong-side and wrong-site (including wrong spinal level) errors. In contrast, the breast region is mostly related with wrong-site errors. See **Figure 4** for an illustration of the frequency of WSS per body region.

Readers should note that the frequency of WSS per category of procedure group (**Table 3**) might be less than the frequency reported in the corresponding category of body region (**Table 4**). Any difference in frequency across corresponding categories between **Table 3** and **Table 4** reflects our use of procedure group categories that are independent of specialty and/or anatomical area. For example, **Table 4** shows that a total of 90 WSS events were associated with the spine body region and **Table 3** shows that there were 41 WSS events associated with the spinal procedure group. This difference in frequency is due to 49 WSS events occurring in the spine body region, but were associated with a biopsy, excision, injection, or other procedure. For a cross-tabulation of WSS events by procedure group and body region, see **Appendix B**.

To better understand the nature of WSS, we also identified the frequency of WSS by body part within each of the body regions, which are presented in **Appendix C**. Across all 368 event reports, there were 28 reports where the body part was unspecified. Within the 340 reports where the body part was identified, we found that a total of 51 different body parts were impacted by the WSS events. In each of the four body regions most frequently associated with WSS, there was at least one body part in each region that was associated with roughly a third to half of the WSS events. For example, within the lower extremity region, the knee was related with 45% (24 of 53) of the WSS events. As another example, the eye represented 35% (22 of 63) of the WSS events among the head/neck region. Overall, the results suggest that certain body parts might be more likely to be associated with a WSS event than other body parts.

Table 5 presents the frequency of WSS by error type and clinician specialty. The table shows that the following clinician specialties were the most frequently related with a WSS event: pain management (15%, 54 of 368), interventional radiology (14%, 52 of 368), and orthopedics (12%, 44 of 368). The table also reveals that some clinician specialties primarily experience one type of error while other clinician specialties are associated with several error types. For example, pain management is primarily associated with wrong side errors while interventional radiology has a notable relation with several types of error: wrong side (37%, 19 of 52), wrong site (37%, 19 of 52), and wrong procedure (23%, 12 of 52).

In addition to the aforementioned **Appendices A, B,** and **C,** see **Appendices D–G** for various cross tabulations of variables related to WSS (**Appendix D**, clinician specialty by procedure group; **Appendix E**, clinician specialty by body region; **Appendix F**, procedure group by facility type by hospital procedure location; **Appendix G**, body region by facility type by hospital procedure location).

The appendices serve the function of providing greater insight into the WSS events. We believe the various combinations of visuals allow patient safety professionals, healthcare leaders, frontline providers, and other concerned stakeholders to better understand the nature of WSS by triangulating this complex and multifaceted issue. With the information, readers can better gauge the degree to which certain variables are impacting the frequency of WSS. Ultimately, the findings reported in the current study help to convey a more complete account of the variables associated with WSS.

Discussion

Many clinicians, patient safety professionals, and organizations take the position that WSS events are preventable and should never occur.[9,11-13,28,43,46,47] For those reasons, the topic of WSS has received considerable attention and many studies have been conducted to monitor and shed light on the occurrences of WSS. Previous research on WSS events used a variety of data sources, including government agencies, hospital systems, accrediting organizations, malpractice claims with insurance companies, and survey of clinicians.[18,24,28,44-46,48-52] There are benefits to using different data sources and taking different approaches to studying a topic; unfortunately, the differences likely impact the findings and create challenges in making valid comparisons that are free of confounding variables. For example, among the studies we identified during our literature review, we found study design differences across the following variables: time period; geography; reporting culture; definitions of surgery and WSS; inclusion or exclusion of near misses; and selective inclusion of categories within clinician specialty, procedure performed, procedure location, and facility type. While there is value in nearly all studies of WSS, the lack of consistency in study design and manner of reporting results (e.g., frequency of WSS vs rate) makes it difficult to directly compare our findings with much of the previous research.

