Cardiovascular Complications in Patients Undergoing Noncardiac Surgery: A Cardiac Closed Claims Thematic Analysis

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More than 200 million adults have noncardiac surgery worldwide every year. Anesthesia closed claims databases allow anesthesia providers to critically examine adverse outcomes that occur during an anesthetic or immediately following the administration of anesthesia, to aid in improving patient care. A qualitative analysis of 34 closed malpractice claims with a cardiac-related event was conducted to determine common themes. Five common themes emerged: preanesthetic evaluation, normalization of deviance, medications, hemorrhage, and knowledge deficit/failed clinical reasoning.

Keywords: Cardiac arrest, cardiovascular collapse, closed claims, malpractice.

More than 200 million adults have noncardiac surgery worldwide every year.[1(p2258)] The incidence of anesthesia-related cardiac arrest is unknown but has been estimated to be 0.5 per 10,000 anesthetics.[2(p829)] Devereaux and Sessler[1] point out that cardiovascular complications are the leading cause of death within 30 days of surgery. The purpose of this article is to present findings from a thematic analysis of anesthesia closed malpractice claims related to cardiovascular events in patients undergoing noncardiac surgery. Cardiovascular complications in this study included cardiac arrest, arrhythmias, cardiac tamponade, myocardial infarction, exacerbation of congestive heart failure, and cardiovascular collapse. Anesthesia closed claims registries are databases of adverse outcomes, including death, that occur during an anesthetic or immediately following the administration of anesthesia and are used to identify opportunities for improving the care provided by anesthesia professionals. By reviewing the claims in these databases, researchers can identify patterns leading to errors, communicate these patterns with practitioners, and work to develop strategies to eliminate adverse patient outcomes.

Methods

The American Association of Nurse Anesthetists (AANA) Foundation closed claims research team, in conjunction with CNA Insurance Companies, generated a database of closed claims (N = 245) to use for future study regarding anesthesia-related complications and patient outcomes.[3] Expert reviewers used a standardized data collection tool that included quantitative and qualitative components (reviewer's narrative, reviewer's assessment, list of accusations, lessons learned). Inclusion criteria for eligibility were malpractice claims from the years 2003 to 2012 that were considered closed (ie, completed the entire litigation process and the payout, if any) and involved either a Certified Registered Nurse Anesthetist (CRNA) and/or a student registered nurse anesthetist. After the dataset was generated, the team was instructed on the use of thematic analysis as described by Braun and Clarke.[4] The team practiced conducting thematic analyses as a group until they were satisfied that they would be able to use the methods. Several team members were experienced qualitative researchers, familiar with the method, and assisted the members who were inexperienced in qualitative methods.

The cardiac investigation team consisted of CRNAs who were from both clinical and academic settings. The team leader conducted a manual query of every closed claim in the closed claims database (N = 245) searching for cardiac events in patients undergoing noncardiac surgery. This query produced 52 claims. The cardiac investigative team independently reviewed the claims for inclusion. After the independent review, the team discussed their findings, and by consensus 18 of the claims were excluded from the final analysis (N = 34). Exclusion criteria included insufficient evidence to correlate the patient outcome with the cardiac event; an outcome that was likely due to pulmonary events instead of cardiac events; or a nonanesthesia-related outcome.

A descriptive analysis of the 34 claims was conducted, followed by a thematic analysis examining the relationship between a cardiac event and anesthesia care. Initially, the team members coded all claims independently. Then,

Step No.	Action
1	Team leader conducted manual query of database for cardiac claims
2	Team of 4 investigators reviewed claims for inclusion/exclusion
3	Team coded 1 case together during a phone conference and reached consensus
4	Team independently coded 3 claims and held a phone conference to reach consensus
5	Monthly, team independently coded 6-8 claims and held phone conferences to discuss the codes and reach consensus (approximately 4 months)
6	Three investigators met face-to-face (1 withdrew) to conduct thematic analysis and reach consensus on final themes

Table 1. Steps in Thematic Analysis of Cardiac Claims

as a group, they discussed the individual codes until they were in complete agreement. Next, each member reviewed the data codes and developed themes, which were discussed as a group until complete agreement was reached on the emerging themes. Finally, results of the data and thematic analysis were sent to an experienced, independent qualitative researcher, who validated the group's findings. Table 1 describes the process of analyzing the data.

