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Education

A mixed-methods needs assessment to identify pharmacology education objectives for emergency medicine residents

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Abstract

Objectives: Medication errors represent a significant threat to patient safety. Pharmacotherapy is one of the 23 Accreditation Council of Graduate Medical Education milestones for emergency medicine, yet there is minimal understanding of what content should be prioritized during training. The study aim was to develop objectives for a patient-safety focused pharmacology curriculum for emergency medicine residents.

Methods: We incorporated data from a de-identified safety event database and survey responses of 30 faculty and clinical pharmacists at a single-site suburban university hospital with 24-hour emergency medicine pharmacists and an annual volume of approximately 70,000. We reviewed the database to quantify types and severity of medication errors over a 5-year period for a total of 370 errors. Anonymous surveys included categorical items that we analyzed with descriptive statistics and short answer questions that underwent thematic analysis by 2 coders. We summarized all data sources to identify curriculum gaps.

Results: Common medication errors reported in our database were wrong dose (43%) and computer order entry errors (14%). Knowledge gaps were medication cost (63%), pregnancy risk information (60%), antibiotic stewardship (53%), interactions (47%), and side effects (47%). Qualitative analysis revealed the need to optimize computer order entry, understand the scope of critical medications, use references, and consult pharmacists. Integration of data suggested specific medications should be covered in curricular efforts, including antibiotics, analgesics, sedatives, and insulin.

Conclusion: We developed objectives of pharmacology topics to prioritize during emergency medicine training to enhance prescribing safety. This study is limited due to its small sample and single institution source of data. Future studies should investigate the impact of pharmacology curriculum on minimizing clinical errors.

KEYWORDS
curriculum, interprofessional education, needs assessment, pharmacy, residency education

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1 | INTRODUCTION

1.1 | Background

Medication errors represent a significant threat to patient safety. Prescribing errors place patients at risk for adverse side effects and negative health outcomes. Errors may take place at any stage in the clinical encounter, including selection, dosing, dispensing, administration, and monitoring.[1] The Joint Commission emphasizes the importance of medication safety and mandates diligent pharmacologic practices.[2–6]

The Institute of Medicine's (now the National Academy of Medicine) *To Err is Human* report and other literature identifies the emergency department (ED) as the most common setting for patient safety errors in the hospital.[7,8] Approximately 5% of ED patients in the United States suffer an adverse drug event.[7,9] Emergency physicians face multiple challenges that may increase risk of errors, including the acute management of undifferentiated patients with incomplete medical histories, reliance on verbal orders, and time pressures associated with overcrowding.[8,10] Medications are often dispensed and administered at point-of-care with only a verbal order, which does not have the same safeguards as orders placed in the electronic health record with pharmacist review.[11] Increased likelihood of errors are more commonly observed with verbal orders, in pediatric populations, during 4am-8am hours, in patients with high acuity conditions, and when ordered by a trainee, particularly at the beginning of an academic year.[12–15] The "July effect" highlights the role of trainees as both key members of the healthcare team and prime targets for interventions that may reduce errors in physician ordering of high-risk medications in the ED.[16]

1.2 | Importance

Pharmacotherapy is 1 of 23 Accreditation Council of Graduate Medical Education (ACGME) subcompetencies in emergency medicine (PC5);[17] however, there is no standard pharmacotherapy curriculum for residency training programs to follow and minimal understanding of how to prioritize content and interprofessional education. As such, pharmacotherapy deserves special attention during residency training in emergency medicine. New trainees generally have insufficient prior experiences with medication selection and ideal prescribing practices during medical school. In a survey of medical students and residents, 25% did not check allergies and only 30% checked for drug interactions.[18] Historically, there has been an expectation that trainees will learn this material in the clinical domain, which results in inconsistencies in education and variable competence. Although formalized curricula have been described in other specialties, such as family medicine, there is no standard content in emergency medicine training.[19] Academic Life in Emergency Medicine's "Capsules" series is an excellent resource, offering an online e-curriculum with practical pharmacology modules on a variety of topics, however, this is not required content during residency training.[20] The lack of a defined pharmacotherapy curriculum and training in safe ordering practices represents a limitation in foundational knowledge and an important quality issue with a direct impact on patient safety. Fortunately, at insti-

