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Simulation Model Algorithm for Pre-Hospital Emergency Care (PHEC) Volunteers in Indonesia

(Algoritma Model Simulasi untuk Sukarelawan Jagaan Pra Kecemasan Hospital (PHEC) di Indonesia)

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ABSTRACT

The first responders who are often exposed to emergency condition play important roles in providing PHEC to victims with road accident trauma. Hence, empowerment of first responders is highly required to achieve the target of response time of less than 10 minutes to provide PHEC in order to minimize the numbers of deaths and disabilities caused by trauma. This study applied quasi-experimental design with static group comparison pattern using cross-sectional approach. A number of 40 samples of common people consisting of 20 samples in treatment group and 20 samples in control group were taken. The statistic test used in this research is t-test. The results reveals that simulation model using algorithm influences the improvement of traffic volunteers' emergency management capabilities with p-value of < 0.05 and mean score difference of 34.5%, and the model is highly effective to be implemented to improve the capability of traffic assistant volunteers to manage trauma emergency with the mean score difference of 11.5%. Algorithm models for PHEC simulation have some strengths in real setting and effective interactive learning to evaluate the capabilities of first responders in managing pre-hospital emergency, and improve problem-solving skills, as well as their performance in such aspects as skill, knowledge, and attitude.

Keywords: Algorithm; emergency; simulation; pre-hospital; volunteers

ABSTRAK

Responden pertama dalam sesuatu keadaan kecemasan berperanan penting bagi membekalkan PHEC kepada mangsa trauma kemalangan lalu lintas. Oleh itu, pemerkasaan responden pertama amat diperlukan bagi mencapai masa gerak balas sasaran kurang daripda 10 min dalam menawarkan PHEC dengan tujuan untuk meminimumkan kadar kematian dan kecacatan yang diakibatkan oleh trauma. Kajian ini mengaplikasikan reka bentuk eksperimen-quasi dengan pola perbandingan kumpulan statik menggunakan pendekatan keratan rentas. Sejumlah 40 sampel yang terdiri daripada orang umum, iaitu 20 sampel merupakan kumpulan rawatan dan 20 sampel lagi merupakan kawalan. Ujian statistik yang digunakan dalam kajian ini adalah ujian-t. Hasil kajian menunjukkan model simulasi yang menggunakan algoritma mempengaruhi penambahbaikan kemahiran pengurusan kecemasan dalam kalangan sukarelawan lalu lintas dengan nilai p < 0.05 dan perbezaaan skor min sebanyak 34.5% maka model ini adalah sangat berkesan untuk diimplementasikan untuk meningkatkan kemahiran sukarelawan pembantu lalu lintas bagi mengurus trauma kecemasan dengan perbezaan skor min sebanyak 11.5%. Model algoritma untuk PHEC mempunyai keistimewaan dalam pembelajaran berdasarkan situasi sebenar dan interaksi berkesan untuk menilai kemampuan responder pertama dalam menguruskan keadaan kecemasan pra-hospital serta kemahiran penyelesaian masalah di samping meningkatkan prestasi mereka dalam aspek kemahiran, pengetahuan dan sikap.

Kata kunci: Algoritma; kecemasan; simulasi; pra-hospital; sukarelawan

INTRODUCTION

Road accidents can affect life and become one of main causes of trauma emergency. Chusaini and Beni (2012) have reported that the number of road accidents on Slamet Riyadi Street, Central Java, Indonesia reached 90.84%, and the top cause of collisions in road accident-prone areas is the driver (97.06%). Approximately 60.61% collisions on the street are associated with drivers' lacking of anticipatory actions. A total of 29.41% accidents occur around 6 a.m. to 12 a.m. Motorcycles (83.58%) are the top vehicle types involving in road accidents. Front-and-side crash (51.52%) is the type of most typically occurring. Most of road accident victims are male aged 15-44, and most of dead and injured victims are pedestrian, motorcyclist and bicyclist.

Road accidents lead to some risks, such as severe organ damages, physical disabilities, and death, and all of them require good management through damage controlling principle, that is quick and proper PHEC (Kureckova et

al. 2017). The success of PHEC of trauma caused by road accidents is attributable to a first responder, a person close to the victim and can provide the fastest PHEC (Tannvik, Bakke & Wisborg 2012). Therefore, it is required to improve the capabilities and skills of common people and first responders to provide PHEC before the victim receives professional medical treatment in the nearest health center. Today, emergency cases have more tendencies to increase on the street, household, and workplace. When accidents happen on street, house and workplace, the fastest and most proper persons to help are those who stay the closest to victims. Besides medical officers, common people and first responders are also expected to provide PHEC to victims at emergency condition.

