A Study on Knowledge of Antidotes and Antidotes Availability among Emergency and Medical Doctors in Central Region Malaysia Public Hospitals

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Abstract

Introduction: Poisoning is a significant global health concern, and its incidence was increasing in many parts of the world. Ensuring that doctors are well equipped with the necessary poisoning and antidotes knowledge is paramount to saving lives and minimising long-term health consequences.
Objective: This study aimed to evaluate the knowledge regarding antidotes and antidotes availability among emergency and medical doctors in three central region Malaysia hospitals, and to identify the preferred methods of acquiring antidote-related knowledge.
Methods: This was a cross-sectional study conducted from January to December 2019, using a validated questionnaire designed by clinical toxicologists and pharmacists. The study population in this study were medical and emergency departments' doctors from three public hospitals in the central region of Malaysia.
Results: Two hundred and thirty six doctors responded to the survey (response rate 84.3%). Emergency doctors had significantly better knowledge than medical doctors on antidotes availability (median score 26 vs 20, $p<0.001$) but there was no difference in terms of antidotes knowledge (median score 9 vs 10, $p=0.891$). Specialists and doctors with more working experience had significantly better scores in both knowledge of antidotes and antidotes availability ($p<0.05$). Most doctors prefer to acquire antidotes-related knowledge through continuous medical education, mobile apps, guidelines and literature.
Conclusion: There is a need to improve the knowledge of antidotes and antidote availability among the emergency and internal medicine doctors, especially among the junior practitioners. More training and teaching sessions in the management of toxicology cases are warranted.
Keywords: Antidote, knowledge, availability, emergency, medical doctors

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Introduction

Intentional and unintentional poisoning is a significant global health issue. In recent years, there is an alarming spike in poisoning cases. The United States (US) poisoning data has reported that poisoning fatalities have exceeded motor vehicles fatalities since 2008 (1). In 2017, poisoning was one of the ten principal causes of hospitalisation (7.2%) and deaths (1.56%) in Malaysian public hospitals (2). Non-opioid analgesics and antipyretics were found to be the most common poisoning agents involved in poisoning admissions locally. On the other hand, chemical agents were responsible for three-quarters of the total deaths in poisoning cases reported in Malaysia. Pesticides are chemical agents that are highly popular in intentional poisoning, hence, the Malaysian authorities have banned all paraquat-containing products as an initiative to decrease the mortality due to pesticides (3).

Despite the high prevalence of poisoning globally, the lack of availability of essential antidotes in healthcare facilities remains a worldwide problem (4). It was found that inadequate stocking of antidotes had occurred despite the existence of published national guidance for stocking of antidotes (4). In Malaysia, the availability and adequate stocking of antidotes is crucial as poisoning cases are becoming more prevalent. Nevertheless, the lack of availability of antidotes in Malaysia's hospital has been reported (5). Maintaining a sufficient antidote stock is a major concern as the timely-use of appropriate antidotes may

improve morbidity and mortality, reduce the requirement of medical interventions, reduce length of hospitalisation and can potentially be life-saving (4,6). World Health Organization (WHO) Guidelines for establishing a poison centre recommended that all antidotes will be needed within 30 minutes, therefore they should be stocked up adequately at all healthcare facilities (7).

Besides the availability of antidotes, appropriate knowledge of the antidotes is equally important for the successful management of poisoning cases (8). As timely use of antidotes and appropriate treatment are vital, healthcare professionals must be equipped with sufficient knowledge and adequate training in treating poisoned patients to avoid treatment delay and error (5,8). Moreover, hospitals should stock an adequate number and variety of antidotes, and healthcare providers are expected to be well aware of the availability of antidotes in the facility. To the authors' knowledge, there were no published studies on the antidote knowledge and its availability among doctors in central Malaysia. Hence, this study aimed to evaluate the knowledge of antidotes and the knowledge of antidote availability among emergency and internal medicine doctors in hospitals. The findings of this study could potentially help to improve the management of poisoning cases in Malaysia. Besides that, this study also aimed to investigate the preferred method of acquiring knowledge of antidotes among emergency and internal medicine doctors.