The Bottom Line

A 5-year review of pharmacological interventions in emergency department visits (>70,000/year) found 370 medication errors, with dosing and computer entry orders as the most common. A limited survey of staff involved showed that the most common knowledge gaps were costs, pregnancy risk, and antibiotic stewardship. The authors highlight areas for enhancing emergency medicine resident training in medication safety.

tutions with clinical emergency medicine pharmacists, this opens the door for interprofessional collaboration to improve education on these topics.

1.3 | Goal of this investigation

Our study aim was to identify knowledge gaps in pharmacotherapy education among emergency medicine residents by performing a multi-source needs assessment. We used quality improvement data and consultation with experts to determine a set of objectives for a future curriculum.

2 | METHODS

2.1 | Study design and setting

We performed a needs assessment between July 2020 and December 2020 using a convergent, questionnaire-variant mixed-methods design[21] at a university-based suburban ED with an annual volume of approximately 70,000 patients and 60 emergency medicine residents (PGY1-4 format). The study consisted of 2 sources of data sampling: review of a hospital error reporting database and use of a survey instrument with both categorical and open text responses. The Stanford School of Medicine institutional review board approved this study (Protocol 56600).

2.2 | Selection of participants

Eligible survey respondents included 11 emergency medicine clinical pharmacists and 90 attending physicians in the department of emergency medicine. Trainees were excluded. Participants were recruited by an email that included consent materials and a link to a survey instrument using Qualtrics (Qualtrics International Inc, Seattle, WA). Completion of the survey was used as a surrogate for informed consent. The survey was open for 6 weeks, and reminders were sent to nonrespondents twice. Surveys were anonymous and no identifying information was collected.

2.3 | Measurements: safety database query

In parallel to the survey of pharmacists and attendings, we used the Stanford Alert For Events (SAFE) quality improvement system to obtain clinical data that would inform our objectives. SAFE allows confidential or anonymous reports of patient safety concerns by any hospital employee, and hospital quality officers follow-up on all submissions within 1 to 2 business days. The event is defined by the reporter as an error. Many events are self-reported, but submissions are frequently performed by pharmacists who note medication errors. Errors are not extracted from orders outside the reference range of the electronic health record. We extracted 370 errors over a 5-year period (2015–2020). Data provided an overview of prescribing errors in our adult and pediatric emergency departments.

2.4 | Measurements: survey design

There was no prior pharmacology curriculum needs assessment available in the literature and no existing survey instruments on which to base this study. Therefore, we developed our survey instrument using a database query, literature review, and expert opinion, which provides content validity evidence.[22,23] We tested our survey extensively among a cohort of emergency medicine faculty members with expertise in medical education research for item generation, optimal item phrasing, matching of item content to the construct, survey functionality, and overall quality. We piloted the survey among the author team and cross-checked results for consistency, to collect response process validity evidence.[22,23]

The final survey instrument consisted of 18 questions. These included 3 demographic questions, 2 categorical questions that consisted of checking up to 5 items from a list, 6 free-text questions on the top 3 most implicated medications, and 7 open-ended short answer questions. The questions queried important topics to be included in a curriculum, likely knowledge gaps, prescribing habits, and common medication errors.

2.5 | Analysis: Safety database

We analyzed de-identified SAFE report submissions of medication errors for type of error, severity of event, and class of medication. Errors were classified by the user in 1 of 6 categories: unsafe condition (0), near miss and did not reach patient (1), reached patient but no harm was evident (2), emotional distress or inconvenience to patient (3), additional treatment required but limited to admission (4), and temporary harm (5). The most common types of medication errors and culprit medications were used to inform the needs assessment.

