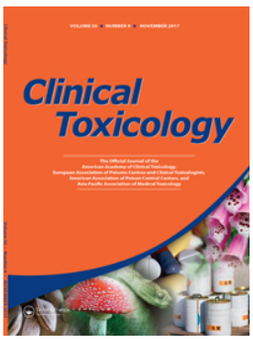

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CLINICAL RESEARCH

Impact of online toxicology training on health professionals: the Global Educational Toxicology Uniting Project (GETUP)

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ABSTRACT

Objective: The Global Educational Toxicology Uniting Project (GETUP), supported by the American College of Medical Toxicology, links countries with and without toxicology services *via* distance education with the aim to improve education. Due to the lack of toxicology services in some countries there is a knowledge gap in the management of poisonings. We describe our experience with the worldwide delivery of an online introductory toxicology curriculum to emergency doctors and other health professionals treating poisoned patients.

Methods: We delivered a 15-module introductory Internet-based toxicology curriculum to emergency doctors and health professionals, conducted from August to December 2016. This Internet-based curriculum was adapted from one used to teach emergency residents toxicology in the United States. Modules covered themes such as pharmaceutical ($n = 8$), toxidromes ($n = 2$) and agrochemicals ($n = 5$) poisoning. Participants completed pre-test and post-test multiple choice questions (MCQs) before and after completing the online module, respectively, throughout the course. We collected information on participant demographics, education and training, and perception of relevance of the curriculum. Participants gave feedback on the course and how it affected their practice.

Results: One hundred and thirty-six health professionals from 33 countries participated in the course: 98 emergency doctors/medical officers, 25 physicians, eight pharmacists/poisons information specialists, two toxicologists, two medical students and one nurse. Median age of participants was 34 years. Median number of years postgraduate was seven. Ninety (65%) had access to either a poisons information centre over the phone or toxicologist and 48 (35%) did not. All participants expected the course to help improve their knowledge. Overall median pre-module MCQ scores were 56% (95%CI: 38, 75%) compared to post-module MCQ scores median 89% (95% CI: 67, 100%) ($p < .0001$).

Conclusions: Our participants demonstrated an increase in medical knowledge based on performance on MCQs. An online toxicology curriculum is an effective way to deliver education to health professionals treating poisoned patients and can help to bridge the knowledge gap and change practice in developed and developing countries.

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Internet; teaching; course; curriculum; program

Introduction

More than one million deaths around the world occur annually because of suicide with a significant amount of these attributable to deliberate self-poisoning [1]. In addition to the lack of antidotes and equipment, resource poor areas may also lack specialist personnel and training to manage the poisoned patient [2].

Despite the need, there is a lack of formal toxicology training programs around the world [3]. Countries may also lack poisons information services over the phone, access to individuals trained in medical toxicology [4] or trained staff to care for acutely ill patients [5].

The Global Educational Toxicology Uniting Project (GETUP), supported by the American College of Medical Toxicology (ACMT), was established to help overcome these barriers (www.acmt.net/GETUP) [4]. The aim of GETUP was to help identify centres without access to poisons information and toxicology services and link them to those that did have access or resources. This was initially undertaken through case-based discussion *via* video conferencing. However, it was also apparent that there was a knowledge gap in the basics of poisoning pathophysiology, risk assessment as well as management.

An asynchronous online curriculum may be an ideal way to reach health professionals managing poisoned patients who do not have access to live toxicology teaching. Online curricula have been used successfully to teach medical, surgical and toxicology skills [6–8]. Previously, a pilot version of the course was demonstrated to increase knowledge amongst Fijian doctors [9].

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Our aim was to investigate whether an online toxicology course could improve the knowledge of health professionals treating poisoned patients in developing and developed countries worldwide.

