Toxicology education in emergency medicine: an assessment and pilot study

JoAn R. Laesa, Katherine G. Katzung, Cullen Hegarty and Samuel J. Stellpflug

*Minnesota Poison Control System, Hennepin Healthcare, Minneapolis, MN; Abbott Northwestern Hospital, Minneapolis, MN; Department of Emergency Medicine, Regions Hospital, Saint Paul, MN*

**ABSTRACT**
Accreditation Council for Graduate Medical Education (ACGME)-accredited emergency medicine programs have no formal requirements regarding training and education in medical toxicology. From review of previously published survey data less than two-thirds of emergency medicine residencies had formalized access to teaching with toxicologists. To evaluate capacity for toxicology education at ACGME-accredited emergency medicine residency programs, assessment of satisfaction in toxicology education and receptiveness to tele-education modalities. Secondarily to determine feasibility of a pilot web education toxicology program. A survey was conducted in 2015 to evaluate toxicology education capacity, satisfaction with current toxicology education, and technological capabilities of emergency medicine residencies (n = 167). We reviewed websites of non-responding residency programs to determine access to toxicology education. A pilot web-conference-based toxicology education program followed with one residency. Of programs that completed the survey (n = 35, 21%), 77% offered a toxicology rotation for trainees and 60% had an American Board of Medical Toxicology (ABMT)-certified Toxicologist on staff. Programs dissatisfied with toxicology education did not have a toxicology fellowship or an ABMT-certified toxicologist. Participants in the pilot educational program favorably rated the usefulness of the technology, effectiveness of the lecture, value of the subject, and educational value. Barriers exist to implementation of web education. Access to toxicology education through a clinical rotation or medical toxicologist is not consistently available among emergency medicine residency programs, which may indicate programs lacking a toxicologist have lower levels of satisfaction. Successful components of the pilot educational program could be disseminated, but further standardization is indicated.

**KEYWORDS**
Toxicology; education; emergency medicine; residency; survey

**Introduction**
ACGME-accredited emergency medicine programs have no formal requirements regarding training and education in medical toxicology. The “Model of the clinical practice of emergency medicine, 5th edition” [1] outlines essential knowledge and skills for the practice of emergency medicine. There is scant literature assessing specific sections, including toxicology. Prior descriptive surveys of emergency medicine (EM) residency program directors found variation in toxicology education and resources. In 1992 only 39% of responding programs required a rotation in clinical toxicology, and only 26% of programs had a toxicologist on staff [2]. Subsequent surveys published in 2000 [3] and 2016 [4] found that about two-thirds of programs had at least one toxicology faculty member and included a required toxicology rotation, often through a poison center. Poisoning is the leading cause of injury-related mortality in the United States [5] and the frequency of emergency department visits for poisoning is climbing [6]. These facts compel EM physicians to master the care of poisoned patients.

Few studies describe implementation of a curriculum to supplement toxicology educational needs of residency programs. However, there is a growing body of literature describing use and effectiveness of technology-based education. In 2010, an appraisal on emergency medicine educational research [7] noted a trend toward research on technology-based medical education. Trials of asynchronous web-based teaching in emergency medicine departments have produced...
mixed results for effect on outcome measures such as test scores or medication errors [8,9]. As suggested by Roe et al. [10] asynchronous learning is likely not as effective as e-learning modalities that use group discussion. Tele-education can incorporate characteristics of successful technology-based learning programs and is supported by national toxicology organizations. However, the investigators are not aware of any interactive toxicology tele-education programs for postgraduate medical training.

The study assessed toxicology education at ACGME-accredited emergency medicine residency programs. We aimed to determine the percentage of programs with access to ABMT-certified Medical Toxicologists and their roles, along with program directors’ perceived satisfaction in toxicology education at their institutions. Secondarily, we inquired about program receptiveness to alternative methods of toxicology education, including tele-education modalities, and capabilities to employ a tele-educational toxicology curriculum at their institution. We then worked with one institution to pilot live tele-education in toxicology. The pilot aimed to determine the feasibility of providing web-based toxicology education and what technology is needed rather than content development of a complete educational package.

