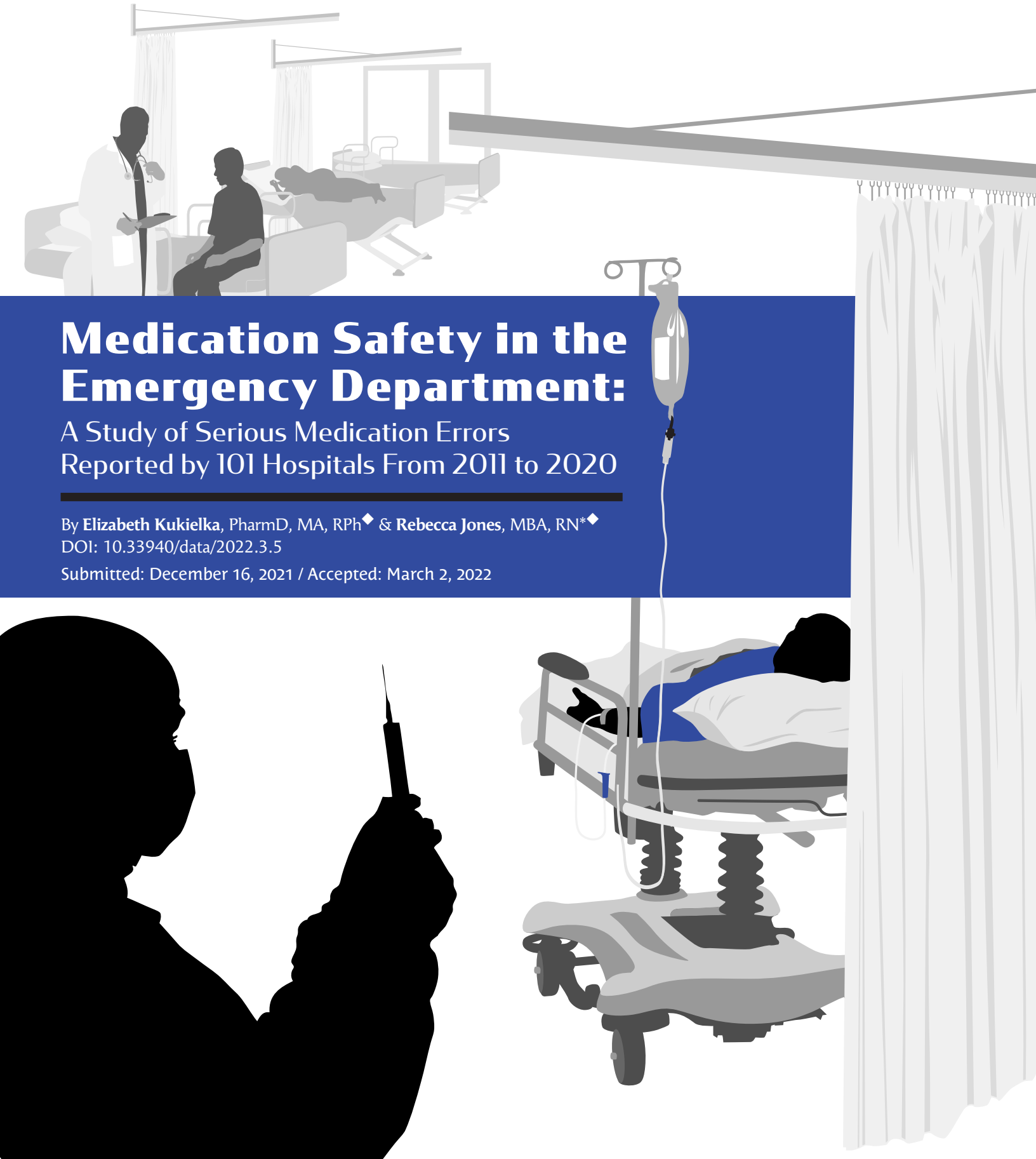

Medication Safety in the Emergency Department:

A Study of Serious Medication Errors Reported by 101 Hospitals From 2011 to 2020

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Abstract

Background: Although serious medication errors are uncommon, accounting for only 0.4% (166 of 46,568) of medication errors reported to the Pennsylvania Patient Safety Reporting System (PA-PSRS) in 2020, their effects can be devastating for patients and their loved ones.

Methods: We queried PA-PSRS for reports of serious events classified as medication errors that occurred in the emergency department (ED) from January 1, 2011, to December 31, 2020. We performed a descriptive analysis to identify trends among patient sex, patient age, event harm score, event day of the week, and event time of day. We also manually coded and analyzed events based on the prescribed medication(s) and medication class(es), stage of the medication-use process at which the error occurred, and medication error type.

Results: We identified 250 reports of serious medication error events in PA-PSRS that occurred in the ED from 2011 to 2020. Reports more often specified that the patient was female (61.2%; 153 of 250), and patients ranged in age from 8 months to 96 years, with a median patient age of 55 years. Events were significantly more likely to occur Friday through Sunday versus Monday through Thursday ($p = .0214$) and in the p.m. hours versus a.m. hours, ($p = .0007$). The most common prescribed medications mentioned in reports were epinephrine, insulin, hydromorphone, sodium chloride, heparin, propofol, diltiazem, ketamine, and morphine. Events occurred most often at the prescribing stage of the medication-use process (42.0%; 105 of 250), and the most common medication error type was a wrong dose (42.0%; 105 of 250).

Conclusion: Potential safety strategies to consider to reduce the risk of medication errors in the ED include stocking epinephrine autoinjectors, using clinical decision support at the ordering/prescribing stage of the process, and adding an emergency medicine pharmacist as part of an interdisciplinary emergency medicine team.

Keywords: *medication safety, patient safety, emergency department, medication error, epinephrine, emergency medicine pharmacist*

Introduction

A medication error is defined as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer."[1] In Pennsylvania, healthcare facilities are required to report all medication errors to the Pennsylvania Patient Safety Reporting System (PA-PSRS)[a]. Any medication error that reaches the patient and results in either death or an unanticipated injury requiring the delivery of additional healthcare services is classified as a serious event.[2] Although serious medication errors are uncommon in PA-PSRS, accounting for only 0.4% (166 of 46,568) of reports of medication errors in 2020,[3] their effects can be devastating for patients and their loved ones.

