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ORIGINAL ARTICLE

The Global Educational Toxicology Toolkit (GETKIT): A 1-Day Course for Teaching Poisoning Essentials in Low- and Middle-Income Countries (LMIC): Course Development and Pilot Data Analysis

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Abstract

Introduction Worldwide an estimated one million deaths occur annually as a result of poisoning. Internationally there is a lack of toxicology training programs, especially in resource poor settings. We developed a one-day, interactive toxicology curriculum for healthcare practitioners in countries lacking clinical toxicology training and evaluated its feasibility and effectiveness for knowledge dissemination.

Methods GETKIT was developed with 3 sections: didactics, hands on toxicology case lab, and technology clinic. The investigators, who are medical toxicologists,created 23 didactic lectures and 42 workshop cases. All materials were peer reviewed by 5 senior medical toxicologists for content validity. Participants atpilot sites were given pre-course, post-course, and 3-month follow-up tests and surveys.

Results GETKIT was delivered internationally at 7 sites between November 2017 and April 2018. There were 186 total participants. One hundred and ten participants (59%) reported their hospital lacked a clinical toxicology service. The median post course score 12 (60%), IQR (6,14) was significantly higher compared to the pre-course score 9 (45%), IQR (6,11) ($p < 0.0001$). There was a significantly higher median 3-month post course score 13 (65%), IQR (8,14) vs. a median pre course score of 9 (45%), IQR (6,11) (p 0.0005). At 3-month follow up 86% of participants reported GETKIT had changed their clinical practice.

Conclusions An improvement in and retention of medical toxicology knowledge was demonstrated with the GETKIT course. It also conferred improvement in selfreportedpoisoning management practices in participants from low resource settings.

Keywords: Toxicology education · International toxicology · Global health

Introduction

Poisoning is a significant global public health problem. Worldwide, an estimated one million deaths occur annually as a result of acute poisonings, with a third of these exposures considered unintentional [1]. According to the World Health Organization (WHO) in 2012, an estimated 193,460 people died worldwide from unintentional poisoning. Of these deaths, 84% occurred in low- and middle-income countries [1]. The quality of medical care provided to poisoned patients

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varies greatly depending on geographical location and healthcare resources available to the medical providers. Resource-poor areas often suffer from a shortage of antidotes, equipment, and specialized clinical providers to optimally manage poisoned patients [2–4]. Additionally, the agents commonly ingested in resource-poor areas tend to be associated with more severe toxicity [2–4].

The development of medical toxicology as a specialty has served to advance the care of poisoned patients in multiple countries [5]. However, there remains a lack of clinical toxicology services and formal training programs in many countries around the world. One survey showed that only 13 countries had a recognized training program in medical toxicology for physicians, seven of which are recognized by formal certification after completion [6]. Remote access to poisoning management information via telephone, for both healthcare professionals and the public, is similarly lacking, especially in developing countries [7].

As a result of the limitations to access of poison control centers and clinical toxicology experts, it remains difficult for treating clinicians in developing countries to receive education in core concepts and emerging research in medical toxicology. Conferences and academic travel to broaden knowledge can be costly and poorly accessible to medical professionals [7]. Available educational offerings may not adequately test or prepare the participants for cases encountered in their local practice settings. Overcoming these barriers to medical toxicology education is essential to improving the management of poisoned patients worldwide.

Previous global educational projects, such as GETUP (Global Educational Toxicology Uniting Project), have been developed for toxicology education to health providers in low- and middle-income countries using online lectures and videoconferencing [8–11]. We hypothesized that the development and delivery of a 1-day interactive toxicology curriculum, the Global Educational Toxicology Toolkit (GETKIT), to healthcare practitioners in low- and middle-income countries that are lacking clinical toxicology training are both feasible and effective for knowledge dissemination.

Methods

Study setting and design

This was a prospective observational pilot study of medical professionals undertaking the GETKIT course from seven sites in four countries. These sites included Kathmandu, Nepal; Mexico City, Mexico; Puebla, Mexico; Moshi, Tanzania; Dar es Salaam, Tanzania; Calcutta, India; and Bhubaneswar, India. All of the training sites were metropolitan hospitals. None of the individual hospitals had known connections to a medical toxicology service or access to a public poison information center prior to the course being given. The sites were chosen based on a previous connection with one of the authors of the study. The course was delivered in person, by board-certified medical toxicologists at all sites. A mixed qualitative/quantitative approach to data collection and analysis was undertaken as described below. The GETKIT project was exempt for IRB approval as it was considered educational research that did not adversely impact the learners or participants.

