Factors Contributing to Perioperative Medication Errors: A Systematic Literature Review

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PURPOSE/GOAL

To provide the learner with knowledge of best practices related to perioperative medication errors (MEs).

OBJECTIVES

1. Discuss the problem of MEs within the perioperative environment.
2. Identify the types, causes, environmental factors, medication classes, human factors, and patient characteristics that are associated with perioperative MEs.
3. Discuss recommendations to reduce the occurrence of perioperative MEs.

ACCREDITATION

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Julie Boytim, DNP, RN, CRNA, and Beth Ulrich, EdD, RN, FACHE, FAAN, have no declared affiliations that could be perceived as posing potential conflicts of interest in the publication of this article.

The behavioral objectives for this program were created by Kristi Van Anderson, BSN, RN, CNOR, clinical editor, with consultation from Susan Bakewell, MS, RN-BC, director, Perioperative Education. Ms Van Anderson and Ms Bakewell have no declared affiliations that could be perceived as posing potential conflicts of interest in the publication of this article.

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ABSTRACT

We conducted a systematic literature review using PubMed and Ovid to analyze the factors contributing to perioperative medication errors (MEs). After the screening process, we included 19 studies in the systematic review. Certain factors emerged as contributors to perioperative MEs in the following categories: types of errors, causes of errors, human factors, medication types, and environmental factors. Across the studies, the most common type of error was wrong dose, and the most common causes of error were labeling and syringe swaps. Haste, stress, distraction, and decreased vigilance all increased MEs. Inaccurate medication reconciliation and patient lack of understanding contributed to MEs both preoperatively and postoperatively. Analgesics, antibiotics, and vasopressors were the medications associated with the highest incidences of error across the perioperative area. These findings may help clinicians formulate strategies to improve perioperative medication systems and decrease perioperative MEs.

Key words: *medication errors, medication reconciliation, medication labeling, syringe, dose.*

Medication errors (MEs) frequently occur in the perioperative area. The complexity of care in perioperative settings combined with the fast-paced and fragmented nature of service delivery may contribute to these errors.[1] Addressing the effectiveness of the entire medication administration system and each component is essential for maintaining quality and safety.[2] Although perioperative MEs have been identified as early as 1978,[3] few improvements or rigorous assessments of the perioperative medication process have been completed. This systematic review compiles and analyzes the factors contributing to MEs, clarifying the aspects of the perioperative medication system that need to be evaluated and guiding improvements in perioperative medication practices.

MEDICATION ERRORS

Medical errors recently have been identified as the third leading cause of death in the United States.[4] In 2000, the Institute of Medicine noted that medication-related errors occurred frequently, were costly, occurred because of system issues, and could be prevented.[5] A single ME can cause harm and lead to increased health care costs. Medication error–related costs per hospital range from $600,000 to $5.6 million annually.[6] An ME is defined as "any error occurring in the medication use process."[7,8] The medication administration process encompasses several subprocesses including prescribing, processing, administering, and monitoring effects. The Institute for Safe Medication Practices (ISMP) outlines the complexity of medication use, describing the

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components of the medication process as follows: patient information; medication information; communication of medication information; medication labeling, packaging, and nomenclature; medication storage, stock, and distribution; medication device use, acquisition, and monitoring; environmental factors; staff competency and education; and patient education.[8] Medication errors are rarely the result of an individual error, but rather a culmination of errors resulting in a system failure.[9]

PERIOPERATIVE SETTING

Although clinicians may consider surgery a single event, a surgical patient moves through the entire perioperative care system, which consists of several departments, teams, and medication processes. Several care transitions in the perioperative environment can lead to fragmented medication administration, medication mishaps, and adverse medication events. Comprising more than 40 steps, the perioperative medication process from pharmacy acquisition to medication administration is complex.[10] Decreased oversight and easily accessible medications can increase the chance and severity of harmful MEs.[11]

In a 2016 evaluation of MEs and adverse medication events, Nanji et al[1] found that MEs occur in every second operation or as often as 1 out of every 20 medication administrations, with nearly one-third contributing to patient harm. Earlier studies found that half of perioperative MEs occur during the medication administration process, resulting from syringe and vial swaps and administration of the wrong dose, which can cause serious harm.[11,12]