Table 5. Frequency of Wrong-Site Surgery by Error Type and Clinician Specialty during 2015-2019

Clinician Specialty	Wrong Side	Wrong Site	Wrong Procedure	Wrong Patient	Grand Total
Anesthesia	29	1	4		34 (9%)
Dermatology	1	8			9 (2%)
Ear, Nose, and Throat	4	1	2		7 (2%)
Foot/Ankle	4	2			6 (2%)
Gastroenterology		1	2	1	4 (1%)
General Surgery	9	11	11	1	32 (9%)
Gynecology	1		1	2	4 (1%)
Interventional Radiology	19	19	12	2	52 (14%)
Neurosurgery	3	1			4 (1%)
Ophthalmology	19	1	2		22 (6%)
Orthopedics	17	22	5		44 (12%)
Other	8	3	2	2	15 (4%)
Pain Management	43	9	1	1	54 (15%)
Spinal Surgery		33	1		34 (9%)
Thoracic Surgery	5	1	1		7 (2%)
Urology	28		2	1	31 (8%)
Vascular	4	3	2		9 (2%)
Grand Total	194	116	48	10	368

Note: The "Other" category consisted of 10 different clinician specialties, which were each associated with two or fewer WSS events. Within each variable, the frequency of events per category are mutually exclusive to other categories. For example, the frequency of events related with the Anesthesia category exclude events associated with the Pain Management category and vice versa. Readers should note that many of the WSS injections were administered by anesthesiologists and pain management specialists. Anesthesiologists tend to care for the patient during the perioperative period whereas the pain management specialists (many of whom are anesthesiologists) treat a patient's pain both in the surgical setting as well as ancillary departments and outpatient care. These two points were the basis upon which the events were classified as either an anesthesia event or a pain management event. Blank cells represent a zero frequency per combination of categories.

Wrong-Site Surgery By Year

The current study showed that WSS events continue to occur, which is consistent with an abundance of published research,[24,28,44,46] including previous studies conducted by the Patient Safety Authority (PSA).[36,53,54] Previous PSA research targeted the frequency of WSS events that occurred in hospital ORs and/or ASFs, and excluded procedure locations of hospital IR and hospital "other" (e.g., radiation oncology, rehabilitation unit, invasive cardiology, emergency department, newborn nursery). In order to monitor the status of WSS events over an extended period of time, we compared data from a previous PSA study[53] that reported WSS events during 2005-2014[#] and our data from 2015-2019 (only Hospital OR and ASF procedure locations). Based on those parameters, we found an average of 58.27 WSS events per calendar year during that 15-year period (median of 57, low of 38 in 2012, and a high of 80 in 2008). When comparing our findings with the previous study, the mean frequency of WSS events per calendar year was 65.8, 51, and 58 during the five-year periods of 2005-2009, 2010-2014, and 2015-2019, respectively. The findings indicate that WSS continues to be a challenge in Pennsylvania and that healthcare facilities should continue allocating resources and putting effort into preventing WSS.

[#]Note that previous PSA studies reported WSS events by academic year as opposed to calendar year.

Wrong-Site Surgery By Error Type And Other Variables

The current study shows that the frequency of WSS events vary by error type and numerous other variables (e.g., facility type, procedure location, procedure group, body region, and clinician specialty). During 2015–2019 the frequency of WSS events per error type were without a clear trend, except for what appeared to be a decreasing trend of wrong-site errors. Taking a closer look at previous PSA studies, we found only two studies that systematically explored the relation between WSS events and error type; however, each of those studies had a relatively narrow focus on events related to orthopedic surgery or ASFs.[54,55] In the study of events at ASFs, the distribution of WSS by error type was similar to what was reported by ASFs in our current study. Overall, the findings in the present study expand upon previous PSA studies by including a broader scope of variables and subcategories that help to provide further insight into distribution of WSS by error type.