In 2011, researchers analyzed reports of medication errors that occurred in the emergency department (ED) submitted to PA-PSRS during a one-year period.[4] The one-year time period of the study did not allow them to fully characterize the ways in which patients are harmed following medication errors in the ED. Therefore, to gain a better understanding of medication errors in the ED that result in patient harm, we analyzed serious medication errors in the ED occurring from 2011 through 2020 that were reported to PA-PSRS. In addition, we reviewed relevant literature to identify strategies that may reduce the likelihood of these errors.

Methods

The Patient Safety Authority (PSA) has been collecting reports of patient safety events in PA-PSRS since 2004, and as a result PA-PSRS is the largest patient safety database in the United States and one of the largest in the world. Medication errors are the second most common event type reported to PA-PSRS, accounting for 16.7% (46,568 of 278,548) of reports submitted in 2020.[3] Medication error reports submitted to PA-PSRS include responses to standard questions such as event date, event time, patient age, patient sex, facility type, event detail (free-text field), and event recommendation (free-text field), as well as medication error–related information, such as medication prescribed, medication administered, dosing information, stage of the medication-use process at which the error occurred, and cause of the medication error (free-text field).

We queried PA-PSRS for reports specified as medication errors that occurred in the ED from January 1, 2011, to December 31, 2020, and were classified as serious events. We performed a descriptive analysis to identify trends among patient sex, patient age, event harm score, event day of the week, and event time of day. A chi-square goodness of fit test was applied to event day of week and time of day data.

To ensure consistency, we reviewed and manually coded each report for the following:

- Prescribed medication(s) and medication class(es) involved in the event
- Stage of the medication-use process at which the error occurred (e.g., ordering/prescribing, medication reconciliation, dispensing)
    - For reports in which multiple stages were mentioned, the earliest chronological stage was used in the analysis
- Medication error type (e.g., wrong dose and wrong route) and subtype (e.g., overdose)

Results

Descriptive Analysis

We identified 250 reports of serious medication error events in PA-PSRS that occurred in the ED from January 1, 2011, to December 31, 2020. All reports were included in the analysis. Reports were

[a]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).[2] All reports submitted through PA-PSRS are confidential, and no information about individual facilities or providers is made public.

submitted by 101 facilities, including 92 acute care hospitals, seven critical access hospitals, and two children's hospitals.

Reports more often specified that the patient was female (61.2%; 153 of 250) than male (38.8%; 97 of 250). Patients in reports ranged in age from 8 months to 96 years, with a median patient age of 55 years (25th percentile = 36 years; 75th percentile = 72 years). Twenty-four reports (9.6%) involved a pediatric patient (age younger than 18 years), and 87 reports (34.8%) involved a geriatric patient (age 65 years and older).

Reporting facilities most often assigned a harm score of E (68.8%; 172 of 250) or F (26.4%; 66 of 250), meaning that the events contributed to or resulted in temporary patient harm and required treatment, intervention, or initial or prolonged hospitalization. The remaining events were assigned a harm score of H (3.2%; 8 of 250) or I (1.6%; 4 of 250), meaning that the events resulted in near-death (i.e., required intervention necessary to sustain life) or death.

The distribution of reports by the day of the week on which each event occurred is shown in **Figure 1**. We grouped events into those occurring Monday through Thursday (n=125) and those occurring Friday through Sunday (n=125). A chi-square test was performed to examine the distribution of reports across the two groups from the study compared to a uniform distribution across days of the week. The result was significant, X^2 (1, N=250) = 5.294, p = .0214. Events were significantly more likely to occur Friday through Sunday versus Monday through Thursday.

The time of the event was provided for 225 reports in this analysis; the other 25 reports indicated the time was unknown. The distribution of reports by the time of the day at which each event occurred is shown in **Figure 2**. We grouped events into those occurring from 12:00 a.m. through 11:59 a.m. (n=87) and those occurring from 12:00 p.m. through 11:59 p.m. (n=138). A chi-square test was performed to examine the distribution of reports across the a.m. and p.m. groups from the study compared to a uniform distribution across these time frames. Events were significantly more likely to occur in the p.m. hours versus a.m. hours, X^2 (1, N=225) = 11.56, p = .0007. We also grouped events into day shift (7 a.m. through 3 p.m., n=76), evening shift (3 p.m. through 11 p.m., n=93), and overnight shift (11 p.m. through 7 a.m., n=56). A chi-square test was performed to examine the distribution of reports across the three shift groups from the study compared to a uniform distribution. The test showed that the events were not uniformly distributed across the three time frames, X^2 (2, N=225) = 9.147, p = .0103. Additionally, post hoc tests were run to test the differences between two shift groups at a time, and events were more likely to occur from 3 p.m. through 11 p.m. compared to 11 p.m. through 7 a.m. The other two pairwise comparisons were not significant.

Qualitative Analysis

Prescribed Medication

Each report was reviewed to identify the prescribed medication or medications involved in the event. We identified 277 prescribed medications across 250 reports, and these were grouped by therapeutic class (see **Figure 3**). The most common therapeutic classes were cardiovascular agents (24.9%; 69 of 277), analgesics (11.2%; 31 of 277), hematologic agents (9.4%; 26 of 277), antidiabetic agents (9.0%; 25 of 277), parenteral nutrition (7.9%; 22 of 277), antibiotics (7.6%; 21 of 277), and general anesthetics (6.1%; 17 of 277). The most common individual prescribed medications were epinephrine (14.4%; 40 of 277), insulin (9.0%; 25 of 277), hydromorphone (4.3%; 12 of 277), sodium chloride (4.3%; 12 of 277), heparin (3.6%; 10 of 277), propofol (3.2%; 9 of 277), diltiazem (2.5%; 7 of 277), ketamine (2.5%; 7 of 277), and morphine (2.2%; 6 of 277).