Methods

This was a cross-sectional study conducted using a self-administered questionnaire designed by clinical toxicologists and pharmacists to study the knowledge of antidotes and knowledge of availability of antidotes among emergency and internal medicine doctors in three public hospitals in the central region of Malaysia, which are Hospital Tengku Ampuan Rahimah (HTAR), Hospital Shah Alam and Hospital Banting. This study was conducted from January 2019 to December 2019. Houseman Officers (HO), Medical Officers (MO), and specialists in the emergency department (ED) and internal medicine department were included in the study. MO or HO with less than one month working experience in both departments were excluded.

Using the formula for estimating a mean without finite population correction with a level of confidence of 95%, mean score knowledge standard deviation of 5.42 and precision of 0.5, an estimation of 231 sample size was calculated for this study (8,9). The questionnaire was divided into three sections which were antidote knowledge, knowledge of antidote availability, and preferred method in acquiring knowledge. The first part on antidote knowledge consisted of 22 questions in which the respondents were required to name the antidote for the type of poisoning cases listed. In the second part of questionnaire, 50 types of antidotes were listed and the respondents had to identify if they were available in their facility by choosing "Yes" for available and "No" for not available. Each correct answer carried one score and each incorrect answer carried zero score. The maximum score that can be achieved for both sections was 72. If the participant was able to get half of the total score which was 36, it was deemed to be of average score. A score of more than 36 was above average whilst a score less than 36 was below average. The final part of the questionnaire on preferred method of acquiring knowledge consisted of eight methods e.g. literature search, continuous medical education, internet search, consulting clinical toxicologists, etc. The respondents were asked to choose their preferred method and they could pick more than one option.

The questionnaire was constructed in English language only and was validated through face validation by a panel of experts consisting of two clinical toxicologists and two senior pharmacists. Ten respondents were randomly chosen to examine the feasibility and suitability of the questionnaire (10). The data from pilot study were not included in the final data analysis. HO, MO, specialists and consultants in ED and internal medicine department in the three public hospitals were randomly selected and recruited into the study. By ratio method, the proportion of number of respondents recruited was divided based on the number of beds and staffs in the hospitals and the respective departments. This self-administered questionnaire required an estimation of fifteen to twenty minutes to be completed. The respondents were required to fill and sign a consent form before proceeding to answer it.

The data were analysed using Statistical Package for Social Sciences Software (SPSS) version 23.0. The data was presented in descriptive analysis. Mann-Whitney-Wilcoxon test and Kruskal-Wallis were used to study the association between the variables and outcome of interest (scores of antidote knowledge and antidote availability knowledge). Level of significance was set as less than 0.05. The results were also analysed based on the difficulty level of managing poisoning cases in section 1 questionnaire. The questions were categorised into three difficulty levels, namely simple, average and difficult, by a clinical toxicologist. Simple cases refer to cases where doctors were more familiar with the conditions and the antidotes were frequently used. Difficult cases, on the other hand, involve scenarios that doctors rarely

encounter and may not be familiar with the available antidotes that are indicated for those poisoning cases. In terms of the scoring system, each poisoning case represents one score. The maximum score for each level was calculated cumulatively. For example, simple poisoning cases have a score of five, average cases have a cumulative score of 15, and difficult cases have a cumulative score of 22. The list was shown in Table 1.