2.6 | Analysis: Survey

For the survey quantitative analysis, the categorical responses were calculated across participants and the total number of selections for each item generated rank lists based on response frequency (Microsoft Excel, 2021). Similarly, free-text responses of top medications were categorized by type of medication and the highest frequency items were identified for each question. For the qualitative component of the survey, we analyzed the open text responses to understand features of principles of pharmacology education, safe prescribing practices, and interactions with the pharmacist consultant. We inductively generated codes from the responses to these short-answer questions. Two coders from the author team, 1 emergency medicine physician and 1 emergency medicine pharmacist, met frequently to discuss code generation and meaning to ensure agreement and consistency between investigators. They performed a thematic analysis using inductive reasoning and generated themes for each short answer question.[24]

2.7 | Integration and objective derivation

The data from the SAFE database and themes from the qualitative analysis were integrated in a convergent design order to identify key topics requiring attention in the emergency medicine pharmacology curriculum. High-frequency topics in the SAFE database that aligned with codes and themes of the qualitative analysis drove objective content. Unifying topics were discussed among the lead physician and pharmacist researcher and iterated as needed to develop encompassing curricular objectives for emergency medicine residents.

3 | RESULTS

3.1 | Safety database query

From January 2015 to June 2020, there were a total of 370 reported events of which 294 (79.4%) were attributed as medication errors (Table 1). Of these, errors were further categorized as related to prescribing (44.9%), administration (16.3%), order communication (13.6%), dispensing (7.8%), and distribution (7.5%). The

TABLE 1 Categories of medication errors in the Stanford Alert For Events report database

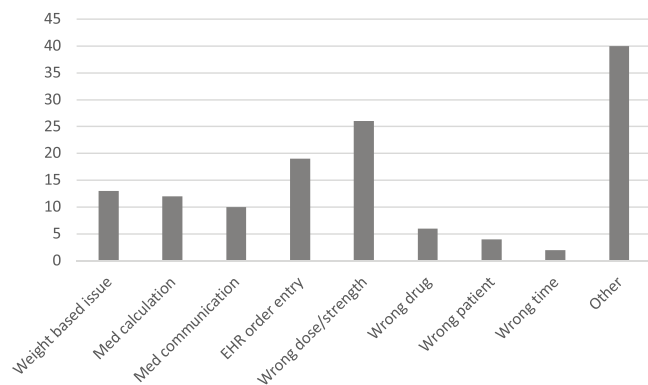| Medication error category	No. (total = 294)	% of total errors
Prescribing	132	44.9
Administration	48	16.3
Order communication	40	13.6
Dispensing	23	7.8
Distribution/storage	22	7.5
Education/training	10	3.4
Compounding	5	1.7
Monitoring	5	1.4
Other	5	1.4
Labeling	3	1.0
Handoff/communication	1	0.3

FIGURE 1 Frequency of 132 prescribing errors by type

prescribing errors were further classified by cause and are summarized in Figure 1. Prescribing errors were classified as 0 "unsafe" (n = 22, 16.7%), 1 or "near miss" (n = 57, 43.2%), 2 "reached patient but no harm" (n = 44, 33.3%), 3 "emotional distress or inconvenience" (n = 3, 2.3%), 4 "additional treatment" (n = 5, 3.8%), and 5 "temporary harm" (n = 1, 0.8%). The most implicated medications were antibiotics, opioid pain medications, nonopioid pain medications, steroids, anticholinergics, epinephrine, potassium chloride, and lidocaine.

3.2 | Characteristics of study subjects

There were 30 survey respondents, including 9 emergency medicine clinical pharmacists (9 of 11; response rate, 82%) and 21 emergency medicine teaching faculty (21 of 90; response rate, 23%). The median number of years in practice was 4.5 (interquartile range [IQR], 7.5) for the pharmacists and 10 (IQR, 13.5) for the physicians.