Figure 1. Distribution of PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Day of the Week, N=250

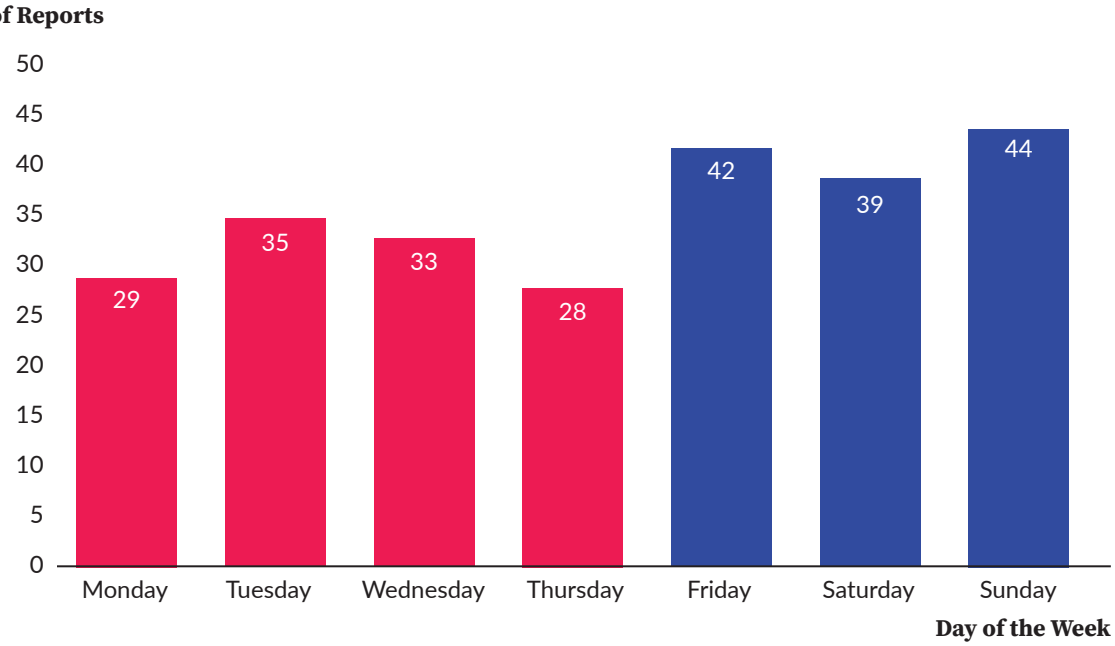
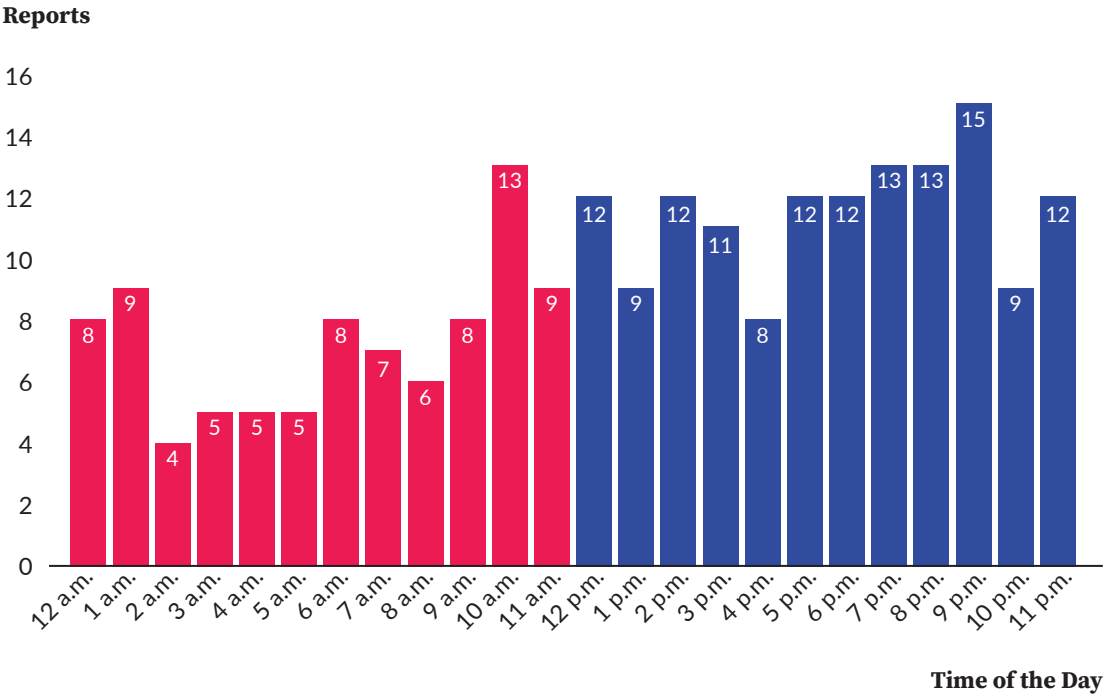


Figure 2. Distribution of PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Time of the Day, N=225



Note: A total of 25 reports indicated the time was unknown.