Results

An evaluation of the 34 cardiovascular complications of noncardiac surgeries revealed that 22 (65%) of the claimants were female, with a mean age of 51 years. Half of the patients had risk factors for a cardiac event. The Figure depicts patient comorbidities found in this study. The type of anesthesia most commonly administered in these claims was general anesthesia (41%, n = 14) followed by monitored anesthesia care (38%; n = 13). Death occurred in 85% of the claims. Twenty claims (64%) had payouts, which ranged from $15,000 to $1 million (mean = $333,448). Nine of the 34 claims were found to be preventable, 4 were found to be nonpreventable, and the other 21 were indeterminate. Most of the cardiac events were cardiac arrest (62%; n = 21), acute myocardial infarction (12%; n = 4), and arrhythmogenic events (6%; n = 2). Cosmetic procedures, obstetric/gynecologic procedures, and general surgical procedures represent the most prevalent types of procedures associated with cardiac closed claims. Table 2 denotes types of surgical procedures found in the claims.

Five themes emerged from the thematic analysis: preanesthetic evaluation, normalization of deviance, medications, hemorrhage, and knowledge deficit/failed clinical reasoning. Table 3 illustrates the themes, their descriptions, and subthemes. Further explanation of the themes, including claims that represent those themes,

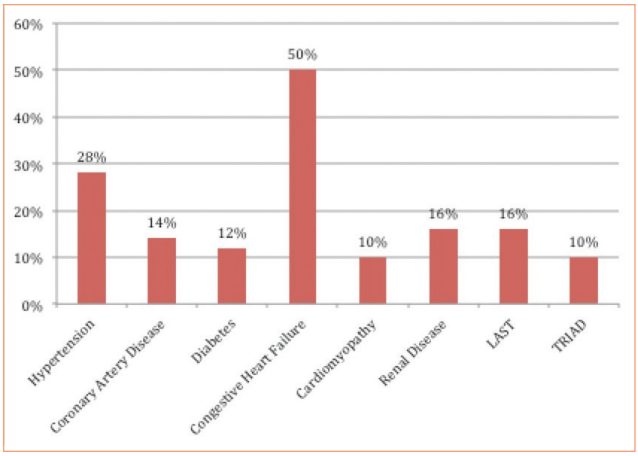

Figure. Percentage of Cardiac Closed Claims Identified by Comorbidity or Chronic Condition

Abbreviations: LAST, local anesthetic systemic toxicity; TRIAD, concomitant use of local anesthetic, epinephrine, and beta adrenergic antagonist.

Procedure/surgery type	Frequency (%)[a]
Cosmetic	7 (20.6)
Obstetric/gynecology	6 (17.7)
General	5 (14.7)
Orthopedic	4 (11.8)
Vascular	3 (8.8)
Podiatry	2 (5.9)
Neurologic	2 (5.9)
Cardiac catheterization	1 (2.9)
Gastrointestinal	1 (2.9)
Bariatric	1 (2.9)
Ophthalmology	1 (2.9)
Dental	1 (2.9)
Total	34 (100)

Table 2. Types of Surgical Procedures Found in Cardiac Claims

[a]Percentages do not add to 100 because of rounding.

follows. Several claims represented more than 1 theme.