Methods

We delivered an introductory Internet-based toxicology curriculum to health professionals who managed poisoned patients from 33 countries. The 15-module introductory toxicology curriculum was delivered from August to December 2016. Invitation and advertisement to participate in the course were disseminated *via* ACMT, American Academy of Clinical Toxicology (AACT), European Association of Poisons Centers and Clinical Toxicologists (EAPCCT), Asia Pacific Association of Medical Toxicology (APAMT), International Interest Groups of the American College of Emergency Physicians (ACEP) and the Australasian College of Emergency Medicine (ACEM), Medecins Sans Frontieres (MSF) and the World Health Organization (WHO).

The Internet-based toxicology curriculum was adapted from a US-based online course (Physician Education and Assessment Center, https://emcc.peaconline.org, Johns Hopkins University, Baltimore, USA). The curriculum was written by medical toxicologists and the pre- and post-module questions were written in consultation with an expert in educational assessment. Post-module questions have been validated in a previous study [10]. The curriculum was supplemented with regionally relevant topics (organophosphate and paraquat) adapted from Wikitox (www.wikitox.org), an online toxicology web resource. Multiple choice questions were created for these additional modules. Modules covered themes such as pharmaceutical ($n = 8$), toxidromes ($n = 2$) and agro/chemicals ($n = 5$) poisoning.

Health professionals participated in a set of pre-module and post-module single best answer multiple choice questions (MCQs) before and after completing each online case-based module. There were a total of 80 pre- and 80 post-module MCQs. Each module was case based and structured to guide participants through the categories of risk assessment, investigations and management of the particular poison. Reading material were summarized for these different categories and referenced to the literature. No pre-reading prior to the course was required. A discussion forum was also available to allow participants to ask questions about the case or in relation to the module topic.

One-month post-release of the last module, a final quiz was released to participants to test knowledge retention. The quiz contained 30 MCQs covering all modules. In addition, course participants completed a feedback survey including questions on relevance to current practice, how the course had changed their clinical practice to date and suggestions for course improvement. All 15 modules were evaluated on a five-point scale from poor (1) to excellent (5).

The primary outcome was to determine the difference in MCQ score pre- and post-module for each participant. Secondary outcomes included final quiz scores, number of participants who thought the course had changed their practice at 1 month post the course and rating of modules.

Information was collected on participant demographics (further analysed as developing economies and advanced economies according to the International Monetary Fund and United Nations Development Programme [11]), prior education and training, access to toxicology resources and expectation of course at time of registration. Final quiz results and final feedback were given *via* web survey (Survey Monkey® 2016, San Francisco, CA).

All course participants gave individual consent prior to participating in the course to allow publication of their results. Approval to analyze and store the de-identified information were given by the Austin Health Research Ethics Committee.

All data were analyzed descriptively. The Wilcoxon signed-rank test was used to compare paired non-parametric data. SPSS (V23, IBM®, New York, NY) was used to perform the analysis.

Results

Out of the 198 health professionals who showed initial interest, 136 from 33 different countries participated in the course (Figure 1). The median age of participants was

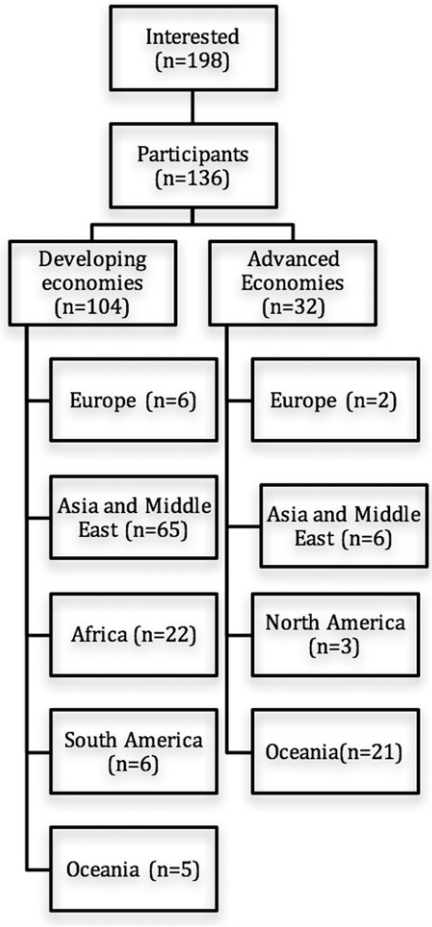

Figure 1. Classification of participants by economy status and region. Based on the United Nations Development Programme and International Monetary Fund classification [11].