During our literature search we identified several other studies that explored error type among WSS events.[24,44,45,49,51] For example, two studies from the Veterans Health Administration (VHA) evaluated WSS events as a function of error type, clinician specialty, and body region variables.[44,45] Between the two VHA studies and the current study, the distribution across all four error types were similar, except for wrong patient errors. In the two VHA studies, wrong patient errors were among the most common and represented at least 27% of the total errors. In contrast, our study found that wrong patient errors were the least common and consisted of fewer than 3% of all errors (10 of 368). Overall, the findings appear to indicate that clinicians within Pennsylvania are relatively effective in preventing wrong patient errors; nevertheless, we would still argue that an average of two wrong patient errors per year is too many.

Further comparison between the two VHA studies[44,45] and our current study revealed some similarities and differences in the distribution of WSS events by clinician specialty. The findings were similar by revealing that interventional radiology, orthopedics, urology, and ophthalmology specialties were associated with the highest frequencies of WSS. The current study also found a notable frequency of WSS events associated with anesthesia and pain management; yet, the VHA studies did not report any events related with those specialties, despite defining injections as a type of WSS. We speculate that this contrast in findings indicates a design difference between studies, as opposed to the VHA's lack of WSS events associated with injections. Finally, the current study revealed a relatively high frequency of WSS events associated with the spinal surgery specialty, which is consistent with previous research.[50,52] In the end, the findings show that each of the 17 categories of clinician specialty have a history of WSS; consequently, many clinicians and healthcare facilities should be concerned with the risk of WSS.

Our WSS findings across the 11 categories of procedure groups were difficult to compare with much of the previous research, including previous PSA studies.[53,56-59] For example, some of the previous studies either targeted only a small number of procedures that were relatively specific (ureteral stents as opposed to all urological procedures or eye blocks by surgeons as opposed to ophthalmic procedures) or the variable parameters were unclear due to lack of information. Regardless, it appears that our findings are consistent with some of the previous PSA studies that reported a high frequency of WSS associated with anesthetic blocks and spinal surgery.[53,57-59]

Our study also showed that the frequency of WSS varied by body region, which is consistent with previous research.[45,54] For example, a VHA study reported that across nine body regions, the eye, upper extremities, and lower extremities were most frequently associated with WSS and the least frequent were abdomen, spine, and head/neck. A portion of their findings are aligned with our results, but in our study the spine was the most frequent body region and the eye was in the bottom 50% of the distribution associated with WSS, which is a notable contrast from the VHA study. A previous PSA study focused on the relation between WSS and seven body parts within the upper and lower extremity regions.[54] The study reported that hand, knee, and foot were most frequently associated with WSS, which is similar to our findings. Nevertheless, the previous PSA study was relatively narrow in scope by only studying events that involved orthopedic surgery and the extremities. Our current study expanded upon previous PSA research by exploring the distribution of WSS across 12 body regions (including body parts, as shown in **Appendix C**) and other relevant variables (e.g., error type, clinician specialty, procedure group, specific procedure, facility type, and procedure location).

Overall, some of our findings are consistent and some are inconsistent with previous literature, which should be expected in part due to the differences in design across the studies. The current study systematically evaluated the frequency of WSS according to 14 different combinations of variables, and this comprehensive approach allows for greater depth of analysis into the complex and multifaceted topic of WSS.

Strategies to Reduce the Likelihood of Wrong-Site Surgery

Based on our study, it is apparent that WSS continues to be a challenge for patient safety and the spectrum of surgical and procedural services. As a result, clinicians and healthcare facilities should continue to review their existing processes and revise their approach as necessary to reduce the likelihood of WSS. The prevention of WSS events is a team effort that encompasses all staff members, starting at the point of procedure scheduling to the successful completion of the consented procedure. Strategies should be employed throughout the perioperative process, which should include preoperative verification and reconciliation, site marking, and timeout and intraoperative verification. Clinicians and healthcare facilities should conduct a gap analysis of their existing processes relative to the 14 risk mitigation strategies described in **Appendix H**.