3.3 | Main results

The first portion of the survey included a list of potential curriculum topics and an item asking participants to select the most likely resident knowledge gaps from that list (Table 2). On the next part of the survey, we queried specific names or classes of drugs most incorrectly ordered, most associated with patient safety events, those with must-know side effects, and those for which dosing should be memorized. The survey results showed that there was a similar profile for incorrectly ordered medications and those associated with patient safety events, including analgesics (40% and 43%, respectively) and insulin (27% and 37%, respectively). Medications that should be memorized were those used in critically ill patients: rapid sequence intubation (RSI) medications (60%), vasopressors (epinephrine [43%] and other vasopressors [27%]), and sedatives (27%).

3.4 | Qualitative survey data

We identified 3 themes associated with the content of an ideal pharmacology curriculum. These included, "commonly used antibiotics," "crit-

TABLE 2 Categorical survey responses of clinical pharmacists and emergency medicine attendings

Categorical survey questions	Most common topics reported (% reporting)
For which of the following topics do you feel there is a knowledge gap among emergency medicine residents?	Cost of medications (63) Medications in pregnancy and lactation (60) Antibiotic selection and stewardship (53) Medication interactions (47) Familiarity with side effects (47)
What are the top 3 types of medications that are most commonly associated with patient safety events?	Pain management/opioids (43) Insulin (37) Sedation medications (33)
What are the 3 most common incorrectly ordered medications in the ED?	Pain medications (40) Antibiotics (30) Insulin (27)
Which 3 specific antibiotics are most commonly incorrectly prescribed in the ED setting?	Vancomycin (43) Piperacillin-tazobactam (30) Trimethoprim/sulfamethoxazole (27) Cephalexin (27)
What are the top 3 must-know side effects and its associated medication?	Medications with risk of EPS (23) Ketamine (17) Opioids (10)
What are the top 3 medications for which emergency medicine residents should have dosing memorized?	RSI medications (60) Epinephrine (43) Vasopressors (27) Sedation medications (27)

Abbreviations: ED, emergency department; EPS, extrapyramidal symptoms; RSI, rapid sequence intubation.

ical care medications," and "scope of medications and resources for ordering." Antibiotics were a frequently cited example, mentioned in ⅓ of the responses. One respondent emphasized this by stating, "appropriate antibiotic use [is important] because it is a vast and difficult to master topic that is ever-changing." Critical care medications were frequently reported, particularly RSI medications, sedatives, tPA, anticoagulation reversal, antiepileptics, antipsychotics, and antiarrhythmics. Resources for ordering were an important theme, notably, "pharmacology resources…because not everywhere will have ED pharmacy support to help with dosing and selection."

Three themes emerged related to general safety tips for medication. These themes included "electronic health record pitfalls," "team communication," and "pharmacy resources and references." Specific electronic health record pitfalls were auto-verification, auto-population, order entry, and pop-up warnings. Elaborating on the auto-verification pitfall, "Some orders are auto-verify meaning that the RN could give the medication before pharmacist review. Do not assume all orders are reviewed by pharmacists." "Communication with team members" encompassed interprofessional interactions with nurses and pharmacists and highlighted closed-loop communication. The third theme encompassed the variety of resources that guide safe prescribing. One respondent provided advice on utilization of these resources,

"Be familiar with and utilize the resources at hand to avoid unsafe med administration; these include asking the patient about preferences/allergies, talking to the nurse about the plan, checking the EMR to see if [the] patient has received the med before and at what doses, and if needed, speaking to the pharmacists." There was an emphasis on double-checking dosing, addressing uncertainty using references and decision tools, and an awareness of pharmacokinetics and side effects.

Additional short-answer questions asked about ways to improve antibiotic stewardship, reasons to consult the pharmacist, characteristics of communication between emergency medicine residents and pharmacists, pharmacy resources that trainees should know, and addressing pharmacology knowledge gaps, all of which are summarized in Table 3.

Integration of the survey data and the safety database by 1 physician researcher and 1 pharmacist researcher generated specific topics needed to improve the rigor of pharmacology content and improve patient safety. These were crafted into 5 key objectives for emergency medicine pharmacology training (Table 4).