Participants

Medical professionals including medical students, residents (referred to as registrars internationally), attending physicians (referred to as consultants internationally), and nurses participated in the course. There were 186 participants in total. Participants were recruited by the local contact at each site, and no specific inclusion or exclusion criteria were used to enroll medical professionals beyond their availability to participate in the full day course.

Course description

GETKIT was developed with 3 sections: lecture-based didactics, hands-on, case-based toxicology workshop, and technology clinic. The investigators, who were medical toxicologists, created 23 didactic lectures (Addendum 1) and 42 workshop cases (Addendum 2). The lecture and workshop case topics were based on the core content of medical toxicology with a focus on topics the authors viewed as key medical toxicology themes. Peer review for content validity of all teaching materials was done by 5 senior medical toxicologists, all of whom are Fellows of the American College of Medical Toxicology (FACMT). There were approximately 5 hours of didactics in the course. All sites were required to have the following didactic lectures: general management/toxidromes (45 minutes), decontamination/laboratory testing (45 minutes), pediatric toxicology (30 minutes), and antidotes (45 minutes), as these topics were viewed as the key introduction lectures to medical toxicology. The other didactic topics were chosen by the sites from the available topic list (Addendum 1). This allowed for the site to choose topics/exposures that were relevant to their region for the remaining 2 hours of the didactic session.

The "Tox-Lab" workshop was a hands-on case-based toxicology session, aimed at reinforcing the key learning points from the earlier didactic sessions. The cases included high-quality visual images, physical items, olfactory aids, animal and reptile models, electrocardiograms (ECGs), and radiographs that served as stimuli for a series of case prompts. A clinically relevant set of questions accompanied each station. Following individual completion of the workshop, there was a group discussion of all cases and key learning points. The "Tox-Lab" workshop was approximately 2 hours in length.

Some examples of the cases and didactic goals of the workshop have been previously presented and published by ACMT International Committee members [12–15].

The third part of the course was the technology clinic. The goal of this session was to provide participants with information about toxicology databases, web-based applications, podcasts, blogs, and other online resources that can further independent learning and online education in medical toxicology through high-quality resources. Many participants used their own laptops, tablets, or smartphones for this portion of the day; however, GETKIT materials also included 5 IPad™ devices for demonstration and use. The technology clinic session was approximately 1 hour in length.

Data collection and post-course follow-up

The primary outcome of this study was to assess the change in participants' scores from the pre- and post-course test. Secondary outcomes included 3-month post-course scores and changes in practice. Qualitative answers from feedback regarding toxicology at the sites and the course were also analyzed.

Participants at all sites were given pre-course, post-course, and 3-month follow-up surveys. A Likert scale was used for all 3 surveys, ranging from 1 (strongly disagree) to 5 (strongly agree) (Table 1). Data that was collected on the pre-course survey included level of medical training, occupation, availability of clinical toxicology services at the participant's home site, availability of a poison center, comfort level with managing poisoned patients, types and number of poisonings and envenomations seen by the individual, and resources used for toxicology education. The post-course survey collected information about whether the participant's expectations of the course were met, details about any enhancement of the individual's toxicology knowledge, and opinion about the value of hands-on Tox-Lab cases and technology clinic.

The 3-month post-course survey collected information on whether participants had used information learned in the course, if clinical management had been changed since the course, and use of resources from the technology clinic. All of the survey instruments are included in Addenda 3–5.

To measure knowledge transfer, all participants were given pre-course, post-course, and 3-month post-course tests consisting of 20 multiple choice questions (MCQs). The topics covered in these tests were related to the selected didactic topics given at that individual site; however, it was not the same test questions pre- and post-course. Test questions were created by the same authors who created or reviewed the specific topic didactic lecture materials.

Statistical analysis

All data were analyzed descriptively. Continuous variables were reported as median (interquartile range) as appropriate and were compared using the appropriate statistical test, e.g., the Mann-Whitney *U* test. The Wilcoxon signed-ranked test was used to compare paired non-parametric data. SPSS (V25, IBM, NY, USA) was used to perform the analysis. Final quiz results and feedback were given via web survey (Survey Monkey, 2018, San Francisco, CA, USA).

Results

GETKIT was delivered internationally at 7 sites between November 2017 and April 2018. There were 186 total participants. GETKIT was delivered in Kathmandu, Nepal ($n = 43$); Puebla, Mexico ($n = 3$); Mexico City, Mexico ($n = 20$); Dar es Salaam, Tanzania ($n = 13$); Kotokal, India ($n = 25$); and Bhubaneswar, India ($n = 19$). In addition, the full 1-day course was delivered in Moshi, Tanzania ($n = 62$) then the following day a second half-day modified course, requested by the site, was delivered with 49 participants.