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Several organizations have published recommendations related to MEs in the perioperative setting. As early as 1997, the ISMP raised concerns about labeling medications in the perioperative setting.[13] In 2002, AORN first published the "AORN guidance statement: safe medication practices in perioperative practice settings" as a framework for safe medication practices.[14] AORN now provides guidance for medication use in the perioperative environment in the "Guideline for medication safety," which was first published in 2011 and continues to be updated based on emerging evidence.[15] In 2007, The Joint Commission added a new National Patient Safety Goal related to labeling medications in the perioperative setting;[16] improving medication safety in the OR (ie, labeling medications on the sterile field) remains a goal in the 2017 update.[17] In 2010, the Anesthesia Patient Safety Foundation produced a video titled *Medication Safety in the Operating Room: Time for a New Paradigm* to help clinicians improve medication practices and to decrease MEs in the perioperative area.[18] The American Association of Nurse Anesthetists also published new standards and recommendations for medication safety in the OR in 2014.[10] In 2015, the American College of Surgeons published guidance related to The Joint Commission's framework for medication management in ambulatory surgery centers, which urges surgeons to make medication management a priority to eliminate potential harm.[19] In 2016, the Institute for Healthcare Improvement initiated and published collaborative tools related to reducing adverse medication events.[20] The ISMP serves as a comprehensive resource for medication safety issues including alerts, error reporting, and assessment of medication practices. These organizations all support efforts to improve perioperative medication practices.

PURPOSE OF THE LITERATURE REVIEW

Identifying the contributing factors of MEs may aid in developing a framework for preventing potential errors. We designed this systematic review to analyze the factors contributing to perioperative MEs. A PICO (population, intervention, control, outcomes) question guided the review: "In the perioperative area, are there identifiable and trending factors, compared to random chance, contributing to the incidence of MEs?"

METHODS

We conducted a comprehensive literature review in March 2016 using PubMed and Ovid MEDLINE. We filtered the search to include only articles written in English and cross-sectional, cohort, randomized controlled, prospective, retrospective, medical audit, chart audit, medical record, medical record

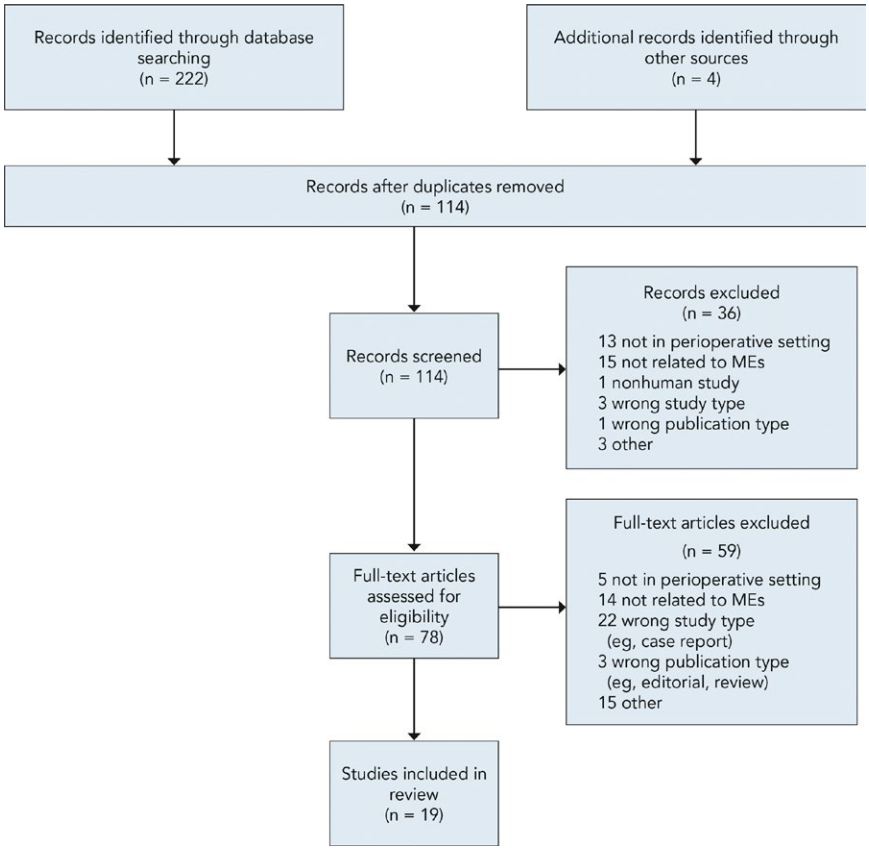

Figure 1. Flow chart demonstrating the inclusion and exclusion of articles in the systematic review. MEs = medication errors. *Adapted from Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement.* PLoS Med. *2009;6(7):e1000097.* doi:10.1371/journal.pmed.1000097.