For further information about various strategies and tools to prevent WSS events, please see the many resources available at the PSA website, patientsafety.pa.gov. Resources include educational posters, self-assessment checklist, sample scheduling forms, observational monitoring tools, and error analysis forms (e.g., wrong spinal level and wrong ureter).

Limitations

We urge readers to avoid interpreting the findings as being representative of the absolute frequency of WSS events across Pennsylvania, as it is possible that some events may go unreported. In particular, certain types of procedures (e.g., injection) might be systematically underreported due to the misperception that those procedures were harmless mistakes. The findings in the present study were reported as a frequency and are consistent with previous studies conducted by PSA; however, without reporting a normalized rate (ratio of WSS events per number of surgical procedures performed) it is difficult for the healthcare community to gauge the risk of WSS as a function of one variable versus another.

Conclusion

The results show that WSS continues to be a challenge throughout Pennsylvania, as evidenced by 368 WSS events reported by 178 healthcare facilities during 2015–2019 and an average of 1.42 WSS events reported each week. Overall, the present study addresses many gaps in the literature and shows that the frequency of WSS varied according to a range of variables, including error type (e.g., wrong side vs wrong patient), year, facility type, hospital bed size, hospital procedure location, procedure, body region, body part, and clinician specialty. We encourage readers to gain insights into the relation among the variables associated with WSS by using various combinations of visuals in the manuscript and appendices. We believe the visuals allow patient safety professionals, healthcare leaders, frontline providers, and other stakeholders to better understand the nature of WSS by triangulating the complex and multifaceted issue. With the information, readers can better gauge the degree to which certain variables are impacting the frequency of WSS. Ultimately, the findings reported in the current study help to convey a more complete account of the variables associated with WSS, which can be used to assist staff in making informed decisions about allocating resources to mitigate risk.

See Online Supplement for Appendices on page i.

Notes

This analysis was exempted from review by the Advarra Institutional Review Board.

References

1. Hall MJ, Schwartzman A, Zhang J, Liu X. *Ambulatory Surgery Data from Hospitals and Ambulatory Surgery Centers: United States*, 2010. National Health Statistics Reports. 2017(102):1-15.

2. Centers for Disease Control and Prevention (CDC) and National Center for Health Statistics (NCHS). National Hospital Discharge Survey. *Number, Rate, and Standard Error of All-Listed Surgical and Nonsurgical Procedures for Discharges from Short-Stay Hospitals, by Selected Procedure Categories*: United States, 2010. Hyattsville, MD2010.

3. National Quality Forum (NQF). NQF Patient Safety Terms and Definitions. Washington, DC: NQF; 2009.

4. Ghaferi AA, Birkmeyer JD, Dimick JB. Variation in Hospital Mortality Associated with Inpatient Surgery. *N Engl J Med*. 2009;361(14):1368-75.

5. International Surgical Outcomes Study Group. Global Patient Outcomes After Elective Surgery: Prospective Cohort Study in 27 Low-, Middle-and High-Income Countries. *Br J Anaesth*. 2016;117(5):601-9.

6. Khuri SF, Henderson WG, DePalma RG, Mosca C, Healey NA, Kumbhani DJ. Determinants of Long-Term Survival After Major Surgery and the Adverse Effect of Postoperative Complications. *Ann Surg*. 2005;242(3):326-43.

7. World Health Organization. *WHO Guidelines for Safe Surgery 2009: Safe Surgery Saves Lives.* Geneva, Switzerland: World Health Organization; 2009. p. 1-133.

8. Health Research & Educational Trust and Joint Commission Center for Transforming Healthcare. *Reducing the Risks of Wrong-Site Surgery: Safety Practices From The Joint Commission Center for Transforming Healthcare Project*. Chicago, IL: Health Research & Educational Trust; August 2014.

9. Patient Safety Network (PSNet). Wrong-Site, Wrong-Procedure, and Wrong-Patient Surgery. *Patient Safety Primer*. Rockville, MD: Agency for Healthcare Research and Quality; September 2019.