The pre-course survey was completed by all 186 participants (Table 2). There was a wide array of participants who took the GETKIT course; 116 (63%) were residents, interns, or medical officers, 44 (24%) were nurses, 10 (5%) were attendings, eight (4%) were medical students, and eight (4%) were unknown. The specific types of attendings who attended were two pediatricians, one critical care, three general practitioners, three emergency medicine specialists, and one anesthesiologist.

One hundred and ten (59%) of the participants reported not having clinical toxicology services at their hospital. Thirteen (7%) participants were unsure if they had toxicology services at their site. The availability of a poison center at the site also varied, with 123 (66%) reporting they did not have a poison center at their site, 41 (22%) participants stating yes, and 22

Table 1 Likert scale for the 3 surveys.

Scoring	Response
1	Strongly disagree/very uncomfortable/never
2	Disagree/moderately uncomfortable/rarely
3	Maybe agree/comfortable/occasionally
4	Agree/moderately comfortable/frequently (once a week)
5	Strongly agree/very comfortable/very often (more than once a week)

Table 2 Pre-course survey responses.

Question	Median score (IQR) out of 5
Tox teaching is lacking at site.	4 (3,4)
It is difficult to connect to a Tox teaching center?	4 (3,4)
Poisonings are common issues in my practice.	4 (3,4)
Feel like can benefit from educational course on toxicology.	5 (4,5)
Current comfort level with caring for Tox patients	3 (2,4)
Confidence taking care of Tox patients	3 (3,4)

IQR interquartile range

(12%) of participants unsure if there was a poison center at their site. Poison center access was available by phone for 76 (41%) of participants. Poison center access by phone was not available for 94 (51%) of participants and was unknown for 16 (8%) of participants.

The most common resources or references used by participants for toxicology information were the Internet ($n = 107$), textbooks ($n = 51$), none ($n = 27$), online toxicology databases ($n = 2$), and colleagues ($n = 2$). The various sites reported a median consult rate of one (IQR 1,3) toxicology case per week and one (IQR 0,2) envenomation per week. The top 5 most common poisonings encountered were organophosphates ($n = 114$), acetaminophen ($n = 23$), kerosene ($n = 18$), snakebite ($n = 15$), and benzodiazepines ($n = 13$).

Based on pre-course surveys, participants overall felt that toxicology education was lacking at their sites, and there was difficulty in connecting to a toxicology teaching center. Participants also reported that they felt like they could benefit from an educational course on toxicology. The full pre-course survey results, along with numerical scores reflecting these sentiments, are in Table 2.

Post-course survey was completed by 144 participants (Table 3). Key responses included that the course enhanced the toxicology education at their site [4 out of 5 (IQR 4,5)] and participants' knowledge had been improved [4 out of 5 (IQR 4,5)]. The hands-on Tox-Lab improved understanding of didactic sessions, and the technology clinic was rated as helpful. The full post-course survey results are in Table 3.

The 3-month post-course survey was completed by 35 people (Table 4). Important responses included participants having used information from the GETKIT course in their medical practice [4 out of 5 (IQR 4,5)] and improved management of poisoned patients per self-report [4 out of 5 (IQR 4,5)]. Participants relied on resources from the technology clinic to enhance their knowledge of poison management, and 86% of respondents stated that their clinical practices had changed since taking the course. Examples of clinical practice changes included assessment of patients and recognition of toxidromes, improved management of specific poisonings (e.g., organophosphates), and enhanced knowledge about ventilator settings when managing severe salicylate poisoning. The full 3-month post-course survey results are in Table 4.

Testing results

There was significant improvement in median test scores, as shown in Table 5 [pre-course median score 9 (45%) out of 20, IQR (6,11)] vs post-course median score [12 (60%), IQR (6,14); $p < 0.0001$]. The median 3-month post-course score was also significantly higher than the pre-course tests scores [13 (65%), IQR (8,14), $p = 0.0005$].

Discussion

Internationally, poisoned patients will receive medical care from a wide variety of healthcare providers. However, very

Table 3 Post-course survey responses.

Questions	Median score (IQR) out of 5
Expectations of the course have been met.	4 (4,5)
Course enhanced Tox education at site.	4 (4,5)
Professional practice would benefit from regular Tox center contact.	4 (4,5)
Knowledge has been improved.	4 (4,5)
Lectures were presented at appropriate knowledge level.	3 (3,4)
Tox-Lab improved understanding of didactics.	4 (4,5)
Tech clinic was helpful.	4 (4,5)
Site had technical errors with course presentation.	2 (2,3)

IQR interquartile range

Table 4 3-month post-course survey responses.