Stage of the Medication-Use Process and Medication Error Type

We analyzed each report to determine the stage of the medication-use process at which the medication error occurred (**Figure 4**). The most common stage was ordering/prescribing, accounting for 42.0% (105 of 250) of reports. The following are examples of reports of ordering/prescribing errors:

> *Patient with type 1 diabetes mellitus presented to the ED and was evaluated for kidney rejection. While in the ED, patient had elevated blood glucose levels, which were not covered with insulin. Upon admission to the floor, it was discovered that the patient was in diabetic ketoacidosis. Patient was admitted to the intensive care unit (ICU) and started on an insulin drip.*

> *Patient had a documented allergy to ibuprofen and was prescribed ketorolac. Ketorolac was administered, and patient developed an anaphylactic reaction. Patient was stabilized and admitted to the ICU for observation.*

> *Patient presented to ED with migraine headache. Prescriber ordered magnesium sulfate 40 grams to be administered wide open (appropriate dose for this indication was 0.04 grams, or 400 mg). Patient was on pulse oximetry and suddenly complained of a body burning sensation and then the monitor alarmed. ED technician entered room and noted patient was blue. Cardiopulmonary resuscitation was started and return of spontaneous circulation was achieved. Patient was admitted to the ICU, required dialysis treatment, and was under the clinical care of an intensivist, a cardiologist, and a nephrologist.*

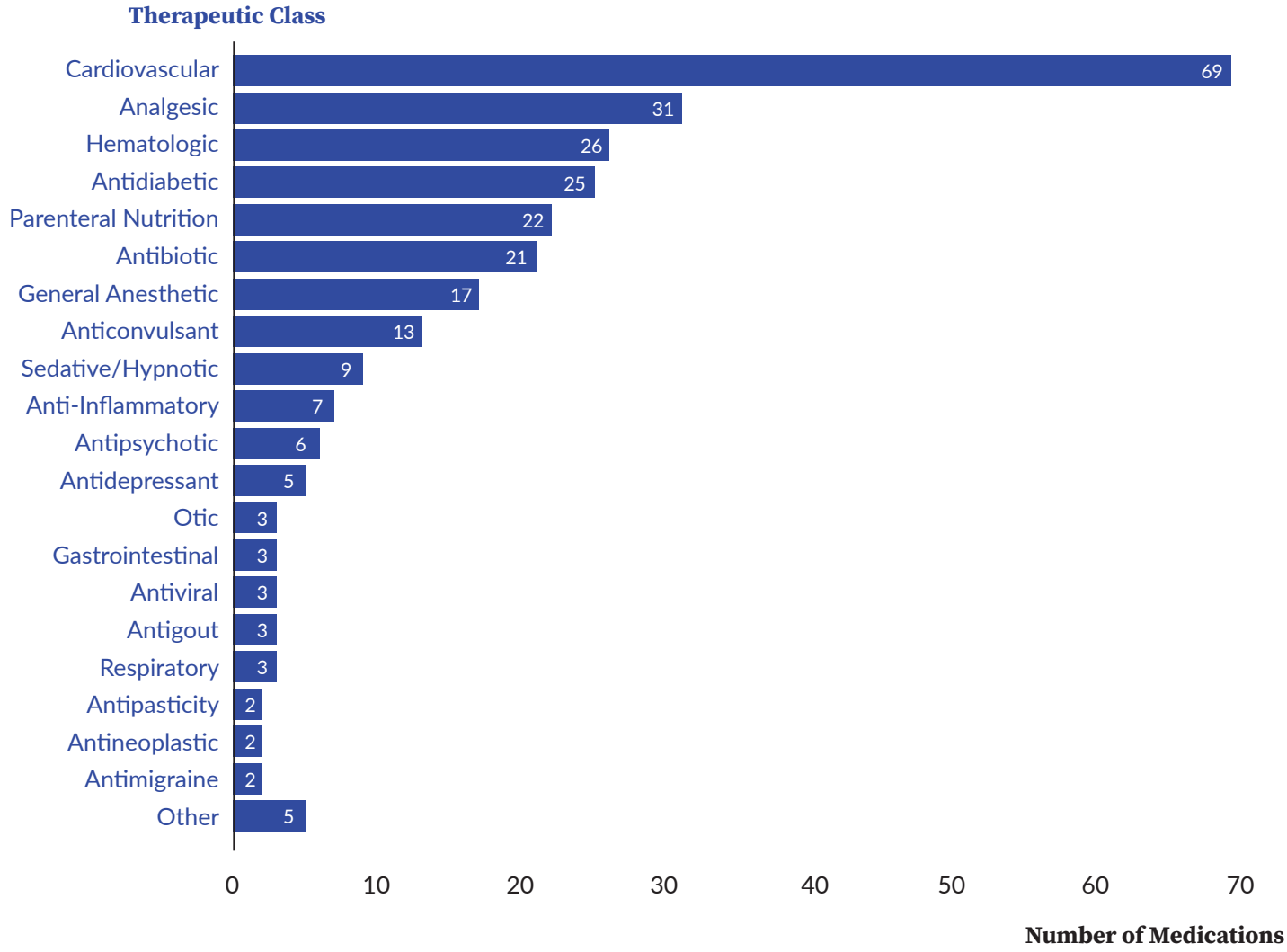
The second most common stage was administration, accounting for 33.2% (83 of 250) of reports. The following are examples of reports of administration errors:

> *Patient presented to the ED with an allergic reaction. Prescriber ordered epinephrine 0.3 mg to be administered intramuscularly. The epinephrine was administered intravenously. Patient reported feeling hot and experienced tachycardia (heart rate 130 beats per minute) and arrythmia on the monitor. Patient was admitted to telemetry floor for continued monitoring.*

> *Patient presented to the ED with hyperglycemia and was started on an insulin drip by overnight staff. Initially, the day shift nurse identified that the infusion was running at the appropriate rate. However, upon entering the room again, the nurse found that the insulin bag was empty, and the infusion pump was programmed at a rate of 75 mL/hr. It was discovered that the insulin had been connected as a secondary infusion and programmed on the infusion pump to run at the correct rate for 1 hour. The pump then reverted to the original rate set for maintenance fluids and the remaining insulin was infused. Patient experienced altered mental status and required intubation.*

The third most common stage was dispensing, accounting for 14.8% (37 of 250) of reports. Nearly all dispensing errors involved medications dispensed outside of the pharmacy (n=35), such as from an automated dispensing cabinet (ADC) or a medication cart; the remaining errors involved a medication dispensed from the pharmacy (n=1) and a medication without a specified source (n=1). The following are examples of reports of dispensing errors:

Figure 3. Distribution of Prescribed Medications Involved in PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Therapeutic Class, n=277



Heparin 3000 units prescribed for intravenous administration. Three 10-mL vials of heparin 1000 units/mL were pulled from ADC and administered. Patient was scheduled for cardiac catheterization, but bloodwork returned to ED prior to procedure revealed the medication error.

