Evaluation of a Guest Lecture on Medical Emergency of Box Jellyfish Envenomation Pathophysiology and First Aid for Medical Students

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Abstract

Introduction: Lethal box jellyfish envenomation has been reported in Indonesia and other countries; therefore, medical students should be equipped with related knowledge. The aim of this study was to evaluate the results of summative exams by student cohort and gender and determine the factors that contribute to success in the summative exams after novel intensive instruction in box jellyfish envenomation pathophysiology and first aid in undergraduate medical students in Surabaya, Indonesia.

Methods: This study used explanatory sequential mixed methods, consisting of a cross-sectional study and interviews. A total population sampling of 203 sixth-semester students was employed. Student cohort, gender, previous semester grade point average (GPA), and English proficiency test (EPT) were considered. All statistical tests were carried out using IBM® SPSS® Statistics version 24.0 for Macintosh. The study was complemented by interviews conducted with 20 students.

Results: The one-way ANOVA test showed that students from the 2016 cohort had significantly higher mean scores in the exam than the 2015 and 2014 cohorts (P=0.002). Independent samples t-test showed that such differences were not gender-specific (P=0.249). In the binary logistic regression, the GPA in the previous semester was the only factor that contributed to success in the summative exam (OR 3.031, 95% CI: 1.520-6.044). All students commented that the lecture and practicum were interesting and beneficial. However, some considered that the language barrier might have prevented them from understanding the topic well.

Conclusion: Results of the summative exam differed by the student cohorts, and previous semester GPA was a predictor of success in the summative exam.

Keywords: Lecture; Medical emergency; Pathophysiology; English proficiency; Medical students

Introduction

Lethal box jellyfish envenomation has been reported in Indonesia and other countries. Box jellyfish (Class Cubozoan) envenomation may lead to life-threatening sequelae and loss of life within minutes throughout Indo-Pacific waters (1). Cubozoan is a class of phylum Cnidaria, a phylum of invertebrates defined by the presence of microscopic stinging organelles, called cnidae, which are used for protection and catching food that is distinguished by their cube-shaped medusae. Cubozoan is colloquially called "box jellyfish" (2). Despite the potentially severe nature of this envenomation, first aid approaches

include many unvalidated anecdotal treatments both in developing and developed countries, such as the use of warm urine, meat tenderizer, gasoline, and site rubbing. Unvalidated first-aid approaches can exacerbate symptoms by stimulating further penetrant cnidae (referred to as nematocysts) discharge, leading to an increase in venom injection into the victim (3).

Box jellyfish stings represent seasonal emergency medicine concerns, as well as public health concerns and a tourism issue (4, 5). Unlike many non-lethal jellyfish species, the box jellyfish is almost invisible, especially in their preferred coastal mangrove habitats. Indonesia is an archipelagic country with a long coastline and a large mangrove forest along the island shorelines (6), potential habitats for box jellyfish.

In previous years, the sixth-semester medical students at Hang Tuah University, Indonesia, have received instruction to treat marine animals' bites or stings as part of the marine health course. However, jellyfish envenomation pathophysiology and evidence-based first aid were not discussed despite its importance as emergency medical cases. In July 2018, the authors carried out a Chirodropid research in Situbondo district, East Java Province, Indonesia. Chirodropidae is an order of box jellyfish (Cubozoa) class, distinguished by their multi-tentacles (2). The second author found a box jellyfish in Mlandingan coastal areas, in Situbondo district, where several cases of box jellyfish sting, including a lethal case, have occurred in the areas.

To better equip medical students with necessary emergency knowledge related to box jellyfish envenomation for their future clinical practice in many coastal areas of Indonesia, the second author, an established expert in this field, was invited to present two lectures and one laboratory practicum with associated reading assignments related to box jellyfish envenomation pathophysiology and first aid for the sixth-semester medical students. The lectures covered introduction to phylum Cnidaria envenomation, tissue models and evidence-based first aid and clinical management, pathophysiology of cardiovascular collapse and Irukandji syndrome after box jellyfish envenomation, biochemical composition of box jellyfish venom, and ultrastructure of nematocysts (7-9). The practicum session covered the structure of venom filled cnidae, and the effect of chirodropid envenomation on red blood cells and was carried out on 21 May 2019.