Table 1: Difficulty level of managing poisoning cases

Difficulty level	Poisoning Cases
Simple	Paracetamol, Organophosphate, Benzodiazepine, Opioids, Warfarin
Average	Toxic Alcohol, Heavy Metal, Iron, Digoxin, Cyanide, Dabigatran, Beta-Blocker, Heparin, Calcium Channel Blocker, Sodium Channel Blockers
Difficult	Hydrofluoric Acid, Methotrexate, Isoniazid, Valproic Acid, Sulphonylurea, Cocaine Induced Hypertension, Thallium

This study was conducted in compliance with ethical principles outlined in the Declaration of Helsinki and Malaysian Good Clinical Practice Guideline. Ethics approval was obtained from the Ministry of Health Medical Research and Ethics Committee (MREC) and the study was registered in the National Medical Research Register with identification number NMRR-19-959-45876.

Results

A total of 280 questionnaires were distributed and 236 (84.3%) were returned. The demographic data of the respondents were shown in Table 2.

Table 2. Demographic data of respondents (n=236)

Characteristics	n (%)	mean (SD)
Gender		
Male	86 (36.4)	
Female	150 (63.6)	
Age (years)		29.8 (4.1)
Hospital type		
Tertiary	213 (90.3)	
Non-tertiary	23 (9.7%)	
Specialty		
Emergency	121 (51.5)	
Internal medicine	115 (48.5)	
Years of working experience		
<3 years	146 (62.0)	
3-5 years	60 (25.7)	
5-10 years	17 (7.2)	
>10 years	13 (5.1)	
Rank		
Specialist	40 (16.9)	
Medical officer	95 (40.5)	
House officer	101 (42.6)	

Abbreviation: SD = Standard deviation

The overall median score for antidote knowledge was nine. Tertiary and non-tertiary hospitals, ED and internal medicine doctors performed equally in their knowledge score on antidotes. Among doctors of different ranking, specialists performed better, followed by MO and HO. This corresponded with the years of working experience whereby those with more years of working experience scored better as shown in Table 3.

Table 3. Respondents and their corresponding scores on antidote knowledge

Characteristics	Median score (IQR) [c]	*p*-value
Hospital type		
Tertiary hospital	9 (0,21)	0.674 [a]
Non-tertiary hospital	9 (5,17)	
Specialty		
Emergency	9 (0,21)	0.891 [a]
Internal Medicine	10 (0,20)	
Rank		
House Officer	8 (0,21)	<0.001 [b] *
Medical Officer	9 (1,21)	
Specialist	14 (8,20)	
Years of working experience		
<3 years	8 (0,21)	<0.001 [b] #
3-5 years	7 (3,15)	
5-10 years	12 (4,21)	
>10 years	14 (9,20)	

Abbreviation: IQR = Interquartile range

[a] Mann-Whitney-Wilcoxon test; [b] Kruskal-Wallis test; [c] possible score range for antidote knowledge was 0 to 22.

* Mann-Whitney test showed statistically significant difference between HO and Specialist, and between MO and Specialist.

[#] Mann-Whitney test showed statistically significant difference between <3 years and 5-10 years, <3 years and >10 years, 3-5 years and 5-10 years, and between 3-5 years and >10 years.

The seniority of doctors and their corresponding scores on the different difficulty levels of managing poisoning cases were shown in Table 4. For simple level questions, part of the HOs (30.7%) scored 4 out of 5 questions, followed by over half of MOs (63.5%) and specialists (80%) scored full marks i.e. 5 out of 5 questions. As for average level questions, specialists (25%) scored the highest which was 12 out of 15 antidote questions, while HO and MO scored 6 out of 15 and 8 out of 15 respectively. For difficult level questions, 11.9% of HO and 16.7% of MO scored 8 out of 22 and 9 out of 22 respectively, whilst 25% of specialists scored 14 out of 22.