Patient with brain cancer prescribed Keppra. Nurse went to retrieve medication from ADC. Nurse typed in "KE" and took first medication vended on list, which was ketamine. Necessary checks to ensure correct medication was given were not performed. Patient given ketamine and sent to CT scan, where patient suffered a respiratory arrest and required intubation. Patient able to be extubated later in day and appeared to have returned to baseline level of function.

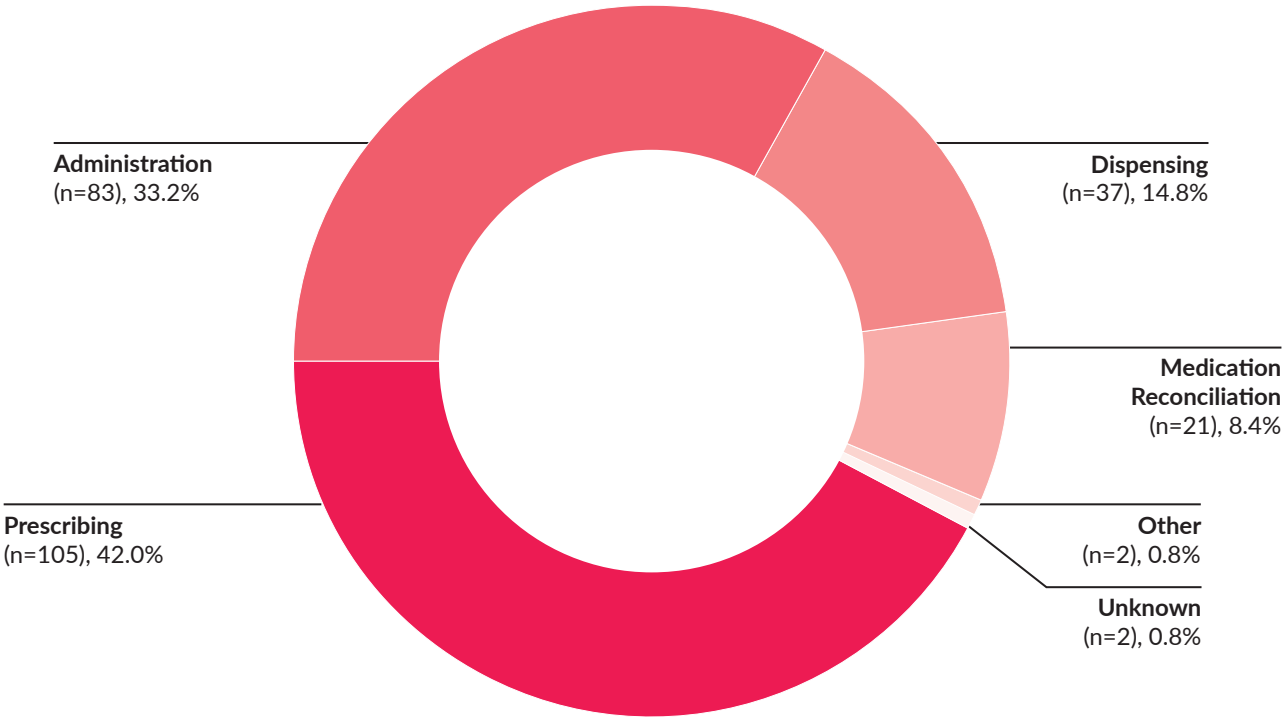
The fourth most common stage was medication reconciliation, accounting for 8.4% (21 of 250) of reports. The following is an example of a report of a medication reconciliation error:

Patient taking calcitriol prior to admission, and frequency was recorded when reconciling home medications during admission in the ED. Calcitriol was prescribed, dispensed, and administered at a frequency of 3 times per day throughout 3-day hospital stay and continued upon discharge back to skilled nursing facility (SNF). Patient was readmitted to another facility due to leukocytosis, and at that time medication error was discovered, with correct frequency of calcitriol noted to be 3 times per week. The medication was discontinued, and patient's symptoms resolved.

We also analyzed each report to determine the medication error type that occurred (**Table 1**). Wrong dose was the most common medication error type identified (42.0%; 105 of 250), followed by wrong route (17.2%; 43 of 250), wrong drug (12.8%; 32 of 250), contraindicated drug (10.0%; 25 of 250), and wrong patient (5.6%; 14 of 250). **Table 2** shows the distribution of serious medication errors in the ED by medication error type and stage of medication use.

Wrong doses were further subclassified as overdoses (n=100) or underdoses (n=4), and one report did not specify the type of wrong dose. Wrong drugs were most often the result of drug name confusion (e.g., drugs with look-alike names; n=14) or drug storage confusion (e.g., drugs stored next to one another or drugs with similar packaging; n=6), and the confused drug pairs are detailed in **Table 3**. Contraindicated drugs were further subclassified as known drug allergies (n=19) or drug-disease state interactions (n=6).

Figure 4. Distribution of PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Stage of Medication Use, N=250



Subgroup Analyses of Most Common Medications

Epinephrine

Epinephrine was the most common prescribed medication mentioned in reports (n=40). Most medication errors involving epinephrine occurred at the administration stage (62.5%; 25 of 40) or the ordering/prescribing stage (35.0%; 14 of 40). Medication errors involving epinephrine were most often classified as wrong-route errors (82.5%; 33 of 40) or overdoses (12.5%; 5 of 40). The following are examples:

> *A 12-year-old patient with a history of idiopathic angioedema presented to the ED with lip and throat swelling. The attending physician, resident, and nurse discussed a plan to prescribe 0.5 mL (0.5 mg) of epinephrine 1:1,000 to be administered intramuscularly. The resident ordered a dose of 5 mL (5 mg) of epinephrine 1:1,000. The nurse administered the ordered dose. The patient became tachycardic, hypertensive, and complained of nausea, vomiting, and a feeling that the heart was racing. The patient received nitroglycerin and aspirin and was placed on oxygen via nasal cannula. An EKG showed S-T segment changes, and the Troponin-I level was elevated. The patient was admitted for telemetry, serial EKGs, and laboratory monitoring.*