Table 1. Course participant demographics.

Demographics of participants	$n = 136$
Median age (years) (IQR)	34 (29, 40)
Sex	Female 63 (46%), Male 73 (54%)
Median years postgraduate (IQR)	7 (3, 12)
Occupation (overall)	98 (72%) emergency doctors/medical officers 25 (18%) specialty physicians 8 (6%) pharmacists/poisons information specialists 2 toxicologists (1.5%) 2 medical students (1.5%) 1 nurse (1%)
Occupation (specialists)	17 (17%) of the 98 emergency doctors/medical officers had finished their training The other 25 physicians: 7 internal medicine (28%) physicians 4 intensivists (16%) 4 general practitioners (16%) 3 forensic toxicologists (12%) 2 psychiatrists (8%) 2 chemical pathologists (8%) 1 occupational medicine physician (4%) 1 paediatrician (4%) 1 surgeon (4%)
Currently studying degree	34 (25%)
Access to poisons information centre	90 (65%)
No access to poisons information centre	48 (35%) Of these: 28 (58%) had no resources 7 (15%) consulted senior colleagues 6 (13%) searched the Internet for information 5 (10%) used online poisons databases 2 (4%) used textbooks

34 (IQR: 29–40) years old (Table 1). Sixty-three were female (46%) and seventy-three were male (54%). Median years postgraduate initial degree was 7 years (IQR: 3.12).

Ninety (65%) participants had access to either a poisons information centre over the phone or toxicologist and 48 (35%) did not. Of the 48 who did not have access to a poisons information centre, 28 (58%) had no resources, seven (15%) consulted senior colleagues, six (13%) searched the Internet for information, five (10%) used online poisons databases and two (4%) used textbooks. All participants have been involved with or treated poisoned patients and expected the course to help to improve their knowledge.

Overall, median pre-module MCQ scores improved from 56% (38, 75%) compared to post-module MCQ scores 89% (67, 100%) ($p < .0001$) (Figure 2). There was improvement in all module median post-test results (Table 2), except the organophosphate module (pre- and post-median score 100%).

Median pre-module MCQ scores from developing economy countries improved from 52% (35, 70%) compared to post-module MCQ scores 86% (63, 100%) ($p < .0001$). Median pre-module MCQ scores from advanced economy countries improved from 59% (40, 78%) to 90% (68, 100%) ($p < .0001$). There was an overall improvement in the median pre-module MCQ score compared to the final quiz score of 86% (IQR: 76, 92%) ($p < .0001$).

One hundred and one health participants (74%) completed the post course feedback survey. Overall the course

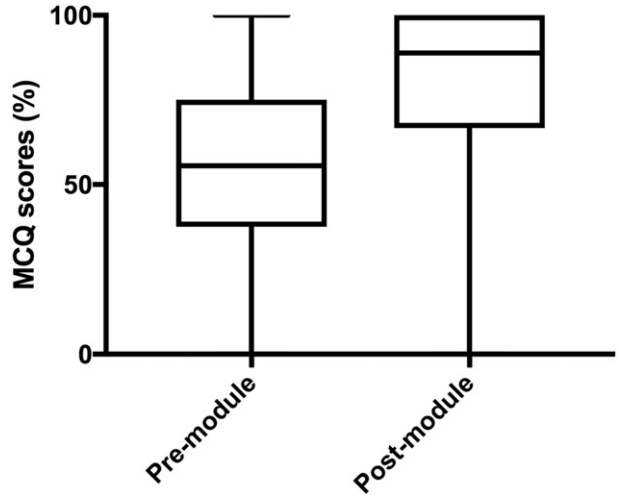

Figure 2. Pre- and post-module multiple choice question (MCQ) scores for entire study group.