Table 4. Respondents and their corresponding scores based on difficulty level of managing poisoning cases

Professional ranking	Median Score (IQR)		
	Simple (Out of 5)	Average (Out of 15)	Difficult (Out of 22)
House officer (n=101)	4 (3,5)	6 (3,9)	8 (0,21)
Medical officer (n=96)	5 (4,5)	8 (5,14)	9 (1,21)
Specialist (n=39)	5 (4,5)	12 (7,15)	14 (8,20)

Abbreviation: IQR = Interquartile range

The scores of knowledge of antidote availability was shown in Table 5. The overall median score for antidote availability was 23. There was no statistically significant difference between tertiary and non-tertiary hospitals, although respondents from tertiary hospitals had higher median scores. Knowledge scores on antidote availability showed significant difference between ED and internal medicine departments (p<0.001). However, both ED and internal medicine only scored a median score of 26 (IQR 5,48) and 20 (IQR 0,42) respectively out of 50. When the knowledge on antidote availability was compared based on seniority and years of working experience, statistically significant differences were observed among the groups (p=0.006 and p=0.034, respectively).

Table 5. Respondents and their corresponding scores on knowledge of antidote availability

Category	Median score(IQR) [c]	*p*-value
Hospital type		
Tertiary hospitals	23.0 (0,48)	0.315 [a]
Non-tertiary hospital	19.0 (10,42)	
Specialty		
Emergency	26.0 (5,48)	<0.001 [a]
Internal Medicine	20.0 (0,42)	
Rank		
House Officer	21.0 (0,42)	0.006 [b]
Medical Officer	23.5 (4,45)	
Specialist	30.5 (7,48)	
Years of working experience		
<3 years	22.0 (4,45)	0.034 [b]
3-5 years	17.0 (2,44)	
5-10 years	26.0 (4,48)	
>10 years	29.5 (7,48)	

Abbreviation: IQR = Interquartile range

[a] Mann-Whitney-Wilcoxon test; [b] Kruskal-Wallis test; [c] possible score range for knowledge of antidote availability was 0 to 50.

As shown in Figure 1, the most preferred methods of acquiring toxicology knowledge were continuous medical education (CME) (84.8%) and followed by mobile applications (76.4%). Consultation with the National Poison Centre and clinical toxicologists were the least preferred methods.