> *Patient presented to ED for facial and throat swelling after eating seafood. Patient did not have known food allergy. IV benadryl was administered with improvement of symptoms initially, but symptoms subsequently worsened and epinephrine 0.3 mg IM was ordered. Nurse administered epinephrine 0.3 mg IV instead of IM. Patient developed tachycardia with headache, chest pain, and back pain. Symptoms were treated with three doses of metoprolol IV, as well as oral prednisone, aspirin, and acetaminophen. Serial troponin levels were checked, with peak of 0.68 approximately 12 hours after IV Epinephrine was administered. Pt was admitted for observation. Serial EKGs, chest CT, echocardiogram, and cardiac cath were ordered. No abnormalities or ischemic changes noted. Patient was diagnosed with Type 2 NSTEMI secondary to demand ischemia and was discharged after 3 days of hospitalization.*

Opioid Analgesics

Among 31 analgesics identified in reports, 30 were opioid analgesics, making this the most frequently prescribed pharmacologic class of medications. The specific opioids prescribed are detailed in **Figure 5**. Half of medication errors involving an opioid analgesic occurred at the ordering/prescribing stage (50.0%; 15 of 30). Overdoses were the most common medication error type, accounting for over half of medication errors involving an opioid analgesic (56.7%; 17 of 30).

Insulin

Insulin was the second most common prescribed medication (n=25), and the type of insulin involved in each report is detailed in **Figure 6**. Most medication errors involving insulin occurred at either the administration (40.0%; 10 of 25) or ordering/prescribing stage (36.0%; 9 of 25). Overdoses were the most common medication error type, accounting for roughly half of medication errors involving insulin (52.0%; 13 of 25).

Discussion

Timing

To our knowledge, this is the first study to consider the timing of serious medication errors in the ED as a potential contributing factor to these events. We observed that serious medication errors in the

Table 1. Distribution of PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Medication Error Type, N=250

Medication Error Type	Medication Error Subtype	Reports of Error Subtypes, n	Reports of Error Types, n (%)
Wrong Dose	Overdose	100	105 (42.0%)
	Underdose	4	
	Not Specified	1	
Wrong Route			43 (17.2%)
Wrong Drug	Drug Name Confusion	14	32 (12.8%)
	Drug Storage Confusion	6	
	Drug Without an Indication	4	
	Drug Discontinued	3	
	Not Specified	5	
Contraindicated Drug	Known Drug Allergy	19	25 (10.0%)
	Drug-Disease State Interaction	6	
Wrong Patient			14 (5.6%)
Delayed or Missed Dose			11 (4.4%)
Drug Omission			6 (2.4%)
Wrong Formulation			6 (2.4%)
Duplicate Therapy			4 (1.6%)
Other			4 (1.6%)
Total			**250 (100.0%)**

Table 2. Distribution of PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020) by Medication Error Type and Stage of Medication Use, N=250

	Stage of Medication Use						
Medication Error Type	Ordering/ Prescribing	Administration	Dispensing	Medication Reconciliation	Other	Unknown	Total
Wrong Dose	34	40	19	9	1	2	105
Wrong Route	15	28	0	0	0	0	43
Wrong Drug	8	2	17	5	0	0	32
Contraindicated Drug	24	1	0	0	0	0	25
Wrong Patient	8	4	0	2	0	0	14
Delayed or Missed Dose	5	6	0	0	0	0	11
Drug Omission	2	1	0	3	0	0	6
Wrong Formulation	5	0	1	0	0	0	6
Duplicate Therapy	4	0	0	0	0	0	4
Other	0	1	0	2	1	0	4
Total	**105**	**83**	**37**	**21**	**2**	**2**	**250**

Table 3. Confused Drug Pairs in PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020), n=24

Wrong Drug Subtype	Row	Intended Drug	Administered Drug	Stage of Medication Use
Drug Name Confusion	1	cefepime (Maxipime)	diltiazem (Cardizem)	Dispensing
	2	clonazepam (Klonopin)	clonidine (Catapres)	Ordering/Prescribing
	3	colchicine (Colcrys)	clonidine (Catapres)	Dispensing
	4	diltiazem (Cardizem)	diazepam (Valium)	Dispensing
	5	diltiazem (Cardizem)	diazepam (Valium)	Dispensing
	6	labetalol (Normodyne)	furosemide (Lasix)	Ordering/Prescribing
	7	levetiracetam (Keppra)	lamotrigine (Lamictal)	Ordering/Prescribing
	8	levetiracetam (Keppra)	ketamine (Ketalar)	Dispensing
	9	levetiracetam (Keppra)	ketamine (Ketalar)	Dispensing
	10	metronidazole (Flagyl)	fentanyl (Sublimaze)	Dispensing
	11	midazolam (Versed)	lorazepam (Ativan)	Ordering/Prescribing
	12	morphine (Duramorph)	hydromorphone (Dilaudid)	Dispensing
	13	nifedipine (Procardia)	nimodipine (Nymalize)	Dispensing
	14	verapamil (Calan)	midazolam (Versed)	Dispensing
Drug Storage Confusion	15	acetaminophen (Tylenol)	nitroglycerin (Nitrostat)	Dispensing
	16	famotidine (Pepcid)	vasopressin (Pitressin)	Dispensing
	17	midazolam (Versed)	butorphanol (Stadol)	Dispensing
	18	normal saline solution	dextrose solution	Dispensing
	19	normal saline solution	dextrose and half normal saline solution	Dispensing
	20	oxygen	room air	Administration
Not Specified	21	ciprofloxacin (Cipro)	heparin	Administration
	22	etomidate (Amidate)	vecuronium (Neovec)	Ordering/Prescribing
	23	ketamine (Ketalar)	rocuronium (Zemuron)	Dispensing
	24	lorazepam (Ativan)	epinephrine (Adrenalin)	Ordering/Prescribing