4 | LIMITATIONS

There were several limitations to this study. First, it was conducted at a single institution with a small cohort, which limits the generalizability. The study took place at an institution with 24/7 emergency medicine pharmacists, and therefore generalizability to institutions without this resource may be limited. Needs assessments are inherently learner and environment specific; a similar needs assessment in another cohort of participants might yield different results. However, we believe that the outcomes of our study represent universal themes in pharmacology education and are likely relevant beyond our institution. Second, the error database information source was retrospective and dependent on entry by a healthcare professional. The majority of errors were categorized as near misses or caused no harm to the patient. Actual events, particularly harmful events, may be underreported. Errors were in predefined categories based on the individual creating the report, rather than by the investigators. The actual clinical impact of such errors is based on a scoring tool of the system, but with limited detail on patient outcome and thus clinical relevance. Regarding the survey, there are standard limitations to survey studies based on instrument design and sampling that apply in our study. One of the items, "What is unnecessary to include in the curriculum" was excluded due to lack of responses across participants. Only supervisors, rather than residents, were surveyed, which was purposeful based on the limited accuracy of self-assessment.[25] Additionally, this study surveyed emergency medicine pharmacists, which will result in inherently biased results toward important topics as perceived by pharmacists.

4.1 | Reflexivity

We acknowledge that the experiences and opinions of our study team may influence the data analysis and outcomes. The lead author (A.R.)

and 3 coinvestigators (K.S., H.C.W., and M.G.) are emergency physicians with extensive training and experience in medical education research and qualitative methods. One investigator (B.D.) is a clinical pharmacist with many years of experience working in an emergency department, providing oversight of medication selection and administration, and consultation with physicians. The interpretation of the qualitative data is both informed by and limited by the experiences of these individuals.

5 | DISCUSSION

Our mixed-methods approach to a curriculum needs assessment identified important pharmacology knowledge gaps among emergency medicine residents. Integration of both quantitative information from the error report database and qualitative responses from the survey demonstrated that prescribing errors are the biggest concern for medication patient safety. Furthermore, the single most common reason for prescribing errors was wrong dose, which highlights a need for familiarity with emergently used medications and comfort with accessible references. The convergent design also revealed advantages and disadvantages of electronic health record order entry, specific classes of medications that require special attention (antibiotics, analgesics, sedatives, and insulin), and the importance of pharmacotherapy for certain populations. Based on our results, there are 2 categories of educational interventions that are required. The first is medication-specific and highlights classes or types of medications that require special attention in a pharmacology curriculum. The second includes elements of clinical practice that might improve safe dosing, with the support of electronic health record entry, available references, and proper consultation with pharmacists. Taken together, preliminary data from our needs assessment yielded final curriculum objectives that address antibiotic selection, dosing of critical medications, utilizing references, implementing safe prescribing strategies, and consultation with pharmacists in the emergency department (Table 4). Such a curriculum would be a collaboration between emergency medicine pharmacists and residency education leadership.

Antibiotics were frequently referenced by participants and the needs assessment identified methods for improving trainee stewardship. Antibiotics are not one-size fits-all and trainees must learn to consider the patient's clinical presentation, laboratory data, and interpretation of previous cultures when selecting an antibiotic. In reviewing the qualitative analysis, there are various factors that influence antibiotic use by resident physicians: institutional prescribing guidelines, use of an antibiogram, physician education, awareness of resistance patterns, and resources integrated into the electronic health record. For example, in selecting an antibiotic, learners should be able to justify actions such as the use of broad-spectrum antibiotics or ordering single antibiotics based on local resistance patterns. Learners must be taught to use institutional antibiograms to select appropriate antibiotics and use electronic health record support for dosing and culture review to guide antibiotic choice. On-shift emergency medicine pharmacists can

TABLE 3 Thematic analysis of short answer survey question responses submitted by clinical pharmacists and emergency medicine attendings