system, and electronic health record studies from 2000 to 2016. Additional inclusion criteria were articles involving the perioperative setting, MEs, and human subjects. The exclusion criteria were publications not in the perioperative area; not related to MEs; animal studies; publications classified as letters, opinions, reviews, or comments; and studies classified as case reports and interventions. We used the search terms *perioperative care*, *intraoperative care*, *postoperative care*, *perioperative nursing*, *preoperative period*, *intraoperative period*, *postoperative period*, *operative time*, *anesthesia recovery period*, *bar code*, *barcode*, *operating rooms*, *medication errors*, *medication reconciliation*, *medication safety*, *medication error*, *medication labeling*, *syringes*, *near miss*, *fentanyl*, *glycopyrrolate*, *neostigmine*, *neuromuscular blockade*, *propofol*, and *rocuronium*.

Article Selection

We included a total of 19 studies in the systematic review (Figure 1). We identified 226 articles during database searching and, based on review of article references, 112 were duplicates. We screened 114 titles and abstracts for potential inclusion. After the initial screening process, we excluded 36 articles, resulting in 78 publications available for full-text review. We screened the 78 publications by critically evaluating the methodology, results, and conclusions of each study. After full-text review, we excluded 59 additional articles. We excluded articles that noted the incidence of errors in the perioperative area but had no specific details about MEs and attributing causes. We used the AORN Research Evidence Appraisal Tool[21] to determine the level and quality of evidence (Supplementary Table 1).

RESULTS

Perioperative MEs are a common cause of morbidity and mortality in surgical patients.[22,23] The incidence of MEs across the 19 included studies that reported ME

frequency ranged from every other surgery and 1 out of 20 administrations[1] to 1 out of 1,285 surgeries.[24] The ME rate based on observation was higher than the ME rate based on self-reported information. The ME rate did not change during a 15-year period in one study.[24]

Types of Errors

Ten studies addressed the types of errors contributing to perioperative MEs.[22,24-32] In the OR, substitution, an incorrect dose, omission, and the wrong medication given accounted for more than 70% of MEs in eight studies.[22,24-26,29-32] Seven studies[25-31] noted incorrect dose to be the most common type of error with a range of 24% (N = 626 MEs with type identified)[26] to 33.9% of MEs (N = 268 MEs with type identified);[29] and two studies noted omission to be the type of error with the greatest incidence of MEs at 26.5% (N = 668 MEs with type identified)[22] to 27% (N = 179 MEs).[32] After implementing a labeling intervention, Webster et al[29] noted the number of incorrect doses administered decreased from 33.9% to 24%, and substitution became the most common type of error. Wrong route contributed to MEs in eight studies.[22,24,26-29,31,32] The least common type of error noted was medication given in the wrong dosage form at 0.9% (N = 668)[22] to 2.0% (N = 626).[26]

In the OR, substitution, an incorrect dose, omission, and the wrong medication given accounted for more than 70% of MEs in eight studies.

Causes of Perioperative MEs

Six studies reported on the causes contributing to perioperative MEs.[22,24-26,30,32] In the perioperative area, the highest incidence of reported errors were related to performance deficit (42.5% [N = 668] to 45.6% [N = 610] of errors) and distraction (16.0% [N = 81] to 48.5% [N = 165] of errors).[22,26] Communication (17.2% [N = 610] to 21.6% [N = 668] of errors), haste (12.0% [N = 81] to 22.9% [N = 179] of errors), and inattention (13% [N = 81] to 17.3% [N = 179] were found to be frequent factors contributing to the causes of errors.[22,25,26,30,32] A knowledge deficit was reported as a cause contributing to error in five studies and across all perioperative areas.[22,24-26,32] Five studies reported that poor communication contributed to error in the intraoperative and postoperative areas.[22,25,26,30,32] Two preoperative studies did not report measured causes contributing to error by category, but noted that a lack of communication and of clarity of preoperative instructions contributed to MEs.[33,34]

Labeling mistakes and syringe swaps were the most common causes of substitution errors in three studies.[12,23,32] To decrease the substitution errors, three studies recommended labeling and double checking medications.[1,12,23] To further improve labeling, five studies recommended using technology (eg, label printers, barcode scanners) to aid in labeling syringes.[1,12,23,24,32] Several researchers noted that the appearance of the vials and packaging was a consistent contributor to error.[22,24-26,32] However, color coding of syringes was not noted to decrease MEs.[12]