First responders (traffic volunteers is a volunteer who served as a police helper in organizing traffic on the highway) are those who are often exposed to emergency condition and play significant roles in reducing the number of deaths and disabilities of trauma victims attributable to road accidents based on their capabilities. Thus, first responder empowerment as the spearhead of safe community in the field is highly required to achieve response time target of less than 10 minutes when providing PHEC to victims in emergency condition. It is expected that their capabilities can minimize the death rate and disabilities associated with road accident trauma. Thus, it is required to improve first responders' emergency trauma management capabilities by applying proper knowledge transfer method. Improper implementation of this method to transfer knowledge will become an obstacle to achieve goals that have been formulated. Many teaching materials are useless due to improper methods delivered by trainers and textbooks regardless trainees' learning needs, facilities, and environmental situation (Pallavisarji, Gururaj & Girish 2013; Amitai, Shaul & Margalit 2009).

One of knowledge transfer model which can be used to improve the emergency trauma management capabilities of common people and first responders is simulation algorithm approach (Ruesseler, Marzi & Walcher 2010). The strengths of the method are expected to improve understanding, minimize misconception, and enable intensive social interaction in learning with direct involvement, and familiarize first responders to understand problems. Mudin's (2013) that simulation method is effective to improve learning outcomes; the learning outcomes increase from 32.43%to 59.46% and learners completed courses increase from 48.65% to 72.97%.

MATERIALS AND METHODS

This study applied quasi-experimental design using static group comparison pattern to provide objective explanation on the effect of algorithm model for PHEC simulation on the improvement of the emergency trauma management capabilities of volunteer in Indonesia. The population of this study is 40 traffic auxiliary volunteers. The study group was divided into two groups; they were divided into two groups; the treatment group (n = 20) and the control group (n = 20). The treatment group was given algorithm model for PHEC simulation while the control group was given first aid trauma emergency modules. The main reasons for choosing the samples are those who are nearest, exposed and often find emergency victims. The sampling technique in this research is purposive sampling, which has met the sample criterion, get explanation and agree the informed consent sheet. The criteria of this research sample are the availability of respondents, minimum primary education background, can read and write, and recorded as permanent member of traffic volunteer. Data were analyzed using t-test with the significance level of 95%.

RESULTS

UNIVARIATE ANALYSIS

Frequency Distribution of the Age of Respondents Frequency distribution of the age of 20 samples observed in treatment group reveals that 10 respondents are above 45 years old, 9 respondents are 36-45 years old, and 1 respondent is 22-35 years old. Meanwhile, frequency distribution of age in control group with a total of 20 samples demonstrates that 12 respondents are 36-45 years old, 5 respondents are above 45 years old and 3 respondents are 22-35 years old. The frequency distribution of respondent's age is displayed in Table 1.

TABLE 1. Frequency distribution of age

Age	Group			
	Treatment		Control	
	Frequency	%	Frequency	%
22-35 years old	1	5	3	15
36-45 years old	9	45	12	60
>45 years old	10	50	5	25
Total	20	100	20	100

Sources: primary data (processed with SPSS 17.0 version, 2016)

Frequency Distribution of Educational Level Frequency distribution of educational background of observed in treatment group indicates that 11 respondents are elementary school graduates, 6 respondents are senior high school graduates, and 3 respondents are junior high school graduates. In the meantime, frequency distribution of educational background of 20 samples in control group discloses that most of respondents are junior high school graduates (7 respondents) and senior high school graduates (7 respondents), while 6 respondents are elementary school graduates. The frequency distribution of respondents' educational background is presented in Table 2.

TABLE 2. Frequency distribution of educational background

Education	Group			
	Treatment		Control	
	Frequency	%	Frequency	%
Elementary school	11	55	6	30
Junior high school	3	30	7	35
Senior high school	6	15	7	35
Total	20	100	20	100

Sources: primary data (processed with SPSS 17.0 version, 2016)

TABLE 3. Frequency distribution of experience

Experience	Group			
	Treatment		Control	
	Frequency	%	Frequency	%
0-5 years	13	65	16	80
6-10 years	7	35	4	25
>10 years	0	0	0	0
Total	20	100	20	100

Sources: primary data (processed with SPSS 17.0 version, 2016)

Frequency Distribution of Experience Frequency distribution of experiences of 20 samples in treatment group suggests that 13 respondents (65%) had been volunteer for 0-5 years and 7 responders (35%) had been responders for 6-10 years. Meanwhile, frequency distribution of experience of 20 samples in control group proves that 16 respondents (80%) had been volunteer for 0-5 years and 4 respondents (20%) have worked for 6-10 years. Frequency distribution of first responders' experiences is provided in Table 3.

Frequency Distribution of mean scores of the improvement of the emergency trauma management capabilities Frequency distribution reveals that the average scores of pre-test and post-test of treatment group improve 4.15 and those of control group improve 0.70. However, in control group, 4 respondents appear to have lower post-test average scores and do not make any improvement after receiving treatment, while the rest 16 respondents make improvements. The distribution of pre-test and post-test average score improvements of respondents are shown in Table 4.