Questions	Median (IQR) out of 5
I have used information from GETKIT course in medical practice.	4 (4,5)
Course improved my management of poisoned patients.	4 (4,5)
Completing the course made me want to get further education on toxicology.	5 (4,5)
Have used resources from tech clinic to improve or more management.	4 (1,4)
How often do you use resources from tech clinic?	4 (3,4)
I feel like I have retained information from the course.	4 (3,4)
Has your clinical practice changed since taking the course (yes)?	30 (86%)

IQR interquartile range

few of these medical providers will have had formal medical education in medical toxicology. This is especially true in resource-poor countries. The goal of this project was to attempt to create a feasible and effective training tool to address this gap. GETKIT aimed to teach the basic pathophysiology of toxins and the general approach to poisoning and overdose management, along with common patterns of poisoning illnesses through case-based learning.

As part of this project, the GETKIT educational course and several survey instruments were successfully administered at 7 international locations over a 6-month period. Our site survey instruments confirmed from various sites worldwide that medical toxicology training is lacking internationally, especially in low- to middle-income countries. The GETKIT course as described here provides one educational model to meet this need, using a combination of lecture-based and case-based components. Additionally, during the technology clinic portion of the course, we were able to share the best practice tips about independent asynchronous learning on high-quality websites, toxicology databases, and other resources. These components of the course were positively received, and participants demonstrated knowledge transfer and retention based on testing done before and after the course delivery. After taking the GETKIT course, almost all participants self-reported improvement of their medical toxicology knowledge and improved patient care in their clinical practice.

The results of this pilot project suggest that a portable, multimodal 1-day course dedicated to the essentials of medical toxicology is feasible and can enhance knowledge transfer and care of poisonings across a range of international practice settings. The in-person delivery method may complement online methods which have demonstrated similar achievements, and both educational models deserve to be studied further. Working with medical educators to develop improved methods of testing could identify which specific content topics are absorbed, retained, and implemented in clinical practice. A related question warranting further study is the impact of a 1-day course on clinical practice. We believe that the introduction of various asynchronous learning tools did help participants further their learning and perhaps explain the higher 3-month test scores compared with the immediate post-course test score.

In undertaking this educational project, we encountered several unique difficulties. At the majority of the sites, the course was taught in English even thought this is not the native language of the host sites. In Puebla and Mexico City, Mexico, the course was taught in Spanish by a Spanish-speaking medical toxicologist. It is thus possible that some of the content was not properly comprehended by the participants because of language or interpretation barriers.

Also, the course was taught at the hospital during times when clinical duties prevented some participants from taking the full course. This observation is supported by the decline of

Table 5 Median scores per site.

Site	Median pre-course score (IQR) out of 20	Median post-course score (IQR) out of 20	*p* value*
Bhubaneswar	10 (9,12)	18 (15,19)	0.003
Dar es Salaam	11 (10,13)	11 (9,13)	1.0
Kathmandu	11 (9,13)	13 (12,16)	< 0.0001
Kolkata	9 (9,11)	15 (13,16)	0.002
Mexico City	10 (7,13)	14 (12,16)	0.04
Moshi day 1	9 (7,10)	11 (7,14)	0.03
Moshi day 2	5 (3,6)	5 (4,7)	1.0
Puebla	1.5 (0,3)	6 (6,7)	0.002

IQR interquartile range

*Wilcoxon matched-pairs signed-rank test with Bonferroni correction

number of people who completed the post-course survey compared with the pre-course survey. This might be because the participants had to return to clinical duties and other commitments. Technical difficulties (email addresses bouncing back/undeliverable) were also encountered when we tried to send the 3-month follow-up emails. These factors adversely affected the total number of responses that we received and may have impacted the quality of the data collected.

Interestingly, to the authors' knowledge when setting up the course, none of the sites had access to medical toxicology services or poison centers. However, as noted in the results section 34% of participants reported having medical toxicology services at their site, 22% of participants reported having access to a poison center at their site, and 41% had access via telephone. On follow-up, the authors verified with the local site coordinators and there is no formal poison center located at any of the sites. There are also no formally trained medical toxicologists at any of the sites. Likely this demonstrates a language barrier issue or misinterpretation of the question in regard to what a poison center is and if there are physicians at the hospital who take care of toxicology patients versus understanding the difference of a formally trained medical toxicologist.