• ***Preanesthetic Evaluation.*** Incomplete and/or inappropriate preanesthetic patient evaluation was found in 62%, or 21, of the claims. Incomplete patient evaluation was further divided into provider and patient categories. An example of provider incomplete patient evaluation included failure to perform and/or document a thorough preanesthetic evaluation. In one claim, a patient, who was scheduled for upper extremity vascular surgery under monitored anesthesia care, had a major history of hypertension, previous myocardial infarction, hyperlipidemia, diabetes, and end-stage renal disease. The patient had an electrocardiogram that showed left ventricular hypertrophy and widened QRS, which was a change from the previous electrocardiogram. There was no current

Theme	Description	Subthemes
Preanesthetic evaluation	Incomplete or inappropriate patient evaluation	• Incomplete patient evaluation • Patient failure to disclose key information • Inappropriate consultation
Normalization of deviance	The gradual process through which unacceptable practice or standards become acceptable[7]	• Production pressure • Inappropriate patient selection for facility
Medications	Any medication administered to the patient by either CRNA or surgeon/proceduralist	• CRNA lack of knowledge related to medications • Local anesthetics, anesthesia agents, antibiotics • Medication errors • Patient reaction to medications
Hemorrhage	Large blood loss	• Large blood loss • Substantial blood products administered • DIC
Knowledge deficit/failed clinical reasoning	Lack of knowledge/not using pertinent information to make appropriate decisions	• Failed clinical reasoning • Missed opportunities

Table 3. Themes and Related Subthemes
Abbreviations: CRNA, Certified Registered Nurse Anesthetist; DIC, disseminated intravascular coagulopathy.

cardiac clearance on the patient's chart, and the CRNA did not request one. Toward the end of the case, the patient became bradycardic, hypotensive, and apneic, requiring cardiopulmonary resuscitation. The patient's vital signs subsequently returned to normal; however, the patient never resumed consciousness and died less than 1 month after the procedure. The postoperative cardiac markers indicated myocardial infarction, and the postoperative echocardiogram showed global hypokineses of the left ventricle.

Incomplete patient evaluation was also represented by patients failing to disclose key information to the provider. An example of failed patient disclosure occurred when the anesthesia provider canceled an elective case because the patient's wheezing not being corrected with a nebulizer treatment. The patient was referred to a pulmonologist. The patient met with the pulmonologist and experienced chest pains during the pulmonary evaluation. The pulmonologist referred the patient to a cardiologist for a cardiac workup. The patient decided not to keep the cardiology appointment and proceeded to have the elective surgery when the wheezing cleared. Preoperatively, the patient failed to mention that chest pain was experienced during the pulmonary consult and that a cardiology consult was suggested and the patient declined. The patient experienced cardiovascular collapse during the elective procedure and died intraoperatively.

Inappropriate patient evaluation was represented in several claims related to inappropriate consult or lack of a consult. A claim involving a patient scheduled for an elective procedure who experienced chest pain relieved by nitroglycerin and who had ST and T changes on the electrocardiogram is an example of this subtheme. An internal medicine physician, rather than a cardiologist, was consulted and determined the electrocardiogram changes were clinically insignificant and recommended proceeding with the procedure. The anesthetic was uneventful; however, the patient experienced a cardiac arrest and died a few hours after discharge to home. The CRNA was accused of failing to obtain appropriate cardiac workup.

• ***Normalization of Deviance.*** *Normalization of deviance*, defined as the gradual process through which unacceptable practice or standards become acceptable,[5] was found in 47% of the claims (n = 16). As the deviant behavior is repeated without catastrophic results, it becomes the norm for the organization.[5] Production pressure and inappropriate patient selection are further illustrations of normalization of deviance. An example of normalization of deviance occurred when a patient with a history of hypertension, noninsulin-dependent (type 2) diabetes mellitus, renal insufficiency, and hyperlipidemia was scheduled for a prone procedure in an area of the hospital that was outside the operating suites. This location lacked appropriate standard monitoring modalities, yet anesthesia professionals provided anesthesia in the location. The patient experienced a sudden, unexplained episode of severe hypertension immediately before the procedure. The decision was made to continue with the procedure using monitored anesthesia care without further patient workup. The patient experienced cardiovascular collapse during the procedure and died less than a week after the procedure. Before this claim, the anesthesia provider expressed a continuing uneasiness with providing anesthesia in the location. Despite knowing these limitations, the

CRNA elected to provide anesthesia for the case.