Environmental Factors

The underlying design and environment of the perioperative area lends itself to increased risk of MEs. Five studies indicated that transfers, fragmentation, and change in providers all increased the risk of MEs.[26,28,32,35,36] An increase in workload also was identified in four studies as a contributor to MEs.[26,28,32,36] However, providers reported workload to be the same with the introduction of technology to label syringes.[23] One study found significantly (P = .002) more reports of error in federally owned facilities compared with nonprofit or privately owned facilities, and in facilities with 100 to 499 beds compared with facilities with fewer than 100 beds or more than 500 beds.[35]

Some studies examined the timing and length of surgery in relation to MEs. Two studies[1,12] identified the anesthesia induction period and one[32] identified the maintenance period to have the highest incidence of MEs. The time of day the surgery was performed also was related to the incidence of MEs; longer procedures and procedures performed during the day were associated with a higher incidence of MEs. Specifically, surgeries occurring between 7 AM and 11 PM were associated with a higher incidence of errors.[25] Nanji et al[1] found that surgeries lasting longer than six hours and with more than 20 medication administrations contributed

to MEs. Emergencies also contributed to an increase in the incidence of MEs in four studies,[26,28,36,37] but Merry et al[23] and Llewellyn et al[38] found no difference.

Medication Class

Twelve studies compared the relationship of the specific medications administered to MEs.[1,12,22,24-26,28,30-32,34,37] Across the perioperative area, the administration of analgesics, antibiotics, and vasopressors led to the highest incidence of MEs. In the OR, when comparing across all included studies, the medication classes with the highest incidence of error were analgesics, antibiotics, muscle relaxants, and vasopressors. Less common medication classes associated with medication errors, antiemetics and anticholinergics, were only associated with MEs in two studies.[30,32]

Medication errors related to syringe swaps (the syringe of one class of medication is swapped for another) occurred across medication classes.[12,29,30,32] The most common medication classes involved in syringe swaps were muscle relaxants and reversal agents.[12,32]

Human Factors

Six studies found that haste, stress, and pressure to proceed were three of the highest human factor contributors associated with errors.[24,25,28-30,37] Five studies found that distraction also led to an increase in errors.[25,28-30,37] Providers reported that decreased vigilance occurred in seven studies,[24,28,29,31,32,37] with an incidence of 12% of 471 MEs noted by Merry et al.[23] Three studies also found that fatigue contributed to an increased incidence of MEs,[28,32,37] with Zhang et al[32] noting 51% of 93 providers who reported the number of hours they slept not having enough sleep to feel rested. Frequent disruptions leading to distraction include personnel, conversation, and noise. Nanji et al[1] identified a need to decrease staff members' opportunities to revert to a previous method when implementing technology use.

Before and after surgery, MEs related to patient understanding and medication reconciliation occur. In one study, 111 (27%) of 408 patients who regularly used medication incorrectly took or discontinued their medications before surgery, and 59% of these 111 patients did so because they misunderstood instructions.[34] Postoperatively, a decreased awareness by providers and patients for the need to restart medications led to 32% of 102 patients incorrectly restarting their medications when managed by the patient and 23% of 174 patients when reinstated by a physician.[34] Often, errors in transcription of home medications and a misunderstanding of preoperative instructions led to medication discontinuity.[34] Preoperatively, patient adherence to medication instructions was found to have the greatest incidence of error.[28,34]

Six studies found that haste, stress, and pressure to proceed were three of the highest human factor contributors associated with errors.

Six studies found that a provider knowledge deficit related to patient allergies when prescribing or administering medications contributed to MEs, with an incidence of 1.3% to 11.3% of the errors that occurred.[22,25,26,30,32] Two studies found no difference in MEs related to type or experience of a provider.[23,37] However, one study found that provider inexperience contributed to 2% of the total number of MEs reported (N = 81);[30] two studies noted increased reporting of MEs by anesthetists in training.[25,32]

Patient Characteristics

Three studies found no difference in error rates related to a patient's physical status, procedure, or age.[1,31,32] One study found a patient's physical status score of two or three to be significantly related to increased MEs.[25] Sex was significant in one study, with men experiencing a higher incidence of errors than women.[23] Three studies found that errors led to a higher acuity of care, with a range from 2% to 46.9% of errors in which the effect of the error was reported.[29,31,32]