ED were significantly more likely to occur on the weekend (Friday through Sunday) compared to a weekday (Monday through Thursday) and during the p.m. hours compared to the a.m. hours. Additionally, we noted that serious medication errors in the ED were significantly more likely to occur during the evening shift (3 p.m. to 11 p.m.) compared to the overnight shift (11 p.m. to 7 a.m.). Because PA-PSRS does not collect specific information about staffing and patient census, we can only speculate that the timing of serious medication errors in the ED could be related to staffing levels or patient volumes.[5]

Epinephrine

Our analysis revealed that epinephrine was the most common medication involved in a serious medication error in the ED. An earlier analysis of epinephrine errors conducted by the PSA revealed that more than one-quarter of events involving epinephrine took place in the ED.[6] Part of the potential confusion related to the use of epinephrine in the emergency setting is that the medication is indicated for both anaphylaxis and cardiac arrest, and each indication has its own dosing and route of administration (see **Box**).[7]

Most of the errors in our analysis involving epinephrine were wrong-route errors in which the medication was administered intravenously to patients presenting with anaphylaxis who should have received the medication intramuscularly or subcutaneously. A potential safety strategy[b] to ensure proper dose and route of administration for epinephrine in the management of anaphylaxis is to stock epinephrine autoinjectors in the ED.[10] However, there are drawbacks to epinephrine autoinjectors, including high costs and limited shelf life.

Ordering/Prescribing Errors

We observed that medication errors in the ED occurred most often during the ordering/prescribing stage of the medication-use process. One potential safety strategy[b] to reduce the risk of medication errors during ordering/prescribing is the use of computerized physician order entry (CPOE) with integrated clinical decision support (CDS). CDS assists prescribers by using drug selection and dosing guidelines, as well as checks for allergies, drug-drug interactions, and duplicate therapies.[11] Many studies have shown CDS to be an effective strategy for improving medication safety during

[b]These strategies are based on existing literature and expert opinion and may help to advance patient safety. Inclusion of these strategies does not constitute an endorsement or formal recommendation by the authors or the Patient Safety Authority.

Figure 5. Opioid Analgesics Involved in PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020), n=30

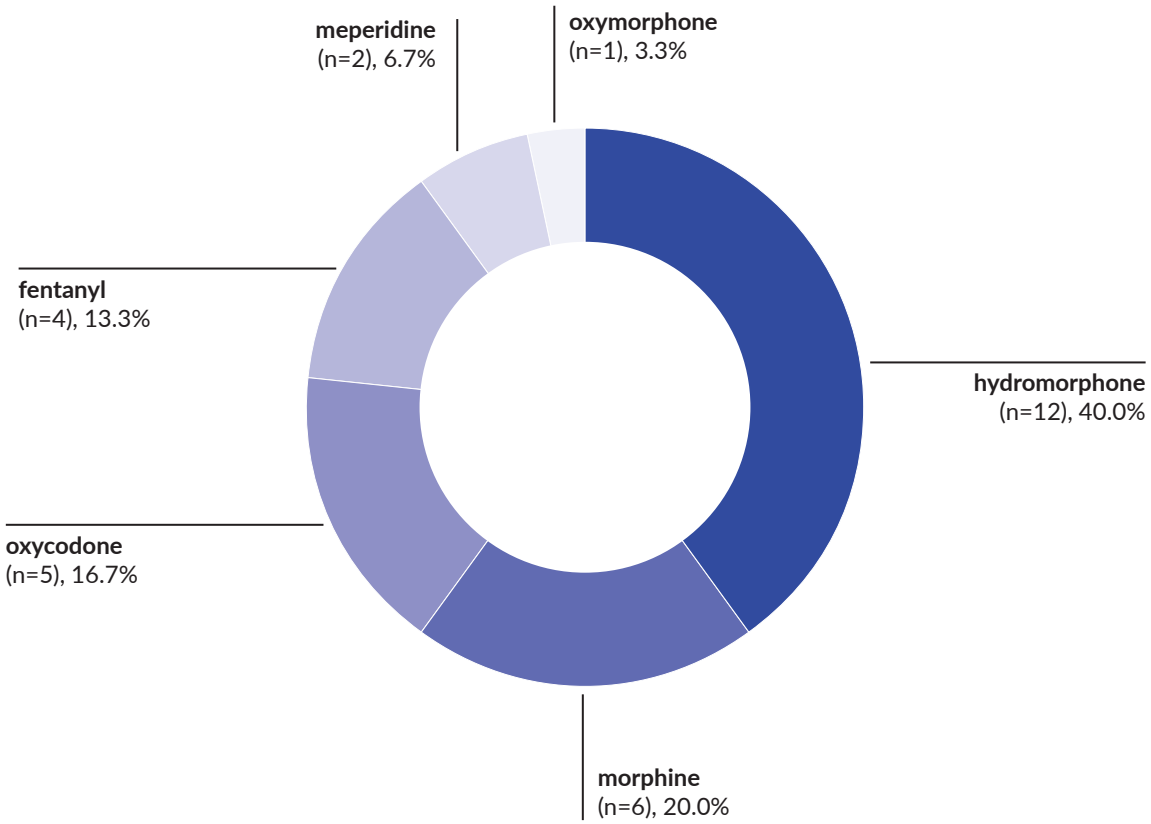
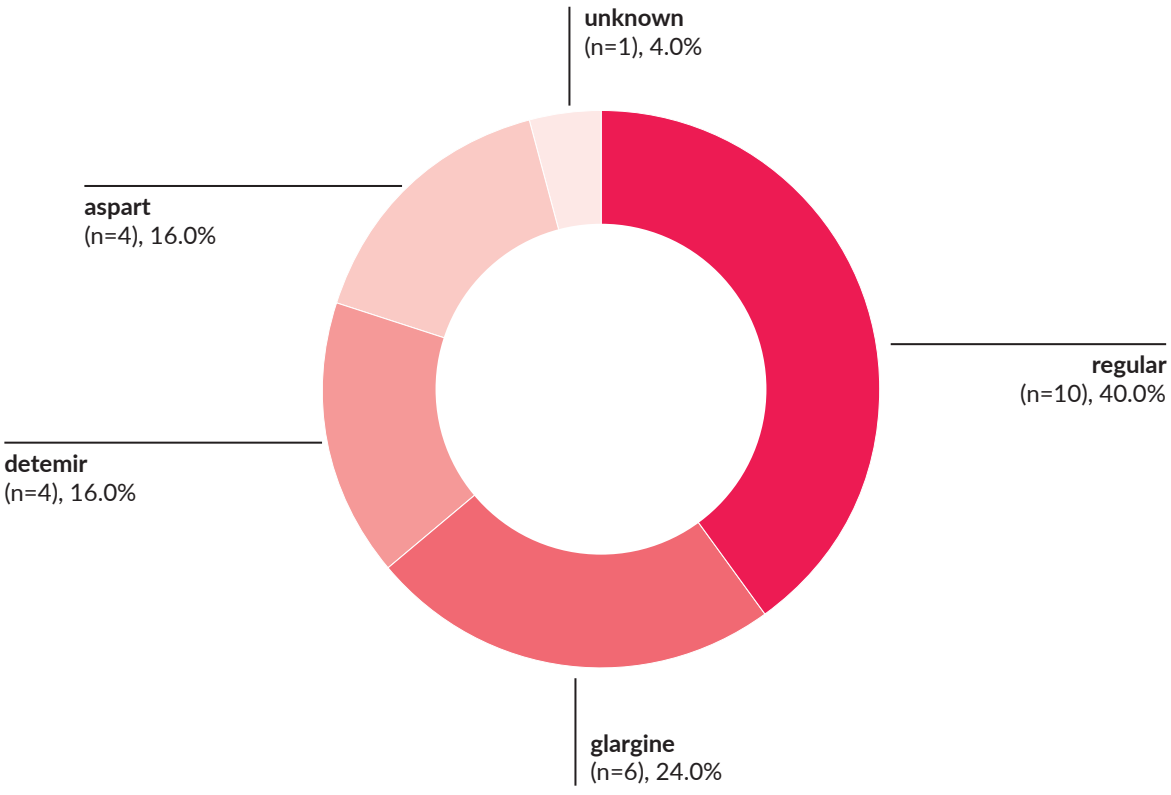