Production pressure was identified as an issue in a claim that involved a patient who presented to an eye center for a procedure to "prevent blindness." The patient's medical history was remarkable for hypertension, congestive heart failure, diabetes, smoking, and illicit drug use. The CRNA did not request a medical clearance, nor was an informed consent for the anesthesia procedure obtained. The CRNA administered a peribulbar block to the patient. An hour after the start of the case, the patient became restless, and the CRNA decided to induce general endotracheal anesthesia. The patient experienced profound bradycardia, requiring resuscitation, after receiving 50 mg of propofol. The patient was transferred to a hospital and was pronounced dead shortly after arrival. The CRNA indicated that the surgeon declared the case an emergency, hence the lack of thorough preanesthetic evaluation. However, the surgeon denied declaring the case an emergency, and there was no documentation in the patient's medical record that the case was an emergency.

Numerous closed claims involved inappropriate patient selection for freestanding facilities. These included morbidly obese patients with obstructive sleep apnea and patients with severe cardiac disease. An example of inappropriate patient selection included a claim where a young, morbidly obese (body mass index of 42 kg/m^2) patient with a history of smoking and anxiety was scheduled for an elective procedure in a freestanding facility. The anesthesia provider expressed reservations about providing anesthesia for this patient in the facility but proceeded despite the concerns. The patient received a subarachnoid block and sedation. During the case, the patient experienced a cardiac arrest requiring resuscitation and activation of emergency medical services for transport to a nearby hospital. The patient never regained neurologic function and died several months after the procedure.

• ***Medications.*** The theme of medications was represented by 14 (41%) of the claims. Medication errors, lack of knowledge related to the mechanisms of action of pharmaceutical agents, or the patient's adverse reactions to medications led to deleterious patient outcomes. Three classes of medications were featured throughout the closed claims files: anesthetic agents, local anesthetics, and antibiotics. In one claim, an anesthesia provider had to use methohexital for induction of general anesthesia because of a facility shortage of propofol. The anesthesia provider was unfamiliar with methohexital and failed to correctly dilute the medication before administration. The patient suffered cardiac arrest because of a substantial overdose of methohexital as well as subsequent anoxic brain injury, and died a month later.

Eight claims of intraoperative cardiovascular collapse following the administration of local anesthetics were identified. In 6 of the claims, local anesthetic systemic toxicity (LAST) may have caused the cardiovascular collapse. In 4 of the claims, cardiovascular collapse occurred following the administration of a β-adrenergic antagonist to treat tachycardia and hypertension caused by the intravascular uptake of local anesthetic and epinephrine. There are several possible mechanisms that may have led to cardiovascular collapse, including (1) LAST, (2) a negative synergistic effect of the combination of local anesthetics and β-adrenergic antagonists on cardiac inotropy, and (3) interaction between epinephrine and β-adrenergic antagonists. Many of these claims occurred before the recommendation of 20% lipid infusion to treat LAST.

Cardiovascular collapse related to antibiotic administration was reviewed in 2 claims. One claim involved a patient with a documented penicillin allergy who received 1 g of cefazolin intravenously. The second claim involved a patient who was rapidly given minimally diluted clindamycin intravenously.

• ***Hemorrhage.*** Hemorrhage was found in 9 (26%) of the claims. Of the 9 hemorrhage claims, 33% (n = 3) were related to obstetric patients, 22% (n = 2) were related to plastic surgery, 22% (n = 2) were related to general surgery, 11% (n = 1) were related to a gynecologic surgery, and 11% (n = 1) were related to a cardiac catheterization. This theme pertained to patients with large amounts of blood loss, administration of blood products, disseminated intravascular coagulopathy (DIC), or coagulopathies. All these claims involved large amounts of blood loss and substantial administration of blood products. A few of the claims had patients who went into DIC. One claim involved failed recognition of hemorrhage. The CRNA stated that she was unaware of the large blood loss because of the surgical drapes. There were a few claims in which patients were tachycardic due to hemorrhage, and they were improperly treated (by registered nurses who were not CRNAs) with β-adrenergic receptor blockers.