The lectures were delivered in English and the first experience for medical students at this university, where English was not the language of instruction. Students were provided with several references and lecture handouts in English, in which some parts of the lecture handouts were translated into the Indonesian language. The practicum was delivered in English, and some students translated it into Indonesian for their peers. This study evaluated the results of the summative exams after novel intensive instruction in box jellyfish envenomation pathophysiology and first aid, by considering student cohorts and gender; it also determined the factors that contributed to success in the summative exam by considering student cohorts, gender, previous semester grade point average (GPA), and English proficiency test (EPT).

Methods
Study design
This study used explanatory sequential mixed methods, in which cross-sectional quantitative data on students' exams were collected and analyzed first; then, qualitative data were collected and analyzed to further explore the didactic bases for the quantitative information (10). The quantitative comparison research design aimed to compare the results of the written summative exam of the marine health course by cohort and gender of all undergraduate medical students during their sixth semester in the 2019/2020 academic year, using a total population sampling. Factors that contributed to success in the summative exam were also determined. The qualitative data were based on the interview that consisted of four questions: the benefit of incorporating lecture, laboratory sessions, fieldwork, and community service; the strengths and weaknesses; the difficulties experienced by students; and any suggestions from students related to the topic.

Subjects
The quantitative study was carried out on all 203 sixth-semester medical students who participated in the summative exam of the marine health course, while the interview was conducted on 20 sixth-semester medical students around two weeks after the summative exam was done. The interview was conducted with several students after the exam, with the hope that it would not interfere with their preparation for the exam and students would have a complete perspective about the learning activities.

The complete summative exam of marine health course consisted of 73 multiple-choice questions (MCQs), including ten MCQs based on the box jellyfish envenomation pathophysiology and first aid lectures and laboratory session.

The MCQ was written by a lecturer; it consisted of a stem in the form of a clinical vignette, a lead-in question, and options. We used five answers as options: the option which matched the key was called correct answer, whereas the other options were distracters. Students took computer-based exam in the exam room that could accommodate 220 students. To prevent cheating, we did not allow the students to bring any equipment into the exam room; also, the order of questions was randomized for each student, and the time limit was one minute for each question. Students who did not pass the main exam could take a remedial exam. The remedial exam comprised different questions and was scheduled several days after the main exam. Students' score in the box jellyfish exam were obtained by (100/number of questions) x number of correct answers. Based on the academic guideline, the passing score for the summative exam was 66, and this cut-off was used in the binary logistic regression.

Student cohort or student enrollment year was classified into three groups: 2014, 2015, and 2016. Previous semester GPA was treated as continuous variable. Based on the academic guideline, the English Proficiency Test (EPT) passing score was 430; therefore, the students were categorized into two groups: pass or fail.

Data analyses

This study used Kolmogorov-Smirnov test to evaluate the normality distribution of the data; it was found that the score of the summative exam, previous semester GPA, and EPT were normally distributed. In the bivariate analyses, student cohorts and gender were treated as the independent variables, while student scores of the summative exam was treated as the dependent variable. One-way ANOVA test was used to compare the difference of the mean score of the summative exam between student cohorts, and two independent samples t-test was used to compare the difference of the mean score of summative exam between genders. The binary logistic regression was used to determine the factors which contributed to success the summative exam, considering the student cohort (in nominal scale), gender (in nominal scale), EPT (in ratios scale), and previous semester grade point average (GPA) (in ratios scale). All the tests were carried out using IBM® SPSS® Statistics version 24.0 for Macintosh with an alpha of 0.05 (11).

Ethical consideration

All procedures followed were in accordance with the ethical standards of the ethics committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and its later amendments. The purpose and procedures of the study were explained to the students before they participated in the study. Informed consent was obtained from all the participants in the study, and a plain-language statement was provided. The study did not involve any identifying data that could breach privacy. Approval for this study was obtained from the Research Ethics Committee at the Faculty of Medicine, Hang Tuah University No. 15/M/DU/EC/KEPFKUHT/VII/2018.