Methods

The investigators’ institutional review board approved this study. We sent a survey (supplemental materials: Toxicology Education in Emergency Medicine Survey) to program directors (or designated responders) at ACGME-accredited emergency medicine residency programs in 2015 (identified by the ACGME list of programs within emergency medicine for the academic year ending 30 June 2015; n = 167). Subsequently, we piloted a tele-education curriculum at one emergency medicine residency program demonstrating need and desire for improved access to toxicology education.

The investigators of the study and the Data Collection Center at the HealthPartners Institute for Education and Research designed the survey. Questions in the survey elicited affiliations of residency programs with toxicology fellowships, poison centers, and board-certified toxicologists, the way these resources are used, and program directors’ perceived satisfaction in toxicology education at their institutions. The survey also elicited interest, capability, and availability to participate in the pilot program. Internal emergency medicine staff, emergency medicine residents, and toxicology fellowship program staff tested and reviewed the survey. The Data Collection Center distributed the survey via email with follow-up email and paper reminders to non-responders. The investigators additionally conducted telephone follow-up for non-responders. To increase response, we entered all respondents in a raffle for a $100 Target gift card. We obtained additional data regarding availability of board-certified toxicologists, toxicology rotations, the presence of a medical toxicology fellowship program, or affiliation with a poison center from the websites of non-responding programs to supplement the survey data set.

The investigators of the study in conjunction with medical toxicology fellows at the host institution developed the pilot program. The investigators’ determined the topics modeled on the institutional curriculum for toxicology training: “Toxidromes,” “Synthetic Drugs of Abuse,” and a two-part session on “Antidotes.” Medical toxicology fellows chose the topic for their lecture based on lectures previously developed under the oversight of a board-certified medical toxicologist and provided to emergency medicine residents. The one-hour sessions comprised of a slide-based lecture with time for question and answer throughout. The “Toxidromes” and “Antidotes” sessions contained case-based presentations. Further details can be found in supplemental material “Pilot Program Toxicology Lecture Content”. We selected one emergency medicine residency program for the pilot tele-education. The pilot used a live, internet-based video-conferencing platform with desktop sharing (VSee online software for video telemedicine by VSee Lab in Sunnyvale, CA) and visualization of the speaker and attendees to each party. Hardware at the investigators’ institution included a desktop computer and camera. The pilot emergency medicine residency used a computer and camera connected to a projector. Multiple microphones set up throughout the conference room at the pilot residency program allowed for voice capture in a large area.

A post-session survey (supplemental material: Post Pilot Session Survey) elicited ratings on format of the didactics, interest and utility of the session topic, and suggestions for modifications from each session. Likert scale response options included 1 (very poor), 2 (poor), 3 (fair), 4 (good), 5 (very good), as well as free-text response fields.

For the aims of the study, the entire sample was used for analysis using descriptive statistics of survey answers and additional data regarding availability of toxicology education from websites of non-responding
programs. Implementation and post-session survey data of the pilot program are described.

**Results**

Thirty-five of 167 (21%) programs completed the survey (Figure 1). A quarter of the responding programs reported association with a toxicology fellowship and 77% of programs offered a toxicology rotation for trainees, with 66% of the rotations at a poison center (Table 1). Sixty percent of responding programs reported an ABMT-certified Medical Toxicologist on staff at their institution. Additional web research on programs not participating in the survey found that 14% of non-responding programs had a toxicology fellowship at their institution, 50% had an ABMT-certified toxicologist on faculty, 61% offered a toxicology rotation, and 34% listed an association with a poison center (Table 1). Of the survey responding programs, the main means of teaching residents about toxicology consist of didactics and case review; over half also offered a toxicology rotation, journal club or online resources (Table 1). Less than half (43%) of the survey respondents indicated they were “very satisfied” with their current level of toxicology education, and 12% indicated dissatisfaction. No responding programs dissatisfied with their level of toxicology education were affiliated with a toxicology fellowship or had an ABMT-certified toxicologist on staff, and 8% of responding programs indicating dissatisfaction were affiliated with a poison center (Figure 2). Of the 65% of survey responding programs indicating an interest in live streaming toxicology lectures less than half have an affiliated toxicology fellowship.