• ***Knowledge Deficit/Failed Clinical Reasoning.*** Knowledge deficit or failed clinical reasoning was found in 41% of the claims (n = 14). It included failed clinical reasoning (failure to incorporate patient-specific information into the plan of care) and missed opportunities (failure to act in a situation in which something could be done). An illustration of failed clinical reasoning involves a claim in which a patient had a bowel perforation related to a procedure that was done the previous day and was scheduled for an emergency exploratory laparotomy. The CRNA did not inquire about the patient's fluid intake, urine output, or the increased hemoglobin level, despite receiving no packed red blood cells. The CRNA placed an epidural anesthetic for postoperative pain management before induction of general anesthesia. The patient was oliguric and tachycardic, for which the CRNA treated with esmolol. The patient became hypotensive and had ST elevation on the electrocardiogram (indicative of ST-elevation myocardial infarction). The CRNA did not recognize the im-

portance of the clinical picture or appropriately treat the patient. The patient sustained hypoxic brain injury and spinal cord infarction, resulting in paralysis.

An example of a missed opportunity included a claim in which both a physician and nurse anesthetist evaluated a patient with pulmonary hypertension who was taking a prescribed drug for treatment of pulmonary hypertension and was receiving oxygen at home. According to the closed claim document, neither the physician nor the CRNA was familiar with the drug or its mechanism of action. Furthermore, they did not document that the patient was taking this drug, despite these drugs being documented elsewhere in the patient's medical record. Because of the mechanism of action of the medication, the patient experienced cardiovascular collapse during the surgical procedure, requiring resuscitation, and died several weeks after the surgery.

Discussion

The aim of this study was to use thematic analysis to determine common themes surrounding cardiac events in anesthesia closed claims. Five major themes were identified: preanesthetic evaluation, normalization of deviance, medications, hemorrhage, and knowledge deficit/failed clinical reasoning. Many of the claims illustrated more than 1 theme.

An imperative component of patient safety is a complete and thorough preanesthetic evaluation. It is the first standard in the AANA Standards for Nurse Anesthesia Practice[6] and serves as the foundation for determining the safest anesthetic plan and mitigates patient risk factors. Anesthesia providers should use various sources to obtain pertinent patient information (eg, patient, medical record, other healthcare providers) and familiarize themselves with anesthetic implications of the patient's medications and comorbidities. A few claims involved patient injury, including death, due to anesthesia provider unfamiliarity with the mechanism of action of patient medications and unfamiliarity with patient comorbidities. Preanesthesia evaluation includes reviewing and/or obtaining appropriate medical/cardiac clearance, if applicable, even if the patient is scheduled for a minor procedure. There were several claims in which patients with multiple comorbidities who were scheduled for minor procedures in freestanding facilities were injured or died. In these claims, the patients did not receive a medical/cardiac clearance, received clearance from an inappropriate source, or the CRNA was told there was a clearance, yet none could be found in the medical record. It is important to examine and document the medical/cardiac clearance and not just take someone's word that it exists.

Patient failure to disclose key health information was found in 6 claims. Death occurred in 5 of the claims, and in the other claim, the patient remained in a permanent vegetative state. Not having a complete understanding of the patient's health information does not allow the anesthesia provider to optimize care, and it jeopardizes patient safety. Patients (and their families) should be informed of the potential harm they may cause themselves by withholding health information.

Anesthesia providers are at risk of engaging in habits that undermine best practices as a result of normalization of deviance. Vaughn[5] coined the term *normalization of deviance* in reference to the Space Shuttle Challenger disaster. It refers to the tolerance of small deviations in acceptable behavior over time, which eventually become the norm. Production pressure is a form of normalization of deviance. Gaba and colleagues[7] reported production pressure in anesthesia as early as 1994. They found that 49% of anesthesiologists in their study witnessed production pressure. Examples of production pressure were proceeding with an elective case despite an inadequate preanesthetic evaluation, pressure to hasten anesthetic procedures, and pressure to avoid delaying cases.[7] They also found that some anesthesiologists perceived unsafe actions being performed because of production pressure.[7] Kirsner and Biddle[8(p4)] state "production pressure is a well known but poorly analyzed factor in the operating room." Prielipp et al[9] note that normalization of deviance and production pressure are human factors that contribute to anesthesia mishaps. Anesthesia providers must ensure patient safety in all aspects of anesthesia care. This may involve informing facility administrators of safety issues and refusing to provide anesthesia care until the safety issues are rectified. Even if procedures are minor, patient comorbidities must be taken into account when deciding if a patient is an appropriate candidate for a freestanding facility, because resources for emergencies can be limited. Policies and procedures should be in place regarding the types of patients and procedures that are appropriate at facilities, especially those that do not have immediate full-scaled support for adverse events. Policies and resources regarding patient transport to other facilities are imperative when an emergency occurs.