Table 2. Group pre- and post-module median MCQ scores.

Modules	Pre-module median scores (IQR)	Post-module median scores (IQR)	Statistical difference (p)
Toxidromes	55 (44, 67)	89 (55, 100)	<.001
Approach to coma	55 (44, 78)	100 (100, 100)	<.001
Organophosphates	100 (67, 100)	100 (67, 100)	.378
Acetaminophen/paracetamol	60 (40, 80)	80 (50, 90)	<.001
Antidepressants	57 (43, 71)	86 (72, 100)	<.001
Antidiabetic medications	50 (42, 67)	100 (100, 100)	<.001
Carbon monoxide and methaemoglobinaemia	50 (38, 63)	75 (63, 88)	<.001
Digoxin	40 (40, 60)	80 (80, 90)	<.001
Lithium	50 (25, 75)	75 (75, 100)	<.001
Salicylate	50 (25, 75)	75 (75, 100)	<.001
Sedative-hypnotic	50 (50, 75)	75 (75, 100)	<.001
Sympathomimetic	33 (33, 50)	100 (83, 100)	<.001
Toxic alcohols	55 (45, 72)	91 (82, 100)	<.001
Caustic Ingestion	38 (31, 56)	63 (50, 88)	<.001
Paraquat poisoning	67 (67, 100)	100 (67, 100)	<.001

was rated excellent (45%), very good (50%) and good (5%). All 15 modules were deemed very relevant to their practice. Each module was rated on a five-point scale. Of the 1515 ratings, modules were rated good ($n = 268$, 18%), very good ($n = 883$, 58%) and excellent ($n = 364$, 24%) (Table 3). No modules were rated poor or very poor. Ninety-seven (96%) responders would recommend the course to other colleagues and four (4%) stated "maybe". Some suggestions for improvements to the course included more pesticide poisoning module coverage for South East Asian countries and requests for ongoing references.

At the time of survey, one month post-cessation of the course, 66 (65%) of the responders had thought the course had changed their clinical practice so far and 35 (35%) did not. Examples of changes in practice included giving structured approaches to evaluation and management of comatose patients with overdose, improving assessment for toxidromes, correct use of antidotes such as naloxone and acetylcysteine, increased knowledge of specific management of poisonings (e.g., organophosphates) and acknowledgement of importance of practising evidence-based medicine.

Table 3. Feedback survey – module ratings by participants and % per-module.

Modules	Very Poor	Poor	Good	Very Good	Excellent	Total
Toxidromes	0	0	20 (20%)	51 (50%)	30 (30%)	101
Approach to coma	0	0	21 (21%)	53 (52%)	27 (27%)	101
Organophosphates	0	0	17 (17%)	61 (60%)	23 (23%)	101
Acetaminophen/Paracetamol	0	0	19 (19%)	56 (55%)	26 (26%)	101
Antidepressants	0	0	21 (21%)	57 (56%)	23 (23%)	101
Antidiabetic medications	0	0	18 (18%)	57 (56%)	26 (26%)	101
Carbon Monoxide and Methaemoglobinaemia	0	0	19 (19%)	65 (64%)	17 (17%)	101
Digoxin	0	0	11 (11%)	68 (67%)	22 (22%)	101
Lithium	0	0	18 (18%)	62 (61%)	21 (21%)	101
Salicylate	0	0	17 (17%)	63 (62%)	21 (21%)	101
Sedative-hypnotic	0	0	15 (15%)	59 (58%)	27 (27%)	101
Sympathomimetic	0	0	18 (18%)	60 (59%)	23 (23%)	101
Toxic alcohols	0	0	12 (12%)	62 (61%)	27 (27%)	101
Caustic Ingestion	0	0	22 (22%)	54 (53%)	25 (25%)	101
Paraquat poisoning	0	0	20 (20%)	55 (54%)	26 (26%)	101