The pilot program provided four separate lectures over a one-month period by three medical toxicology fellows (one fellow presenting per lecture with the presence of a board-certified medical toxicologist). Post-session survey results indicate participants found the usefulness of the technology and effectiveness of the lecture style to be “good” (Figure 3). The value of the subject topic and overall education value had variability between the sessions, with an overall rating of “good.” Suggestions for topics tended to be outside of what would be considered “core” curriculum, including suggestions to cover psychiatric medication toxicology and uncommon toxidromes. Technology barriers limited discussion during the sessions, especially the first two. The residency program then elected one or two resident representatives to communicate questions and responses to the lecturer due to issues with audio. It is unclear whether the difficulty resulted from software or hardware limitations. During one lecture, the pilot residency could only see a portion of the slide frames, negatively affecting the learning experience.

**Discussion**

Emergency medicine programs offer training in toxicology, primarily based at poison centers, and about half of programs have an ABMT-certified toxicologist
on staff. However, toxicology education was not consistently available among all emergency medicine residency programs. At many programs, while dedicated training in toxicology is possible, there is not on-site clinical training available with a board-certified toxicologist. Education offered by a poison center differs from clinical toxicology—phone-based consultation for poison center versus on-site consultative services. By offering “on-site” education by medical toxicologists, education may be more clinically applicable to the emergency department setting. Programs dissatisfied with their level of toxicology education were not affiliated with a toxicology fellowship or an ABMT-certified toxicologist.

The limitations of the study include a poor survey response rate (adequate survey response rate has been previously established at 50% [11]). Though mitigated by additional research conducted on the programs’ website pages to obtain information about availability of toxicology expertise and training in toxicology, validation of the website review did not occur and it was difficult to ascertain the nature of the toxicology rotation offerings or the contributions of ABMT-certified staff to toxicology education. The depth of the survey

---

**Table 1. Toxicology education in emergency medicine survey responses.**

| Survey question                                      | Survey respondents n (%) | Web search n (%) |
|------------------------------------------------------|--------------------------|-----------------|
| Association with toxicology fellowship               |                           |                 |
| No                                                   | 35 (21%)                 | 132 (79%)      |
| Yes                                                  |                          |                 |
| 3-Year Program                                       |                           |                 |
| Program size                                         | 26 (74%)                 | 12 (26%)       |
| Median residents/year (R/Y)                         | 10 R/Y                   | 12 R/Y         |
| Range residents/Year (R/Y)                          | 10-21 R/Y                | 6-21 R/Y       |
| Rotation at poison center                            | 16 (46%)                 | 32 (24%)       |
| ABEM toxicology-certified MD                         | 13 (37%)                 | 46 (35%)       |
| Formal instruction                                   | 10 (29%)                 | N/A            |
| Informal instruction                                 | 3 (9%)                   | N/A            |
| Teaching resources                                   |                          |                 |
| Didactics                                            | 25 (71%)                 | 8 (23%)        |
| Case review                                          | 24 (69%)                 | 9 (26%)        |
| Toxicology rotation (with or w/o ABEM toxicologist)  | 14 (40%)                 | 63 (48%)       |
| Journal club                                         | 15 (43%)                 | N/A            |
| Online resources                                     | 16 (46%)                 | N/A            |

---

**Figure 2.** Survey respondent satisfaction with toxicology education and level of interest in web lectures with presence of toxicology expert resources.
questions limited further information about education—whether the toxicology rotation was required or elective, the number of hours of dedicated toxicology education, or the specifics of the toxicology curriculum.

The pilot program did offer toxicology expertise to a residency program that did not have on-site expertise, however, the pilot endured challenges to implementation. The main barrier related to technical difficulties with sound and communication between the lecturer and the trainees. As the residency program was chosen due to adequate access to technology to identify barriers even in the “optimal” set-up, feasibility is not generalizable across all programs. Many programs have less technological capabilities and there may be costs associated with obtaining equipment to support the technology. The technology for implementation requires adequate audiovisual hardware and software that can facilitate interpersonal interactions such as eye contact, expressive body language, and verbal discussion between individuals in the group setting. Access to slides on a personal device during the lecture could facilitate multiple learning styles. Scheduling was not a significant barrier in the pilot as the residency program had dedicated curriculum time, though regional time

| Post-session Survey | Session 1: Toxicidromes | Session 2: Synthetic Drugs of Abuse | Session 3: Antidotes Part 1 | Session 4: Antidotes Part 2 |
|---------------------|-------------------------|-----------------------------------|---------------------------|---------------------------|
| Additional Comments | Technology needs to be smoother; lecturer could not hear participants; better communication needed | Couldn’t see entire slide | Enjoyed case based; need more difficult material; need material that they wouldn’t otherwise get | Too in depth of topic |
| Additional Topics   | Uncommon toxicidromes; Psychiatric medications toxicology; Regional trends in toxicidromes | |

*Figure 3. Pilot post session survey responses.*
differences could be a factor in scheduling for the instructors.