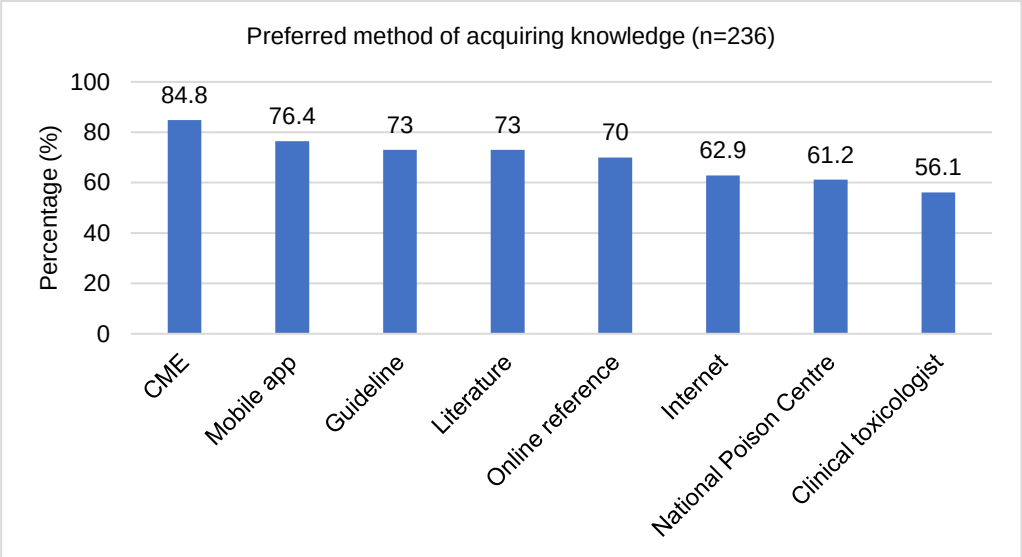

Figure 1. Preferred method of acquiring knowledge

Discussion

Undoubtedly, knowledge of antidotes is crucial as it is potentially lifesaving during intoxications. In our findings, there was no significant difference in antidote knowledge among ED and internal medicine doctors. Looking at the number of poisoning cases received in one of our study centres in year 2023, out of the 468 cases received at the ED, about 10% were admitted to medical wards or intensive care units, therefore the doctors in these wards were also involved in the management of toxicology cases. Studies by Khadka et al. and Liu et al. conducted in Kathmandu and China respectively reported that half of the poisoning cases admitted to the emergency department were transferred to intensive care units or medical wards, hence it was not surprising that the antidote knowledge survey results did not differ significantly based on their specialty (8, 11). According to Wax and Donovan (2000), the majority of emergency medicine board certified doctors (68%) have gone through fellowship training under the American College of Medical Toxicology but they were not the only disciplines who underwent training. Other disciplines who received toxicology training included paediatric medicine (18%) and internal medicine (17%) (12). Although

we did not collect data on the qualifications or previous training in clinical toxicology, the findings of our study might imply that the internal medicine doctors also had some degree of knowledge on antidotes based on previous knowledge gained during medical school and working experience.

Based on professional ranking, specialists from all study sites performed significantly better than MO and HO in terms of antidote knowledge. This may be due to higher level of exposure and training in medical toxicology during the specialists' residency programmes as compared to basic toxicology education in medical schools (13). The American College of Emergency Physicians (ACEP) stated that "emergency physicians should be qualified to render toxicologic care, and they should be prepared by training and by facility organisation to fulfil this function" (13). Hence, it was not surprised that specialists had better knowledge in antidotes. In contrast, toxicology was not widely taught in medical schools according to a study by Hays et al. Medical toxicology was not paid much attention to, and was integrated with other pharmacology lectures, which in the authors' opinion should be a separate course by its own during medical school years (14).

In our study, about three quarters of the doctors were able to answer the simple antidote knowledge questions. For example, paracetamol was considered one of the simple poisoning cases as paracetamol poisoning was common and it is an easily obtained over-the-counter medication. Furthermore, Malaysia has no restriction on the purchase of paracetamol-containing products (3). In one of our study sites, pharmaceutical drug poisoning was most prevalent, accounting for 35.5% of 468 cases, and these included paracetamol poisoning. Moving on, insecticide poisoning was also commonly reported in Malaysia due to its agricultural background. Studies have shown that organophosphorus pesticide poisoning was high among agricultural farmers. (15). It was also reported that the increased number of pesticide poisonings was caused by intentional ingestions. A 10-year retrospective analysis by the National Poison Centre, Malaysia reported 11,087 pesticide poisoning cases with an increasing trend over the years (16). Lastly, while the usage of opioids in Malaysia was still considered low when compared to other countries, the consumption of opioids had steadily increased from 2011 to 2014 (2). The rise in opioid usage had also led to an increase in opioid abuse, misuse, and overdose (17).

In contrast to simple antidote questions, average and difficult antidote questions were poorly answered. For average difficulty level questions, specialists scored the highest among all three rankings. The average level poisoning cases, such as toxic alcohol, were not uncommon as methanol poisoning had made headlines in Malaysia in recent years (18, 19). Poisoning cases involving hydrofluoric acid, methotrexate, and a few other agents were categorised as difficult questions in this study as these cases were more rarely seen compared to the rest as evident by the limited number of published studies regarding them. The published ones were mostly case reports such as methotrexate poisoning by Isoardi et al. (20) and hydrofluoric acid poisoning by Björnhagen et al. (21). Therefore, it was observed that most respondents did not score well for difficult level antidote questions. More efforts are needed to ensure that medical practitioners are equipped with adequate knowledge and skills to manage poisoning events.

Our results showed that those with more working experience performed better in antidote knowledge. However, these results were different from Liu et al. who reported that doctors in China with 3-10 years of work experience performed better than those with over 10 years experience. The authors attributed it to the fact that emergency medicine and toxicology is considerably a young specialty in China (8). Whereas on our side, doctors with more working experience had better knowledge as the knowledge can be accumulated by handling more poisoning cases over the years. Studies have reported that doctors with more working experience have more time to accumulate knowledge and skills, which may correlate with better quality of patient care and improved clinical outcomes (8, 22).