DISCUSSION

Certain factors emerged as contributors to perioperative MEs in the types, causes, human factors, environmental factors, and patient characteristics categories (Figure 2). The findings of this review reveal the following contributors to perioperative MEs:

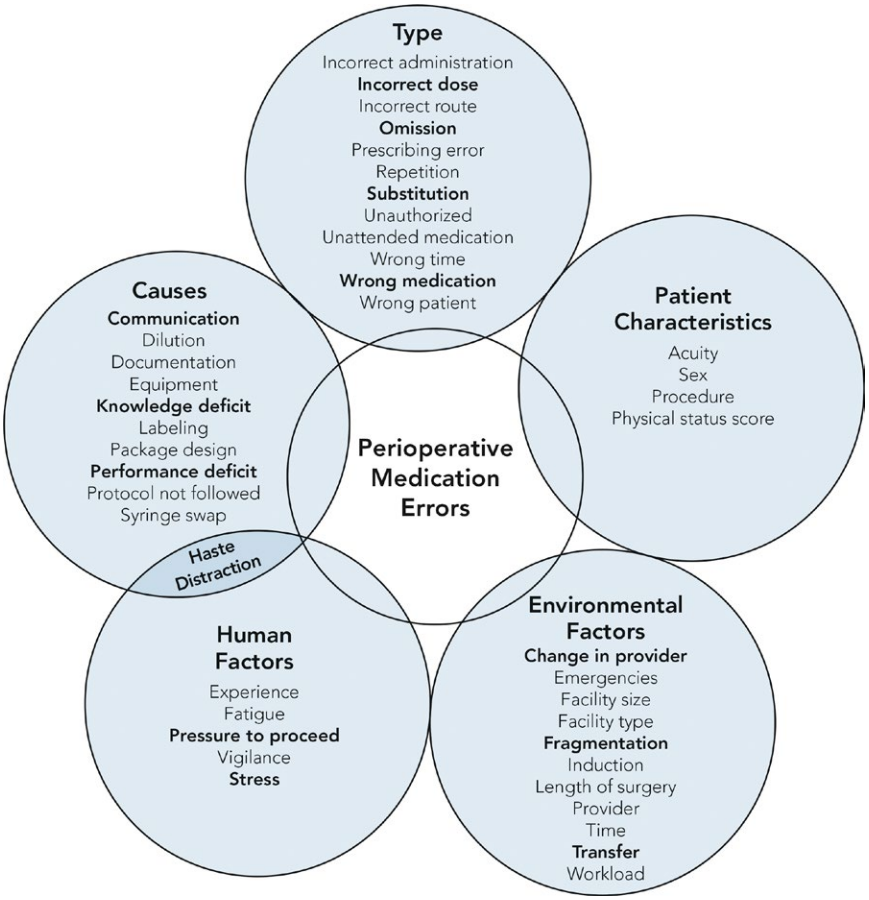

Figure 2. Factors contributing to perioperative medication errors. Bolded words indicate the most frequent errors in each category. Factors in overlapping categories occur in both categories.

- Wrong dose was the most common type of error.
- Labeling and syringe swaps were the most common cause of error.
- Haste, stress, distraction, and decreased vigilance all increased MEs.
- Inaccurate medication reconciliation and patient lack of understanding contributed to MEs both preoperatively and postoperatively.
- Analgesics, antibiotics, and vasopressors were associated with the highest incidences of error by medication class.

The contribution of hospital data to national databases will help identify and address MEs with a collaborative effort across institutions. Because of the complexity of perioperative medication processes, an interdisciplinary approach including nurses, surgeons, pharmacists, anesthesia care providers, and ancillary staff members is essential to decrease MEs.

Error Rate

The data exemplifies the assertion by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP)[39] that measurement of ME rates varies between institutions. The observed error rates were higher than the self-reported rates. Decreased MEs, mortality rate reduction, and decreased hospital lengths of stay suggest improved outcomes after implementing improvement strategies, and measuring the outcomes helps clinicians assess opportunities for additional improvement.[40,41]

Pharmacists for Medication Reconciliation

Organizations should consider the inclusion of pharmacists in the perioperative areas during care transitions to oversee patients' medications as they move into and out of the surgical area. Surgeons, nurses, and anesthesia care providers may receive different

medication lists or may place conflicting orders.[42,43] Bell et al[44] found that, postoperatively, patients' medications were discontinued unintentionally 7.5% of the time; warfarin was the medication most commonly discontinued. The introduction of a pharmacist to help reconcile medications and provide standardized instructions in the perioperative period has been found to decrease the incidence of MEs.[28,34,45,46] This recommendation is congruent with the results of this review and the Anesthesia Patient Safety Foundation Medication Safety Conference recommendations from 2010.[18] Pharmacists may be helpful in reconciling home medications, incorporating medications related to the surgery, identifying medications needing special attention (eg, antithrombotics, beta-blockers, steroids), and providing a transition of medications back out of the surgical area.