Qualitative survey questions	Themes	Example
In your opinion, what topics must be included in a pharmacy curriculum for ED residents and why?	Commonly used antibiotics	"Risk factors for MDRO/PsA, antibiotic spectrum coverages to decrease unnecessary use of broad spectrum antibiotics if not warranted"
	Critical care medications	"RSI, post intubation sedation/analgesia, sepsis, ID, anticoag+reversal,"
	Scope of medications and resources for ordering	"How to rapidly look up items"
What are general safety tips for medication ordering that all trainees should know?	Electronic health record pitfalls	"Double checking what is being ordered instead of clicking what first populates; our epic clinical decision tools aren't the most ED-friendly"
	Team communication	"360 confirmation of ordering—call it out and hear it back"
	Pharmacy resources and references	"Don't memorize, have a system for looking up SE [side effects]/interactions"
How can we improve our antibiotic stewardship in the ED?	Hospital guidelines for prescribing	"Have antibiogram and summarized guide available on app"
	Resistance patterns	"Follow up complication rates - resistance, C-diff, if possible; in some hospitals, there is way for 72 h returns to come in EPIC in a separate folder"
	Antibiotic selection	"Education. Monitoring prescribing habits. Pharmacist reviews."
	Electronic health record resources	"Smart orders—we have sophisticated software and it is unreasonable for an ED resident to know the specifics of dosing based on body weight, organ function, and indication. These can all be calculated by Epic for both in ED orders and discharged meds."
What pharmacology topics should residents consult the pharmacist about while on-shift?	Uncertainty or curiosity	"Anything they are not sure about, or anything they are curious about"
	Dosing adjustment or modification	"Dosing, frequency, appropriateness of therapy, alternative therapy options"
	Medications of high urgency	"Pressor of choice and all things push dose pressors"
How would you characterize the communication between ED residents and pharmacists? If you have any recommendations for improvement, please describe here.	Interactions were positive and professional	"Generally professional and focused, the pharmacists are incredible, patient and fantastic educators"
	Pharmacists are a valued team member	"Pharmacists attended every trauma/code/stroke alert/medical resuscitation which was incredibly helpful in high-stress environments when math becomes exceedingly difficult"
	Need simple method of contact	"…Very good—they typically know how to find pharmacy, call us, message us etc"
	Frequent educational communication and feedback	"…The pharmacists are a great part of the team. Would love to increase the discussions with them if they have the bandwidth."
What pharmacy resource do you think trainees are most unfamiliar with but should know? Why?	Website prescribing resources	"Sanford Guide for antibiotic selection and dosing, it is brief and usually better aligned with guidelines than UpToDate"
	Limitations of resources and pharmacy consultation	"I've found the pharmacists extremely helpful when I am worried about something Tox. When we consult about symptoms, they are often more helpful than poison control about identifying what the agent may be."
	Special patient populations	"Briggs Drugs in Pregnancy and Lactation—these questions always come up!"
How can we best address pharmacology knowledge gaps during residency education?	Formal curriculum	"We only have 3 assigned talks, building more into small lectures for conferences, collaborative journal clubs, or emails (pharmacy newsletters?, we have the education board now)"
	Multimodal on-shift teaching	"Immediate feedback with verification of orders is always helpful. In my experience as a resident (at a different hospital), the pharmacists would often just fix my orders without telling me and for certain meds, I ordered them incorrectly for months before anyone clarified that they were fixing it for me."
	Accessible pharmacy resources	"More education session, more easily viewable resources"

Abbreviations: ED, emergency department; MDRO, multidrug-resistant organism; PsA, prostate-specific antigen; RSI, rapid sequence intubation.