As the pilot program aimed to determine feasibility of providing web-based toxicology education, a full curriculum was not designed for the study. Thus, systematic evaluation of content and performance of the presenters did not occur. Content was not standardized nor externally validated for the importance of the chosen topics. The nature of the program precluded any data regarding changes to knowledge base or clinical skills. While focusing topics on the “Model of the clinical practice of emergency medicine” prepares residents for board examination, per feedback from the pilot institution balancing core topics with topics that residents receive less clinical exposure to is ideal. As there is variability in teaching style of the medical toxicology fellows and medical toxicologists, we also suggest further research into standardized educational curriculum and effectiveness of the curriculum using a pre- and post-test with board style or case management questions before disseminating such a program.

Developing a full curriculum that is evidence-based task a significant amount of time and resources. Any program that undertakes a project such as this needs to explore funding options, and the pilot study for feasibility provides information on potential barriers to implementation.

Conclusions

Nearly half of emergency medicine residency training programs lack board-certified toxicologists. Lack of access may lead to dissatisfaction with the quality of toxicology training. Web-based learning has potential to bridge the gaps, but needs further research into standardization and content of curriculum.

Acknowledgements

Thank you to Drs Jenna LeRoy, Travis Olives, and Sean Boley for their participation in the pilot program.

Disclosure statement

JL, KG, CH, SS report no conflicts of interest.

Funding

This study was funded by the Toxicology Trainee Research Grant from the American Academy of Clinical Toxicology. This study has not been previously presented or published.

ORCID

Katherine G. Katzung (http://orcid.org/0000-0003-0150-3761)

References

[1] Perina DG, Brunett CP, Caro DA, et al. The 2011 model of the clinical practice of emergency medicine. Acad Emerg Med. 2012;19:e19–e40.
[2] Caravati EM, Ling LJ. Toxicology education in emergency medicine residency programs. Am J Emerg Med. 1992;10:169–171.
[3] Hantsche CE, Mullins ME, Pledger DL, et al. Medical toxicology experience during emergency medicine residency. Acad Emerg Med. 2000;7:1170.
[4] Alruwaili N, Kazzi ZN, Morgan B. A descriptive cross sectional survey of medical toxicology rotations at US allopathic and osteopathic emergency medicine residency programs. Arch Med. 2016;8:1–15.
[5] Warner M, Trinidad JP, Bastian BA, et al. Drugs most frequently involved in drug overdose deaths: United States, 2010-2014. National Vital Statistics Reports. 2016; 65:1–15.
[6] Mazer-Amirshahi M, Sun C, Mullins P, et al. Trends in emergency department resource utilization for poisoning-related visits, 2003–2011. J Med Toxicol. 2016;12:248–254.
[7] Kuhn GJ, Shayne P, Coates WC, et al. Critical appraisal of emergency medicine educational research: the best publications of 2009: EM Education Research 2009. Acad Emerg Med. 2010;17:S16–S25.
[8] Burnette K, Ramundo M, Stevenson M, et al. Evaluation of a web-based asynchronous pediatric emergency medicine learning tool for residents and medical students. Acad Emerg Med. 2009;16: S46–S50.
[9] Frush K, Hohenhaus S, Luo X, et al. Evaluation of a Web-based education program on reducing medication dosing error: a multicenter, randomized controlled trial. Pediatr Emerg Care. 2006;22: 62–70.
[10] Roe D, Carley S, Sherratt C. Potential and limitations of e-learning in emergency medicine. Emerg Med J. 2010;27:100–104.
[11] Beauchamp GA, Perrone J. making surveys count: enhancing the rigor of survey-based research in medical toxicology. J Med Toxicol. 2016;12:329–331.