Measures to Decrease Wrong Dose Errors

One of the most common types of errors, wrong dose errors, could be decreased by implementing preventive measures. Eliminating provider-prepared medications and instead using pharmacy or commercially-available preparations in standardized concentrations or diluents in ready-to-use bolus or infusion form (eg, prefilled syringes) that are acceptable for adult and pediatric use decreases administration of the wrong dose.[47] This process change eliminates perioperative dilution of medications and provides medications ready for administration. Two other methods that may decrease wrong-dose errors include delivering infusions using an electronically controlled smart device that contains a medication library and using a system that supports independent double-checks.[48,49]

Distractions

Distractions can cause mental lapses and impaired thought processes that interfere with patient care and increase the incidence of error.[50] Perioperative care necessitates vigilance and attention to detail because of its complexity.[10,51] Team members should make an effort to adjust the culture and provide an environment with few distractions and interruptions, especially during critical phases of care.

Contributors to distraction and interruption may include unnecessary conversation, music, personal electronic devices, and alarms.[52] The American Association of Nurse Anesthetists, AORN, and the American College of Surgeons all have position statements related to noise and the use of music and personal electronic devices in the perioperative area.[53-55] The use of music and electronic devices along with unnecessary conversation in the perioperative area may further increase the number of distractions and alter the provider's ability to maintain focus.[50,52,55-57] Pape and Dingman[56] noted that an average of 7.5 distractions or interruptions occur every nine minutes in the OR, equating to approximately 68 distractions per hour for an anesthesia care provider.

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Practitioners working in the perioperative area are challenged to provide safe, high quality care in an intense environment. Despite time pressures to expedite care (eg, emergencies, turnover times), providers should take caution and continue to follow processes with attention to detail to prevent sacrificing patient safety.[58] Temptations to work around a system or process because of perceived inefficiencies, personal preference, or perceived clinical risks can increase the risk and incidence of errors.[59] Instead, efforts should be made to streamline processes while maintaining functionality to improve the overall system. The principles of quality improvement can be applied to improve processes within a system. Models including Lean, Six Sigma, and the Plan-Do-Study-Act method have been shown to be effective and should be considered in this context.[58]

Syringe Labeling

In many perioperative locations, clinicians remove medications from their original container to administer them with syringes or place them on the sterile field. Without adequate and proper labeling, inherent risks exist.

Clear and legible medication labeling is imperative both on and off the sterile field to reduce the incidence of MEs.[10,23,60-62] Merry et al[60] found the implementation of technology-assisted labeling decreased MEs by one-third. Providers may need to consider incorporating labeling technology (eg, label printers)

Key Takeaways

- The perioperative environment is complex and fast-paced, which may contribute to the frequent occurrence of perioperative medication errors (MEs).
- The frequency of MEs reported in this literature review ranged from every other surgery and 1 out of 20 administrations to 1 out of 1,285 surgeries.
- Frequent causes of perioperative MEs that were identified in this literature review included performance deficits, distraction, communication, haste, inattention, poor communication, knowledge deficits, labeling mistakes, and syringe swaps.
- Recommendations to reduce perioperative MEs include involving pharmacists in medication reconciliation, using pharmacy or commercially-prepared dosages (eg, prefilled syringes), minimizing distractions (eg, music), ensuring clear and legible medication labeling, and maintaining provider wellness.

into practice because several studies have shown technology use can decrease the incidence of MEs.[1,10,29,60,61]

Wellness of Providers

Maintaining the wellness of providers is key considering the causes and human factors that contribute to errors.[63] Providers note that fatigue increases the incidence of overall anesthesia errors, with more errors occurring in the late afternoon and evening.[51,64] AORN offers a position statement that outlines factors to consider for safe perioperative staffing, which suggests considering the negative effects of extended shift hours on staff member performance.[65] Sleep, rest, and avoiding burnout are key to optimizing cognitive performance.[51,66-70]

Standardized Categories of MEs

An explicit agreement to standardize the categories of the various factors contributing to perioperative MEs may make it easier to track errors and improve data analysis. Although the NCCMERP offers medication error categories as a starting tool for classification, a more explicit delineation of the types, causes, human factors, and environmental considerations may help identify trends in the relationships between errors and the system. For example, in the postoperative area, tracking patient-controlled analgesia errors would benefit from a well-defined classification system so that the accuracy of error tracking would improve.[71] Creating a standardized taxonomy of factor categories contributing to MEs (eg, human factors) with subcategories (eg, stress) could allow for better data collection.