Discussion

A variety of health professionals will manage poisoned patients. Unfortunately, many poisoned patients do not receive care from physicians with specialized training in the management of poisoning. Compounding this issue is smaller doctor to patient ratios in countries without poisons information or toxicology services. For example, the World Health Organisation estimates there are approximately 0.2 doctors per 1000 population in developing countries (such as Cambodia and Nepal) without toxicology services. This compares to 2.4 doctors per 1000 population in the US and 2.8 doctors per 1000 population in the UK, both countries having established medical toxicology training pathways and poisons information services [12].

Although poisons centres have continuously shown that they provide a service to the public and health professionals in providing poisons information [13], a large proportion of participants in our study had no access to a poisons information centre. A significant number of participants signaled they had no resources to advise management of poisoned patients. Clinicians without resources or training may use the Internet and consultation of senior colleagues, as substitution for formal training.

We attempted to bridge this gap by offering an introductory toxicology curriculum. This work adds to prior investigation that shows an Internet-based course toxicology course can improve medical knowledge [10]. We observed significant improvement in pre-module MCQs compared with post-module MCQs throughout all participants. This suggests a need for such a course, regardless of the economic status of the participants' country of origin. In addition, there was a significant proportion of participants who had finished specialist medical training and showed improvement in knowledge. However, improvement was not consistent across modules. The median organophosphate module test results were similar pre- and post-module. This lack in improvement may be attributable to prior participant familiarity with organophosphate poisoning, as this is a common cause of severe worldwide poisoning [1,14]. In contrast, scores in modules related to pharmaceutical toxicity, rising in frequency throughout the world [15], showed improvement from pre- to post-test.

In addition, the one-month post-test conducted showed significantly higher median scores compared to pre-module MCQ scores. This improvement suggests that learners retained knowledge from the course. In addition, a majority of participants provided examples of how the course had changed their current medical practice to that point. We do not know how or if this improvement in medical knowledge will translate to better medical care. Future investigation should determine whether Internet-based toxicology training improves patient outcomes.

This is the largest investigation of worldwide delivery of an Internet-based clinical toxicology course to health professionals. There are several advantages to Internet-based curricula. Internet training programs are easily disseminated and updated and facilitate testing of learners. Learners also find Internet-based training to be accessible and convenient [16,17]. Poor Internet access may have limited participants, but did not seem an issue to those who undertook the course. Internet training may be one part of the solution to lack of international toxicology training, in addition to development of toxicology and emergency medicine residency training programs for example.

The principle limitation of Internet-based curricula is the lack of face-to-face discussion. The use of online discussion forums and other video conferencing may help to offset this limitation. As with any training modality, the amount of content we can deliver is limited by learner time. Adding more topics or depth might benefit learners but would necessitate a longer course and may decrease participation. Similarly, retention of knowledge tested after longer time periods may be more useful. Despite these limitations, our learners demonstrated an increase in medical knowledge and this increase was preserved one month after cessation, or four months after initiation of the course. Conclusions of this research is limited to the participants involved and all identified that a toxicology course could help to improve their knowledge at registration. Some of the participants may have had a higher degree of toxicology knowledge prior to the course if they had associations with a toxicology college. Despite this bias, knowledge improvement was universal across all participants suggesting further need regardless of prior associations. Future research should seek to validate these results in similar and larger cohorts.

Conclusions

Our participants demonstrated an increase in medical knowledge based on performance on MCQs. An online toxicology curriculum is an effective way to deliver education to health professionals treating poisoned patients and can help to bridge the knowledge gap and change practice in developed and developing countries. Future investigation should determine whether Internet-based toxicology training improves patient outcomes.

Disclosure statement

The authors declare no conflicts of interest.

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