In terms of knowledge on antidote availability in healthcare facilities, there were limited published literatures up to date. Respondents from the tertiary hospitals performed better most likely because these hospitals stocked up more antidotes, hence their doctors were more familiar with their availability (23). Besides that, doctors from the ED were more familiar with the availability of antidotes in their respective hospitals compared to internal medicine. This was because poisoning cases were mainly handled by ED, and antidotes need to be given in a timely manner so some antidotes are available as floor stock in the ED. An expert panel has stated in an antidote stocking guideline that out of 44 recommended antidotes, half of it should be stocked in a location for immediate availability. Examples of immediately available antidotes are atropine, calcium gluconate, flumazenil, glucagon and sodium bicarbonate (23). In a study by Greenberg et al., it was reported that emergency physicians knew very well on the availability of common

antidotes such as atropine and diazepam, but were less aware of antidotes such as dimercaprol and pralidoxime (24).

In our study, although ED doctors and doctors from tertiary hospitals scored better in terms of knowledge on antidote availability, there was still room for improvement as the median scores were just about half of the total score. Similarly, the median antidote knowledge scores in most categories were less than half of the total score. A study from Punjab on the evaluation of antidote knowledge among doctors and pharmacists found that pharmacists had fair knowledge on common antidotes such as activated charcoal, atropine, calcium gluconate and sodium bicarbonate. On the other hand, antidotes which are rarely used such as digoxin immune fab, edetate calcium disodium, glucagon and physostigmine reported poorer knowledge levels (25). Another study from Korea reported that only 16.7% of pharmacists were being asked regarding drug overdose, and almost half of them had to obtain recommendation from other facilities or by searching through references. Up to 61.6% of the pharmacists had no knowledge on antidotes while the rest of them had attended education courses at least once (26). This highlighted that pharmacists' knowledge on antidote were lacking as well.

For the preferred method of acquiring knowledge, most of the doctors prefer acquiring knowledge through CME teaching sessions which can provide them a greater exposure in the management of toxicology cases. They also prefer acquiring knowledge through reliable and convenient references that provide fast and accurate answer. Mamary and Charles reported that self-directed modes such as literature review and internet search were most effective in improving doctors' performance, however instructor-directed modes such as attending conferences and teaching sessions still remained the most utilised methods for acquiring knowledge (27). The least preferred method of acquiring knowledge is through the National Poison Centre and consulting toxicologists. Based on a study by Brassard et al., the reasons hindering the attending doctor to consult a poison centre were time-consuming, complexity of managing an unstable patient while considering recommendations from the centre (28).

One of the limitations of the study was that a time limit was not able to be set for responders to answer the questionnaire. There is a possibility that respondents answered the questionnaire with the help of outside sources. Another limitation would be that about half of the doctors from tertiary hospitals who participated in the study were HOs whilst no HO participated from non-tertiary hospitals. This may have skewed the results of tertiary hospitals towards lower level of knowledge.

Conclusion

There is a need to improve the knowledge of antidotes and antidote availability among the emergency and internal medicine doctors, especially among the junior doctors. Most doctors prefer to acquire knowledge through continuous medical education, mobile apps, guidelines and literature. This study has given an overview of the baseline knowledge on antidotes in the central region of Malaysia and it warrants more training and teaching sessions to educate young doctors to provide them a greater exposure in the management of toxicology cases.

Acknowledgement

The authors would like to thank the Director General of Health Malaysia for his permission to publish this article. In addition, the authors would also like to thank all the pharmacists who participated in the data collection and the staffs of Emergency and Trauma Departments for their kind co-operation.

Conflict of interest

No funding was received to assist in the preparation of this study. The authors have no conflict of interest to disclose.

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