10. American Academy of Orthopaedic Surgeons. OK Plan to End Wrong-Site Surgeries: Academy Seeks Unified Effort with Surgical Groups. *American Academy of Orthopaedic Surgeons Bulletin*. October 1997:1-3.

11. Patient Safety Network (PSNet). Never Events. *Patient Safety Primer*. Rockville, MD: Agency for Healthcare Research and Quality; September 2019.

12. Wong DA, et al. Sign, Mark & X-Ray. *Prevention of Wrong-Site Spinal Surgery*. Burr Ridge, IL: North American Spine Society; 2014. p. 1-10.

13. National Quality Forum (NQF). *Serious Reportable Events in Healthcare—2011 Update: A Consensus Report*. Washington, DC: NQF; 2011.

14. Nwosu A. The Horror of Wrong-Site Surgery Continues: Report of Two Cases in a Regional Trauma Centre in Nigeria. *Patient Saf Surg*. 2015;9(6):1-4.

15. Boodman SG. The Pain of Wrong Site Surgery. *Washington Post*. 2011 June, 20.

16. Harrison W, Narayan B, Newton A, Banks J, Cheung G. Litigation Costs of Wrong-Site Surgery and Other Non-Technical Errors in Orthopaedic Operating Theatres. *Annals R Coll Surg Engl.* 2015;97(8):592-7.

17. Mulloy DF, Hughes R. Chapter 36. Wrong-Site Surgery: A Preventable Medical Error. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville, MD: Agency for Healthcare Research and Quality (AHRQ Publication No. 08-0043); March 2008.

18. Kwaan MR, Studdert DM, Zinner MJ, Gawande AA. Incidence, Patterns, and Prevention of Wrong-Wite Surgery. *Arch Surg*. 2006;141(4):353-8.

19. Mehtsun WT, Ibrahim AM, Diener-West M, Pronovost PJ, Makary MA. Surgical Never Events in the United States. *Surg*. 2013;153(4):465-72.

20. Makary MA, Mukherjee A, Sexton JB, Syin D, Goodrich E, Hartmann E, et al. Operating Room Briefings and Wrong-Site Surgery. *J Am Coll Surg*. 2007;204(2):236-43.

21. Conley DM, Singer SJ, Edmondson L, Berry WR, Gawande AA. Effective Surgical Safety Checklist Implementation. *J Am Coll Surg*. 2011;212(5):873-9.

22. Collins SJ, Newhouse R, Porter J, Talsma A. Effectiveness of the Surgical Safety Checklist in Correcting Errors: A Literature Review Applying Reason's Swiss Cheese Model. *AORN J*. 2014;100(1):65-79.

23. The Joint Commission. National Patient Safety Goals Effective July 2020 for the Hospital Program. *National Patient Safety Goals®* Effective July 1, 2020. The Joint Commission: Oakbrook Terrace, IL; March 2020. p. 1-14.

24. DeVine J, Chutkan N, Norvell DC, Dettori JR. Avoiding Wrong Site Surgery: A Systematic Review. *Spine*. 2010;35(9S):S28-S36.

25. Mahajan RP. *The WHO Surgical Checklist. Best Practice & Research Clinical Anaesthesiology*. 2011;25(2):161-8.

26. Hanchanale V, Rao AR, Motiwala H, Karim OA. Wrong Site Surgery! How Can We Stop It? *Urol Ann*. 2014;6(1):57-62.

27. Santiesteban L, Hutzler L, Bosco III JA, Robb III W. Wrong-Site Surgery in Orthopaedics: Prevalence, Risk Factors, and Strategies for Prevention. *JBJS Rev*. 2016;4(1).

28. Hempel S, Maggard-Gibbons M, Nguyen DK, Dawes AJ, Miake-Lye I, Beroes JM, et al. Wrong-Site Surgery, Retained Surgical Items, and Surgical Fires: A Systematic Review of Surgical Never Events. *JAMA Surg*. 2015;150(8):796-805.