Figure 6. Types of Insulin Involved in PA-PSRS Reports of Serious Medication Errors in the ED (2011–2020), n=25



Box. Overview of Epinephrine Dosing for Adults in the ED[8,9]

Indication	Anaphylaxis	Cardiac arrest
Concentration	1 mg/mL (previously 1:1,000)	0.1 mg/mL (previously 1:10,000)
Dose	0.3 to 0.5 mg	1 mg
Route	Intramuscular injection in the lateral thigh	Intravenous injection

ordering/prescribing.[11-16] Based on their systematic review of the literature, Hajesmaeel Gohari and colleagues concluded that CPOE and CDS use in the ED reduced the incidence of adverse drug events, including medication errors, by decreasing prescribing errors.[12] Two other studies—both focused on prescribing errors in a pediatric ED—showed significant decreases in prescribing errors with the use of CDS.[14,15] While CDS can be an effective strategy, software and systems must be tested and updated regularly[11,16] and decisions about new notifications must be made carefully to avoid alert fatigue.[16]

Another potential safety strategy[b] to prevent ordering/prescribing errors in the ED is the inclusion of an emergency medicine pharmacist (EMP) as part of an interdisciplinary emergency medicine team.[5,13,17-23] Both the American College of Medical Toxicology and the American College of Emergency Physicians have published position statements supporting a dedicated role for EMPs to ensure the safe and effective use of medication in the ED.[20,21] EMPs have had a demonstrated impact on patient outcomes in the ED, from reducing medication errors to decreasing costs.[17,20,23] To guide hospital pharmacy departments in the introduction or expansion of EMP services into their facilities, the American Society of Health-System Pharmacists published revised guidelines based on expert consensus and published evidence.[18] The following are the key responsibilities of the EMP:[18]

- Patient care
  - Provision of medication information to clinicians in the ED
  - Resuscitation
  - High-alert medications and procedures
  - Medication procurement and preparation
  - Medication order review
  - Medication therapy monitoring
  - Documentation
  - Patient and caregiver education
  - Care of patients boarded in the ED
  - Transitions of care
  - Medication reconciliation
- Administrative
  - Medication safety
  - Quality improvement
  - Emergency preparedness planning
  - Education and training of pharmacy personnel (e.g., pharmacists, residents, and students) as well as other healthcare professionals (e.g., physicians, medical residents, advanced practice providers, and nurses)
  - Research and scholarship
  - Professional development
  - Leadership activities

Limitations

Despite mandatory event-reporting laws in Pennsylvania, our data are subject to the limitations of self-reporting. Because each reporter decides which details to include in the free-text fields of an event report, pertinent information was sometimes missing, such as the medication indication or the sequelae experienced by the patient following a medication error. In addition, this study covers a 10-year time period when technology was advancing rapidly. While the intent of this study was not to analyze trends over time, it is possible that the implementation of technologies such as electronic health records, CPOE, CDS, barcode medication administration, and smart infusion pumps, may have impacted the types and frequency of medication events that were reported during the study period.

Conclusion

Our analysis revealed that serious medication errors in the ED occurred most often during the ordering/prescribing and administration stages of the medication-use process and that the most common medication error types were wrong dose (specifically overdose) and wrong route. The medications most frequently involved were epinephrine, opioid analgesics, and insulin. To reduce serious medication errors within the ED, hospitals can consider implementing safety strategies, such as stocking epinephrine autoinjectors, using CPOE with CDS, and incorporating an EMP into their emergency medicine team or expanding their existing EMP services.

Notes

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

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