Results

In academic year 2018/2019, the six-semester students consisted of four students from 2014 cohort, 24 from 2015 cohort, and 175 from 2016 cohort. Based on gender, students in the sixth semester consisted of 71 males and 132 females. The characteristics of the students are shown in Table 1.

There were differences in the mean score of the complete summative exam and box jellyfish exam by students' cohort. However, no difference was found between the genders (Table 2).

In the binary logistic regression, the success of passing or failing the box jellyfish exam with a minimum score of 66 was treated as the dependent variable. Student cohort (in nominal scale), previous semester GPA (in ratios scale), gender (in nominal scale), and EPT (in ratios scale) were included as independent variables. The 2016 cohort and female were treated as references. The logistic regression results are shown in Table 3.

The binary logistic regression was carried out in 203 students who took the box jellyfish exam, and the omnibus tests of model coefficients showed $\chi2$ (4)=24.633, P<0.001, meaning that the full model significantly fitted better than the null model. The Hosmer and Lemeshow test showed $\chi2$ (8)=5.348, P=0.720, indicating that the predicted probabilities did not deviate from the observed probabilities. The binary logistic regression model explained 15.5% (Nagelkarke R Square) of the variance in passing the exam and the classification table showed that the model correctly classified 67.8% of the cases. It appeared that only previous semester GPA was a significant predictor of success in the box jellyfish exam.

Of the 20 students interviewed related to incorporating box jellyfish envenomation pathophysiology and first aid, all (100%) commented that the lecture and practicum were interesting and beneficial for their future career as a physician in coastal areas. A female student stated, "From the lecture, I know the pathophysiology of box jellyfish envenomation.

Table 1: Characteristics of the students

Characteristics		Value
Cohort		
2014	n (%)	4 (2.0%)
2015	n (%)	24 (11.8%)
2016	n (%)	175 (86.2%)
Gender		
Female	n (%)	132 (65.0%)
Male	n (%)	71 (35.0%)
English proficiency test		
Overall	Mean±SD	4.666±34.16
Pass	n (%)	198 (97.5%)
Fail	n (%)	5 (2.5%)
Previous semester GPA		
Overall	Mean±SD	2.9±0.6
2014	Mean±SD	1.4±0.5
2015	Mean±SD	2.2±0.5
2016	Mean±SD	3.1±0.5

Table 2: Mean score, standard deviation (SD) and range of the exam by student cohort and gender

Mean±SD and range	Cohort			P^a
	2014 (N=4)	2015 (N=24)	2016 (N=175)	
Complete Summ Exam	46.8 (3.6) [41.9-50.2]	47.1 (13.8) [31.0-74.9]	65.6 (13.5) [36.5-96.8]	<0.001
Box Jellyfish Exam	47.5 (17.1) [30.0-70.0]	55.4 (14.1) [20.0-80.0]	64.1 (13.9) [30.0-100.0]	0.002
Mean±SD and range	**Gender**			**P^b**
	Male (N=71)	Female (N=132)		
Complete Summative Exam	62.3 (13.5) [31.0-96.8]	63.4 (15.5) [36.5-96.8]		0.453
Box Jellyfish Exam	61.1 (14.7) [30.0-90.0]	63.6 (14.1) [20.0-100.0]		0.249

P^a: significance based on one-way ANOVA test. P^b: significance based on two independent samples t-test

Table 3: Binary logistic regression

	β	S.E.	Wald	df	P	Exp (β)	95% CI for Exp (β)	
							Lower	Upper
Cohort(1)	0.346	0.572	0.366	1	0.545	1.414	0.461	4.338
PrevGPA	1.109	0.352	9.920	1	0.002	3.031	1.520	6.044
Gender(1)	-0.391	0.326	1.441	1	0.230	0.676	0.357	1.281
EPT	0.007	0.005	1.879	1	0.170	1.007	0.997	1.016
Constant	-6.782	2.218	9.350	1	0.002	0.001		