29. ECRI Institute. Event Reporting and Response. *Healthcare Risk Control*. 2016.

30. Hanlon C, Sheedy K, Kniffin T, Rosenthal J. *2014 Guide to State Adverse Event Reporting Systems*. National Academy for State Health Policy; 2015.

31. Levinson DR. *Adverse Events in Hospitals: State Reporting Systems*. In: Office of Inspector General, editor.: Department of Health and Human Services; December 2008.

32. Weinberg J, Hilborne LH, Nguyen Q-T. Regulation of Health Policy: *Patient Safety and the States. Advances in Patient Safety: From Research to Implementation*. Rockville, MD: Agency for Healthcare Research and Quality; 2005. p. 405-22.

33. Macrae C. The Problem With Incident Reporting. *BMJ Qual Saf*. 2016;25(2):71-5.

34. Classen DC, Resar R, Griffin F, Federico F, Frankel T, Kimmel N, et al. "Global Trigger Tool" Shows That Adverse Events In Hospitals May Be Ten Times Greater Than Previously Measured. *Health Aff*. 2011;30(4):581-9. doi: 10.1377/hlthaff.2011.0190. PubMed PMID: 21471476.

35. Lind DP. Patient Safety Week: Different Approaches Can Be Taken in Iowa. In: *The Health Autonomist*, editor. Clive, IA: Heartland Health Research Institute; March 2020.

36. Clarke JR, Johnston J, Finley ED. Getting Surgery Right. *Ann Surg*. 2007;246(3):395-405.

37. Kepner S, Jones R, Hoffman R, Allen C, Glunk D, Weitz E, et al. 2019 Pennsylvania Patient Safety Reporting: An Analysis of Serious Events and Incidents from the Nation's Largest Event Reporting Database. *Patient Saf*. 2020;2(1):80-94.

38. Wright S. *Memorandum Report: Few Adverse Events in Hospitals Were Reported to State Adverse Event Reporting Systems*. OEI-06-09-00092. Washington, DC: Office of Inspector General, Department of Health and Human Services; 2012.

39. Sheedy K, Hanlon C, Kniffin T, Rosenthal J. *Adverse Event Reporting in Massachusetts and Other States: Status and Trends in 2014*. Portland, ME: National Academy for State Health Policy; 2014.

40. Pennsylvania's Patient Safety Reporting System. New York, NY: The Commonwealth Fund; 2007.

41. West N, Eng T, Kirk A. *Update on State Government Tracking of Health Care-Acquired Conditions and a Four-State In-Depth Review*. CMS Contract No HHSM-500-2005-00029I. Baltimore, MD: Center for Medicare and Medicaid Innovation, Centers for Medicare & Medicaid Services; 2012.

42. Loeb S, Dynarski S, McFarland D, Morris P, Reardon S, Reber S. *Descriptive Analysis in Education: A Guide for Researchers*. (NCEE 2017-4023). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance; 2017.

43. Patient Safety Authority. Doing the Right Things to Correct Wrong-Site Surgery. *Pennsylvania Patient Safety Advisory*. 2007;4(2):32-45.

44. Neily J, Mills PD, Eldridge N, Carney BT, Pfeffer D, Turner JR, et al. Incorrect Surgical Procedures Within and Outside of the Operating Room: A Follow-up Report. *Arch Surg*. 2011;146(11):1235-9. doi: 10.1001/archsurg.2011.171.

45. Neily J, Mills PD, Eldridge N, Dunn EJ, Samples C, Turner JR, et al. Incorrect Surgical Procedures Within and Outside of the Operating Room. *Arch Surg*. 2009;144(11):1028-34. doi: 10.1001/archsurg.2009.126.

46. Robinson P, Muir L. Wrong-site surgery in orthopaedics. *J Bone Joint Surg Br*. 2009;91(10):1274-80.

47. Michaels RK, Makary MA, Dahab Y, Frassica FJ, Heitmiller E, Rowen LC, et al. Achieving the National Quality Forum's "Never Events": Prevention of Wrong Site, Wrong Procedure, and Wrong Patient Operations. *Ann Surg*. 2007;245(4):526-32.