Medication errors or a lack of knowledge related to the underlying pharmacodynamics and pharmacokinetics of medications may lead to deleterious patient outcomes. Production pressure may limit the time anesthesia providers become knowledgeable about new or unfamiliar medications and their potential anesthetic implications. Many anesthesia providers have been affected by anesthesia drug shortages. These shortages may require the anesthesia provider to use an unfamiliar drug substitution or an unfamiliar concentration of a drug. This unfamiliarity may lead to a patient safety threat. The Food and Drug Administration (FDA) Safety and Innovation Act of 2012 requires drug manufacturers to report manufacturing disruptions of lifesaving drugs.[10] The FDA has a strategic plan to reduce drug shortages and to reduce the cause of the drug shortages. Anesthesia associations such as the

Anesthesia Patient Safety Foundation (APSF), the AANA, and the American Society of Anesthesiologists (ASA) have addressed anesthesia drug shortages and made recommendations. Some recommendations for anesthesia providers are to request that pharmacists inform them of impending potential drug shortages, to work with pharmacists to identify and provide education related to alternative medications, and to report adverse events and patient impacts related to drug shortages.[10-12]

The incidence of LAST is low; however, it can be detrimental to patients. In 2006, Weinberg[13] established a website devoted to the treatment of systemic drug toxicity by infusing 20% lipid emulsion. It was not until 2010 that the American Society of Regional Anesthesia and Pain Management (ASRA) published a practice advisory related to the prevention, diagnosis, and treatment of LAST.[14] Suggestions for prevention of LAST include the following: use the lowest effective dose of local anesthetic; use incremental (3-5 mL) injections of local anesthetic, pausing 15 to 30 seconds between injections; aspirate before each injection; add an intravascular marker (eg, epinephrine) to potentially toxic doses of local anesthetic; and use ultrasound guidance.[14(p156),15] The ASRA recommendations for the treatment of LAST include the following: use benzodiazepines to treat seizures; initiate modified Advanced Cardiac Life Support (ACLS, using smaller epinephrine bolus doses, not using vasopressin, avoiding calcium channel blockers and β-adrenergic receptor blockers, and treating ventricular arrhythmias with amiodarone instead of lidocaine or procainamide); initiate lipid emulsion therapy; and institute cardiopulmonary bypass if all other treatments fail.[14(p157),15]

Most of us have been taught that there is a 10% risk of cross-reactivity between penicillins and cephalosporins. Literature reviews reveal a 1% cross-reactivity rate with first-generation cephalosporins and negligible cross-reactivity rates when third- and fourth- generation cephalosporins are given to penicillin-allergic individuals.[16,17] Cross-reactivity is related to a similar chemical side chain in the structure of penicillin and some cephalosporins. Cross-reactivity is minimized when using cephalosporins lacking the chemical side chain.[16,17] Patients should be questioned about their penicillin allergy to determine if they had an anaphylactic response. If so, cephalosporins with similar penicillin side chain structures should be avoided.[16]

Hemorrhage is a known risk of surgical intervention. Substantial hemorrhage related to surgical procedures is a rare but potentially deadly complication.[18(p450)] Obstetric patients accounted for the most claims found in the hemorrhage theme. This coincides with an anesthesiology closed claims study related to hemorrhage where Dutton and colleagues[18] found that 30% of the claims were related to obstetric patients. To optimize patient care, anesthesia providers must, as members of an interdisciplinary team, identify patients at risk of major blood loss, identify substantial blood loss when it occurs, and appropriately intervene to resuscitate the patient. Early recognition and treatment of hemorrhage may prevent adverse patient outcomes and cardiovascular collapse. Being proactive as a patient's advocate during surgery enhances patient safety.