EPT: English Proficiency Test

From the practicum, I know the effect of box jellyfish envenomation on the blood cells, so I understand why a jellyfish sting is an emergency case and needs a certain first aid." Another female student stated, "The knowledge is very applicable in the field, and I think every doctor should know this." Also, a male student commented, "The lecture and practicum open new insights about the emergence of marine animals' sting and venom. The knowledge is based on real field research and experiences, making it more interesting. It stimulates us to know more by reading the references". Another male student suggested, "I think the knowledge should be disseminated to the fishermen as box jellyfish are found in Indonesian coastal areas. Fatal cases of box jellyfish sting have been reported." However, around 50% of the students in the interview argued that there might be a language barrier for many students. The lecture was delivered mainly in English, and they were not used to having lectures in English. In addition, there was limited time with quite many references to read.

Discussion

The Indonesian national standard for professional medical education requires that 80% of the curriculum contains the national standard for medical competency, while a maximum of 20% consists of a specific local content developed by every medical education institution in accordance with vision, mission, and local conditions (12). The local content at our institution is related to marine health, marine biota utilization, and the

health of coastal community.

As to emergency cases of box jellyfish stings in coastal areas in Indonesia, it is necessary to provide medical students at preclinical phase with emergency knowledge related to box jellyfish envenomation and first aid in preparation for their clinical phase and future clinical practice. The expelled nematocyst in a harpoon-like fashion through box jellyfish stings, within only a nanosecond discharge process, is considered ultra-fast exocytosis (7, 13) and needs immediate treatment. The novel intensive instruction in box jellyfish envenomation pathophysiology and first aid consisted of the lectures, and the practicum sessions were very beneficial to be provided to medical students in Indonesia, a tropical country with long coastlines. This is in line with the findings that box jellyfish habitat is in tropical and subtropical coastal waters (14). Undergraduate medical students who have already known about the topic during their preclinical phase should be involved in the first aid management of jellyfish sting victims as an authentic experience gained in their clinical stage. Experience-based learning may support the students for practical work as a physician (15, 16).

As to the language barrier, English is not a medium of instruction at Hang Tuah University. Accordingly, English language proficiency among medical students varied. Around 198 (97.5%) of the sixth-semester students had passed the English Proficiency Test (EPT) in their first year of study (cohort 2016), with an average score (SD) of 466.6 (34.2), while the passing score was 430. The English course was only available in the first year; therefore, their competence in English often reflects their secondary schooling experience and their efforts to obtain additional off-campus English courses. Around 50% of the sixth-semester students who attended the box jellyfish envenomation pathophysiology and first aid class experienced language difficulty. A prior study reported that using a second language in medical education might create a barrier, especially for students whose second language was not practiced much during their education (17, 18).

A systematic review study reported that written examinations, either in multiple-choice, extended matching, or short-answer questions had a significant correlation with the clinical performance of the students of health-related professions (19, 20). Earlier studies also suggested that individual ability, learning styles, and motivation might affect the students' academic achievement. Moreover, grade point average, rather than gender or ethnicity, was important for predicting students' success in

the university (21, 22). In this study, the GPA in the previous semester was the only factor that predicted whether a student might pass the box jellyfish exam. It appeared that increasing the last semester GPA was associated with an increased likelihood of passing the box jellyfish exam (OR 3.031, 95% CI: 1.520-6.044).

The findings of this study reported herein should be considered in light of some potential limitations. The quantitative analyses were based on limited variables that underestimated the influence of other factors on the results of the study. In addition, the qualitative finding was specific to the condition of the study setting; therefore, it cannot be generalized.

Conclusion

Results of the summative exam differ by student cohorts, and previous semester GPA was a predictor of success in the summative exam. The interviews revealed that box jellyfish envenomation pathophysiology and first aid were valuable, especially from gaining essential locality-specific knowledge they can build on as tomorrow's doctors in Indonesian coastal zones. As a suggestion, for better understanding the box jellyfish envenomation pathophysiology and first aid, the lecture should become a constant part of the marine health course; also, the lecture should be translated into Indonesian, and students' learning load should be reconsidered.

Authors' Contribution

W.D, A.A.Y. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work, Drafting the work or revising it critically for important intellectual content, Final approval of the version to be published, Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflicts of Interest: None declared.

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