Adequate Objective Data

Additional data on the true (or verifiable) incidence of perioperative MEs will help clarify the causes and incidence of errors. Although self-reporting yields data, observation may provide a more accurate measure of errors. Taghon et al[72] developed a trigger tool to help identify MEs in chart review, allowing for increased error detection. Nanji et al,[1] through survey and database review, found the incidence of errors may be higher than previously reported.

Perioperative Nurse Reporting

Although the incidence of perioperative MEs may vary by institution, understanding the contribution of MEs to the perioperative experience is important to improving the quality and safety of perioperative care. Perioperative nurses can help increase understanding of perioperative MEs by reporting all near-miss and error events with as much detail as possible and participating in reviews of errors with risk management. Perioperative leaders should consider reporting errors into the ISMP reporting system for additional review so data from multiple facilities can be correlated. In turn, organizations dedicated to medication safety may use this information to more clearly categorize and define factors contributing to MEs.

LIMITATIONS

A major limitation of this review was the lack of standardized definitions of MEs, types of error, causes of error, environmental factors, and human factors across all 19 studies. The NCCMERP describes five major causes of

MEs: communication, name confusion, labeling, human factors, and packaging or design.[39] However, the use of categories is not standardized across health care to classify types of error.

A second limitation of this systematic literature review was the lack of consistency in the measurement of MEs. Measurement of MEs and methods of reporting vary between institutions, and the studies do not all consider the same factors attributed to error. Additionally, only three articles addressed all perioperative areas.[28,33,36] The majority of studies addressed either preoperative, operative, or postoperative MEs.

Another limitation was the level of available evidence and the age of the studies. Many of the studies included in this review are more than five years old because there are not enough recent high-quality studies. Two of the studies measured errors based on observation; the majority of studies used database review or surveys that relied on self-reporting of events. Because of the nature of the topic, few randomized controlled trials can be completed, and self-reporting may underrepresent the actual incidence of errors. Evidence-based medicine implies using the best evidence available to answer our clinical questions and provide care to patients, integrating clinical research, clinical experience, and patient values.[73] Additional investigation into the causes of perioperative MEs will help providers develop quality improvement initiatives using current evidence to decrease the incidence of errors.

Using direct observation, Nanji et al[1] demonstrated that relying on self-reporting to measure the frequency of MEs may obscure the data. Another study reported that 68.3% of 687 providers who commit errors did not report errors because they felt the error was inconsequential.[74] Although direct observation would increase the accuracy of the data, the associated costs and the potential for observer bias may inhibit the ability to collect data in this manner.

CONCLUSION

Decreasing MEs in the perioperative area is a step toward improving the safety of perioperative care. Our findings provide clinicians with additional insight into the types and causes of MEs that occur in the perioperative area. This information may help clinicians formulate strategies to improve perioperative medication systems and decrease MEs. This review indicates the need for additional work in the field to improve systems and decrease the incidence of perioperative errors. Researching, reporting, identifying, and analyzing perioperative ME data both externally and internally will help organizations focus efforts and resources on preventing MEs, thus minimizing their human and monetary effect on patients and organizations.

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SUPPORTING INFORMATION

Additional information may be found online in the supporting information tab for this article.

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Continuing Education

Factors Contributing to Perioperative Medication Errors: A Systematic Literature Review

2.1 CE www.aornjournal.org/content/cme

PURPOSE/GOAL

To provide the learner with knowledge of best practices related to perioperative medication errors (MEs).

OBJECTIVES

1. Discuss the problem of MEs within the perioperative environment.
2. Identify the types, causes, environmental factors, medication classes, human factors, and patient characteristics that are associated with perioperative MEs.
3. Discuss recommendations to reduce the occurrence of perioperative MEs.

The Examination and Learner Evaluation are printed here for your convenience. To receive continuing education credit, you must complete the online Examination and Learner Evaluation at *http://www.aornjournal.org/content/cme*.