In clinical practice, anesthesia providers are expected to make rapid clinical decisions related to patient care.[19] Failure to incorporate advances in anesthesia treatment to care for the patient or failure to incorporate patient information into the plan of care is known as failed clinical reasoning. Failed clinical reasoning may result in preventable negative patient outcomes. Several recent review articles analyzed cognitive processes and decision making in anesthesia.[19-21] The authors found that cognitive errors led to incorrect or delayed diagnoses and/or treatment.[19-21] They found several common cognitive factors that are related to anesthesia practice. *Confirmation bias* means that the anesthesia provider seeks only information to support the diagnosis and not information that may rule out the diagnosis. *Visceral (transference) bias* is related to the anesthesia provider's feelings toward the patient; for instance, a modification in normal practice may occur if anesthesia is provided to a celebrity. *Omission bias* refers to inaction to preserve the status quo, when a change would be better for the patient. *Overconfidence*, another cognitive bias related to anesthesia practice, is the inaccurate high self-assessment. This can lead to not asking for help, not recognizing an error, and not adopting safety practices developed by others.[21] Stiegler and Tung[21] discuss education strategies to improve decision making, such as providing timely and specific feedback related to clinical decisions. They suggest self-reflection of decision making and the thought process behind it as a strategy to improve decision making. They also offer clinical aids, such as cognitive self-monitoring strategies and clinical decision support tools, as strategies to improve clinical decision processes. One aid is the rule of three, in which the anesthesia provider considers 3 alternate explanations before making the diagnosis. Using clinical practice guidelines and checklists are additional strategies to improve the clinical decision process. Becoming aware of clinical biases and using strategies to improve clinical decision making should improve patient safety. Ensuring baseline levels of knowledge as well as continuous lifelong learning will decrease the potential for these errors.

Three major lessons were learned from an analysis of these claims. First, a thorough preanesthetic patient evaluation is imperative to provide appropriate anesthesia care. Second, anesthesia providers must be cognizant of normalization of deviance that may be occurring in their practice setting. Third, anesthesia providers must continue lifelong learning to remain current on drug therapies and anesthesia management of patient comorbidities.

There are several limitations to this study, common among closed claims data analysis. First, retrospective data were used for secondary data analysis. Retrospective data collection and analysis can be used to identify statistical associations but are not suitable for determining causation.[22] Other limitations associated with closed claims datasets include (1) the inability to compare risks between different groups, (2) the fact that datasets are not representative of all injuries because all injured patients do not pursue medical professional liability claims, (3) the inability to determine frequency of occurrence, (4) the presence of missing data needed to answer the research question, and (5) the inability to use parametric tests because statistical assumptions are not met.[23,24]