Other limitations of the study included the Hawthorne effect: the novelty and pressure of testing may cause the participants to perform differently (*often better*) than they otherwise would in formative assessments of the intervention. It is possible there was a participant self-selection bias in that the more motivated or least clinically occupied healthcare professionals enrolled in the course and completed the 3-month follow-up.

It is also difficult to make large generalizations when there is substantial variety in participant number and topics covered at the various sites. Also, psychometric testing was performed with the course test content.

The clinical impact of this study is difficult to ascertain, as our study outcomes did not directly address the larger question about whether and how the project would improve clinical metrics related to patient care or clinical competence in poisoning management. An approximate measure of these measures is the self-reported improvement in clinical practice on both post-course surveys. More rigorous assessment of these parameters may be the focus of future work in this area.

Future steps for this endeavor including planning for sustainability and expansion of the GETKIT course and establishing partnerships between ACMT and international emergency medicine, critical care, other toxicology organizations, and public health organizations to offer this course. We envision that, as this educational paradigm evolves, GETKIT can continue to be transported, tailored, and delivered to a variety of healthcare settings. A certificate of completion at the end of the course would also solidify commitments and reinforce the importance of this body of basic toxicology knowledge which is critical to under-resourced settings worldwide. The development of a course manual and translation into other languages would also help make this course more useful to a larger number of clinicians worldwide. Finally, establishing a "train the trainer" model for this course could also help continue the propagation of this course and deserves further attention.

Conclusions

The GETKIT 1-day course is a highly portable and feasible model for delivery of core medical toxicology content in low-resource settings. This course has the ability to increase emergency medicine and critical care clinicians' self-reported knowledge in toxicology and could potentially improve care of poisoned patients across a range of international practice settings.

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Compliance with Ethical Standards

Conflict of Interest None.

References

1. The Global burden of disease report 2014, WHO website, International Programme on Chemical Safety: Poisoning Prevention and Management, www.who.int/ipcs/poisons/en. Date last accessed 9th Jan 2017.
2. Howland MA, Weisman R, Sauter D, et al. Nonavailability of poison antidotes. N Engl J Med. 1986;314:927–8.
3. Wickramasinghe K, Steele P, Dawson A, Dharmaratne D, Gunawardena A, Senarathna L, et al. Cost to government healthcare services of treating acute self-poisonings in a rural district in Sri Lanka. Bull World Health Organ. 2009;87(3):180–5.
4. Nadeem UK, Fayyaz J, Khan UR, Feroze A. Importance of clinical toxicology teaching and its impact in improving knowledge: sharing experience from a workshop. JPMA. 2013;63(11):1379–81.
5. Curry SC, Brooks DE, Skolinik AB, Gerkin RD, Glenn S. Effect of a medical toxicology admitting service on length of stay, cost, and mortality among inpatients discharged with poisoning-related diagnoses. J Med Toxicol. 2015;11(1):65–72.
6. Wood DM, Wax P, Nelson L, Vohra R, Dargan PI. What do other countries want from the ACMT? Results of the American College of Medical Toxicology International Committee Survey. Clin Toxicol (Phila). 2011;49:603.
7. Vohra R, Gosselin S, Wong A, Kopec K, Gunja N. ACMT International Member Summer Survey 2013. J Med Toxicol. 2014; 10(1):97.
8. Wong A, Vohra R, Ruha AM, Koutsogiannis Z, Graeme K, Dargan PI, et al. The Global Educational Toxicology Uniting Project (GETUP): an analysis of the first year of a novel toxicology education project. J Med Toxicol. 2015;11(3):295–300.
9. Thompson TM. Medical toxicology education in a world of limited resources. J Med Toxicol. 2015;11(3):281–2.
10. Thapa AS. Is GETUP Helpful and Relevant in a Resource Poor Setting Like Nepal? J Med Toxicol. 2016; 12(2):216.
11. Wong A, Vohra R, Dawson AH, Stolbach A. Impact of online toxicology training on health professionals: the Global

Educational Toxicology Uniting Project (GETUP). ClinTox. 2017;55(9):981–5.
12. Vohra, Gunja, Kopec. ToxiLab Workshop: ACMT Symposium for the APAMT 11th Congress Annual Congress, Hong Kong, December 2012.
13. Vohra R, Spano S. Circus Venomous: an interactive tool for toxinology education. Toxicon. 2013;69:126–30.
14. Vohra R, Tomaszewski. ACEP Workshop: Tox Lab. ACEP Annual Scientific Assembly, 2010, 2011, and 2012.
15. Vohra, Gunja, Kazzi Z. ACMT Workshop: Tox Bazaar. 8th Mediterranean Emergency Medicine Congress, Rome 2015.