48. Meinberg EG, Stern PJ. Incidence of Wrong-Site Surgery Among Hand Surgeons. *J Bone Joint Surg*. 2003;85(2):193-7.

49. Seiden SC, Barach P. Wrong-Side/Wrong-Site, Wrong-Procedure, and Wrong-Patient Adverse Events: Are They Preventable? *Arch Surg*. 2006;141(9):931-9.

50. James MA, Seiler III JG, Harrast JJ, Emery SE, Hurwitz S. The Occurrence of Wrong-Site Surgery Self-Reported by Candidates for Certification by the American Board of Orthopaedic Surgery. *J Bone Joint Surg*. 2012;94(1):1-12.

51. Vachhani JA, Klopfenstein JD. Incidence of Neurosurgical Wrong-Site Surgery Before and After Implementation of the Universal Protocol. *Neurosurg*. 2013;72(4):590-5.

52. Mody MG, Nourbakhsh A, Stahl DL, Gibbs M, Alfawareh M, Garges KJ. The Prevalence of Wrong Level Surgery Among Spine Surgeons. *Spine*. 2008;33(2):194-8.

53. Arnold TV. Update on Wrong-Site Surgery: More Data Provides More Insight. *Pennsylvania Patient Safety Advisory*. 2018;15(1):1-5.

54. Clarke JR. Wrong-Site Orthopedic Operations on the Extremities: The Pennsylvania Experience. *Pennsylvania Patient Safety Advisory*. 2015;12(1):19-27.

55. Arnold TV. Update on Wrong-Site Surgery: Reports from Ambulatory Surgical Facilities. *Pennsylvania Patient Safety Advisory*. 2016;13(4):160-2.

56. Clarke JR. Quarterly Update on Wrong-Site Surgery: Marking for Regional Anesthetic Blocks. *Pennsylvania Patient Safety Advisory*. 2014;11(3):136-40.

57. Clarke JR. Quarterly Update on Wrong-Site Surgery: Areas to Focus Attention *Pennsylvania Patient Safety Advisory*. 2013;10(4):142-5.

58. Clarke JR, Arnold TV. Quarterly Update on Wrong-Site Surgery: Work to Be Done. *Pennsylvania Patient Safety Advisory*. 2013;10(3):110-5.

59. Patient Safety Authority. Quarterly Update on the Preventing Wrong-Site Surgery Project: Digging Deeper. *Pennsylvania Patient Safety Advisory*. 2010;7(1):26-31.

About the Authors

Robert A. Yonash (ryonash@pa.gov), a registered nurse, has been with the Patient Safety Authority (PSA) since 2009 as the patient safety liaison for the Southwest region of Pennsylvania. He works with medical facilities to eliminate medical errors and has undertaken several projects, including a joint initiative with the Pennsylvania Society of Anesthesiologists on wrong-site blocks and serving as a Core Team Lead for the PSA's Center of Excellence for Improving Diagnosis. Yonash is a member of the American Society of Professionals in Patient Safety and has attained certification as a Certified Professional in Patient Safety (CPPS) and a Lean Six Sigma Healthcare Green Belt. He is also a master trainer in TeamSTEPPS.

Matthew A. Taylor (MattTaylor@pa.gov) is a patient safety analyst for the Patient Safety Authority (PSA), where he conducts research; uses data to identify patient safety concerns and trends; and develops solutions to prevent recurrence, as well as tools and materials to help facilities and clinicians improve patient safety. Prior to joining the PSA, Taylor was a scientific writer and research specialist at the University of Pittsburgh School of Pharmacy, and he has served fellowships at the Centers for Disease Control and Prevention (CDC) and the VA Pittsburgh Healthcare System. His expertise in data analysis and research covers a range of topics, including patient safety, public health, employee training, process efficiency, human factors, workplace culture/climate, behavior change interventions, and organizational management.