REFERENCES

1. Devereaux PJ, Sessler DI. Cardiac complications in patients undergoing major noncardiac surgery. *N Engl J Med.* 2015;373(23):2258-2269. doi:10.1056/NEJMra1502824
2. Ellis SJ, Newland MC, Simonson JA, et al. Anesthesia-related cardiac arrest. *Anesthesiology.* 2014;120(4):829-838. doi:10.1097/ALN.0000000000000153
3. Jordan LM, Quraishi JA, Boust R, et al. The AANA Foundation Malpractice Closed Claims Study: a descriptive analysis. *AANA J.* 2015;83(5):318-323.
4. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol.* 2006;3(2):77-101. doi:10.1191/1478088706qp063oa
5. Vaughn D. *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA.* Chicago, IL: University of Chicago Press; 1996.
6. American Association of Nurse Anesthetists. Standards for Nurse Anesthesia Practice. https://www.aana.com/docs/default-source/practice-aana-com-web-documents-(all)/standards-for-nurse-anesthesia-practice.pdf?sfvrsn=e00049b1_2. Accessed February 2019.
7. Gaba DM, Howard SK, Jump B. Production pressure in the work environment. California anesthesiologists' attitudes and experiences. *Anesthesiology.* 1994;81(2):488-500.
8. Kirsner K, Biddle C. Production pressure and a culture of deviance in the insular operating room and the consequences of their 'normalization': have we reached a Hooper moment? *Internet J Law Healthc Ethics.* 2012;8(1):1-11. https://print.ispub.com/api/0/ispub-article/14279/ Accessed August 3, 2017.
9. Prielipp RC, Magro M, Morell RC, Brull SJ. The normalization of deviance: do we (un)knowingly accept doing the wrong thing? *AANA J.* 2010;78(4):284-287.
10. Orlovich DS, Kelly RJ. Drug shortages in the U.S.: a balanced perspective. *Anesth Patient Safe Found Newslett.* 2015;29(3). http://www.apsf.org/newsletters/html/2015/February/06_DrugShortages.htm Accessed October 6, 2015.
11. American Association of Nurse Anesthetists. Negative impact of anesthesia drug shortages lessened through improved communication efforts, survey data reveal [press release]. http://sharepoint.aana.com/newsandjournal/News/Pages/05072013Negative-Impact-of-Anesthesia-Drug-Shortages-Lessened-through-Improved-Communication-Efforts,-Survey-Data-Reveal.aspx Originally accessed October 6, 2015. URL updated January 30, 2019.
12. American Society of Anesthesiologists. Drug shortages. https://www.asahq.org/advocacy-and-asapac/advocacy-topics/drug-shortages Originally accessed October 6, 2015. URL updated January 30, 2019.
13. Weinberg G. Lipid rescue resuscitation. http://www.lipidrescue.org Accessed August 3, 2017.
14. Neal JM, Bernards CM, Butterworth JF IV, et al. ASRA practice advisory on local anesthetic systemic toxicity. *Reg Anesth Pain Med.* 2010;35(2):152-161. doi:10.1097/AAP.0b013e3181d22fcd
15. American Society of Regional Anesthesia and Pain Medicine. Checklist for treatment of local anesthetic systemic toxicity. https://www.asra.com/advisory-guidelines/article/3/checklist-for-treatment-of-local-anesthetic-systemic-toxicity/ Accessed March 1, 2016.
16. Campagna JD, Bond MC, Schabelman E, Hayes BD. The use of cephalosporins in penicillin-allergic patients: a literature review. *J Emerg Med.* 2012;42(5):612-620. doi:10.1016/j.jemermed.2011.05.035
17. Pichichero ME. Cephalosporins can be prescribed safely for penicillin-allergic patients. *J Fam Pract.* 2006;55(2):106-112.
18. Dutton RP, Lee LA, Stephens LS, Posner KL, Davies JM, Domino KB. Massive hemorrhage: a report from the Anesthesia Closed Claims Project. Anesthesiology. 2014;121(3):450-458. doi:10.1097/ALN.0000000000000369
19. Stiegler MP, Ruskin KJ. Decision-making and safety in anesthesiology. *Curr Opin Anesthesiol.* 2012;25(6):724-729. doi:10.1097/ACO.0b013e328359307a
20. Stiegler MP, Neelankavil JP, Canales C, Dhillon A. Cognitive errors detected in anesthesiology: a literature review and pilot study. *Br J Anaesth.* 2012;108(2):229-235. doi:10.1093/bja/aer387
21. Stiegler MP, Tung A. Cognitive processes in anesthesiology decision making. *Anesthesiology.* 2014;120(1):204-217. doi:10.1097/ALN.0000000000000073
22. Polit DF, Beck CT. *Nursing Research: Generating and Assessing Evidence for Nursing Practice.* 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins; 2012.
23. MacRae MG. Closed claims studies in anesthesia: a literature review and implications for practice. *AANA J.* 2007;75(4):267-275.
24. Staender S, Schaer H, Clergue F, et al. A Swiss anaesthesiology closed claims analysis: report of events in the years 1987-2008. *Eur J Anaesthesiol.* 2011;28(2):85-91. doi:10.1097/EJA.0b013e3283414fea

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