QUESTIONS

1. Medication errors have been reported to cost hospitals between _____ and _____ annually.
   a. $500,000; $4.6 million b. $1.6 million; $5.6 billion
   c. $600,000; $5.6 million d. $600,000; $5.6 billion

2. An ME is defined as any error occurring in the medication use process.
   a. true b. false

3. The Institute for Safe Medication Practices outlines the complexities of medication use, the components of which include
   1. medication labeling, packaging, and nomenclature.
   2. environmental factors.
   3. patient education.
   4. medication storage, stock, and distribution.
   5. staff competency and education.
   6. medication device use, acquisition, and monitoring.

   a. 1, 3, and 5 b. 2, 4, and 6
   c. 2, 3, 5, and 6 d. 1, 2, 3, 4, 5, and 6

4. In the OR, the types of errors that accounted for more than 70% of MEs were
   1. omission.
   2. substitution.
   3. incorrect dose.
   4. wrong medication.
   5. wrong patient.

http://doi.org/10.1002/aorn.12005

a. 4 and 5 b. 1, 2, 3, and 4
c. 1, 2, 4, and 5 d. 1, 2, 3, 4, and 5

5. Causes of MEs in the preoperative, operative, and postoperative environments included
   1. syringe swaps.
   2. haste.
   3. knowledge deficit.
   4. labeling mistakes.
   5. communication.
   6. distraction.

   a. 1, 3, and 5 b. 2, 4, and 6
   c. 2, 4, 5, and 6 d. 1, 2, 3, 4, 5, and 6

6. Nanji et al found that surgeries lasting longer than three hours and with more than 40 medication administrations contributed to MEs.
   a. true b. false

7. The human factor that led to 59% of 111 patients taking their medication incorrectly in one study was
   a. misunderstanding of instructions. b. fatigue.
   c. haste. d. distraction.

8. The medication classes that were associated with the highest incidences of error included
   1. vasopressors.
   2. antibiotics.
   3. analgesics.

   a. 1 and 2 b. 1 and 3
   c. 2 and 3 d. 1, 2, and 3

9. The introduction of a(n) _____ to help reconcile medications and provide standardized instructions in the perioperative period has been found to decrease the incidence of MEs.
   a. anesthesiologist b. surgical fellow
   c. pharmacist d. advanced practice RN

10. Preventive measures to potentially decrease wrong-dose errors include using
    1. a system that supports independent double-checks.
    2. prefilled syringes.
    3. standardized concentrations or diluents.
    4. quality improvement methods.
    5. pharmacy or commercially available preparations.

    a. 4 and 5 b. 1, 2, 3, and 5
    c. 1, 2, 3, and 4 d. 1, 2, 3, 4, and 5

Continuing Education

Factors Contributing to Perioperative Medication Errors: A Systematic Literature Review

2.1 CE www.aornjournal.org/content/cme

This evaluation is used to determine the extent to which this continuing education program met your learning needs. The evaluation is printed here for your convenience. To receive continuing education credit, you must complete the online Examination and Learner Evaluation at *http://www.aornjournal.org/content/cme*. Rate the items as described below.

OBJECTIVES

To what extent were the following objectives of this continuing education program achieved?

1. Discuss the problem of MEs within the perioperative environment.
   Low 1. 2. 3. 4. 5. High
2. Identify the types, causes, environmental factors, medication classes, human factors, and patient characteristics that are associated with perioperative MEs.
   Low 1. 2. 3. 4. 5. High
3. Discuss recommendations to reduce the occurrence of perioperative MEs.
   Low 1. 2. 3. 4. 5. High

CONTENT

4. To what extent did this article increase your knowledge of the subject matter?
   Low 1. 2. 3. 4. 5. High
5. To what extent were your individual objectives met?
   Low 1. 2. 3. 4. 5. High
6. Will you be able to use the information from this article in your work setting?
   1. Yes 2. No
7. Will you change your practice as a result of reading this article? (If yes, answer question #7A. If no, answer question #7B.)

7A. How will you change your practice? (*Select all that apply*)
1. I will provide education to my team regarding why change is needed.
2. I will work with management to change/implement a policy and procedure.
3. I will plan an informational meeting with physicians to seek their input and acceptance of the need for change.
4. I will implement change and evaluate the effect of the change at regular intervals until the change is incorporated as best practice.
5. Other: _____

7B. If you will not change your practice as a result of reading this article, why? (*Select all that apply*)
1. The content of the article is not relevant to my practice.
2. I do not have enough time to teach others about the purpose of the needed change.
3. I do not have management support to make a change.
4. Other: _____

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