TABLE 4 Objectives for an emergency medicine residency pharmacotherapy curriculum derived from the needs assessment

Objectives
By the end of the session, the learner will describe the role of the clinical pharmacist
By the end of the session, the learner will defend antibiotic use for specific clinical scenarios based on spectrum of activity
By the end of the session, the learner will select proper dosing and administration of critical medications
By the end of the session, learners will interpret information from high-yield references to guide prescribing practices, with attention to special populations
By the end of the session, learners will implement safe prescribing strategies particular to electronic health record order entry

provide direct feedback to the prescribing resident in order to enhance compliance with these principals.

Participants emphasized the need to use pharmacology resources. Residents must learn to confirm pharmacokinetics, side effects, alternatives, and interactions for a given medication. Our study highlighted the importance of teaching trainees to use these resources, such as Lexicomp (Lexicomp, Hudson, OH) or Micromedex (IBM, Armonk, NY), particularly for special populations, such as patients with toxicologic overdose, lactation, pregnancy, or pediatric patients. Interestingly, the top selection did not relate to medication errors but rather the cost of medications (63% response). This highlights potential bias of pharmacist respondents given that this information is rarely included in the workflow of a physician, but also raises the question if it should be more readily available during order selection. As we continue to refine pharmacology education, we must make space for residents to consider the cost of medications. Beyond cost, it is imperative that we teach trainees how prices may impact medication compliance, financial security of patients, and social determinants of health. In conjunction with pharmacists, this is a feature that can be integrated into electronic health record prescribing.

Another topic emphasized by our participants was an understanding of the electronic health record interface for safe prescribing practices. Interestingly, this topic had both negative and positive characteristics emerge in the analysis. Auto-verification occurs when an order is processed without being reviewed by a pharmacist and poses a safety threat to patients. Trainees are often not aware of auto-verification and have a false sense of security that their orders are always reviewed by a pharmacist, when in fact the order goes directly to the nurse for administration. Automatic electronic health record features such as pop-ups, auto-population, and hard stops are meant to promote patient safety but may result in "alert fatigue" for trainees.[26] On the other hand, smart orders streamline medication selection for learners, particularly in antibiotic prescribing. A pharmacology curriculum should familiarize learners with these features of the electronic health record and alert them to potential pitfalls as well as utilize built-in decision support.

Clinical pharmacists are an important resource for residents in training, particularly in instances of uncertainty or when information cannot be readily found in a reference. A clinical pharmacist aids in preventing medication errors through screening and bedside interactions, assists with monitoring patients receiving high-risk medications, and is readily available in resuscitations.[8] The number of clinical pharmacists in emergency departments has increased greatly since the 1970s.[27,28] Pharmacists were highly regarded in the qualitative analysis as valuable team members, particularly in high-stress circumstances, including high acuity cases. It is essential that residents seek teaching and feedback from clinical pharmacists. Priorities for interprofessional education and assessment by emergency medicine clinical pharmacists represent an opportunity for future research.

Based on our study, we offered learning objectives for a pharmacology curriculum for emergency medicine residents, generated via a needs assessment that used multiple sources of data (Table 4). Our preliminary outcomes may serve as a curriculum design guide for emergency medicine clinical pharmacists and emergency medicine educators. Future investigation is needed to understand the most impactful interprofessional interactions and how to best assess trainee competence in pharmacotherapy. Importantly, future studies should evaluate the most effective curriculum interventions in decreasing errors. Due to the limitations of the retrospective safety database review, a consideration is to have clinical pharmacists involved in the tracking of errors and their clinical outcomes to better understand which interventions would have the greatest impact on patient safety.

In summary, our preliminary data identified pharmacology topics to be prioritized by emergency medicine clinical pharmacists and physician educators during emergency medicine residency training. We distilled this information into 5 key objectives that should be used to advance pharmacology curriculum content with the goal of enhancing prescribing safety.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

ACR: conceptualization, methodology, investigation, data collection, data analysis, and writing. BTD: methodology, investigation, data collection, data analysis, writing, and editing. HAC-W: conceptualization, review, and editing. KAS: conceptualization, review, and editing. MAG: conceptualization, review, and editing. ACR took final responsibility for the manuscript.

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