TABLE 4. Distribution of mean scores of the improvement of emergency trauma management capabilities

No	Group					
	Treatment			Control		
	Pre-test	*Post-test*	Difference	*Pre-test*	*Post-test*	Difference
1	5	9	4	5	6	1
2	6	8	2	5	4	-1
3	4	7	3	6	8	2
4	5	10	5	3	6	3
5	6	13	7	6	8	2
6	4	13	9	6	7	1
7	4	12	8	6	9	3
8	5	9	4	7	8	1
9	6	9	3	7	8	1
10	5	11	6	6	5	-1
11	8	11	3	7	8	1
12	4	8	4	6	7	1
13	5	9	4	5	5	0
14	6	13	7	6	6	0
15	4	6	2	5	4	-1
16	8	13	5	7	8	1
17	7	8	1	6	6	0
18	10	11	1	5	6	1
19	9	12	3	7	6	-1
20	8	10	2	7	7	0
	20	20	20 $\bar{x} = 4.15$	20	20	20 $\bar{x} = 0.70$

Sources: primary data (processed with SPSS 17.0 version, 2016)

Frequency distribution of emergency trauma management capabilities of treatment group Distribution of emergency management capability in treatment group before receiving any treatments signposts that 14 respondents (70%) are considered incapable, 5 respondents (25%) are less capable and 1 respondent (5%) is capable. Meanwhile, frequency distribution of the capability of emergency management after receiving treatment indicates that 11 respondents (55%) are categorized capable, 8 respondents (40%) are less capable and 1 respondent (5%) is incapable. Frequency distribution of treatment group's emergency management capability is illustrated in Table 5.

TABLE 5. Frequency distribution of emergency management capability of treatment group

Capability	Group			
	Pre-test		*Post-test*	
	Frequency	%	Frequency	%
Incapable	14	70	1	5
Less capable	5	25	8	40
Capable	1	5	11	45
Total	20	100	20	100

Sources: primary data (processed with SPSS 17.0 version, 2016)

Frequency distribution of emergency trauma management capability of control group Frequency distribution of emergency trauma management capabilities related to road accidents before any treatment is provided to control group indicates that 14 respondents are categorized incapable (70%), and 6 respondents are considered less capable (30%). Meanwhile, frequency distribution of emergency trauma management capabilities related to road accidents before receiving any treatment shows that 10 respondents (50%) are considered incapable, 10 respondents (50%) are categorized less capable, and there is no one (0%) considered capable. The frequency distribution of emergency trauma management is presented in Table 6.

TABLE 6. Frequency distribution of emergency management capability of control group

Capability	Group			
	Pre-test		*Post-test*	
	Frequency	%	Frequency	%
Incapable	14	70	10	50
Less capable	6	30	10	50
Capable	0	0	0	0
Total	20	100	20	100

Sources: primary data (processed with SPSS 17.0 version, 2016)

BIVARIATE ANALYSIS

Mean matching of experimental groups In reference to the results of analysis of pre-research data, both treatment and control groups share similar mean scores on the emergency trauma management capabilities and have no significant differences in variants. The mean matching results in treatment group's mean score of 45.95 and control group's of 55.05. It follows that both groups have the same initial capabilities in emergency road accident trauma management. Table 7 denotes the results of mean matching test for both treatment and control group.

TABLE 7. The results of mean matching test

Capability	Mean Score	Description
Treatment group	5.95	Both groups have the same initial capabilities in accident trauma management.
Control group	5.90	

The Influence of Algorithm Model for the Improvement Emergency Trauma Management Capabilities The results of the t-test demonstrate that ρ-value of treatment group is 0.00 with a mean score difference of 3.45 and significance level of 95%. Regarding that $0.00 < 0.05$ with such mean difference, there is an influence of algorithm model for PHEC simulation on the improvement of first responders' emergency road accident trauma management. Table 8 presents the analysis results of a test for mean score difference in emergency trauma management capabilities.

The Effectiveness of Algorithm Model for the Improvement of the Emergency Trauma Management Capabilities The analysis results of the t-test show that the p-value of treatment group is 0.00 with mean score difference of 1.150, while the p-value of control group is 0.186 with mean score difference of 0.150 and significance level of 95%. The comparison of the values implies that algorithm model for PHEC simulation enables to make 11.5% improvement of capabilities in emergency road accident trauma management to first responders. Based on mean scores on the emergency trauma management capabilities, a group treated with algorithm model for PHEC simulation performs better than those treated with a learning method involving conventional information provision. Clearly, algorithm model is proven to be more effective in improving first responders' emergency trauma management capabilities. Table 9 details the effectiveness of algorithm model for PHEC simulation in the improvement of the emergency trauma management capabilities.

TABLE 8. The result summary of *t*-test

Variable	Probability		Description
	P-value	Mean score	
Algorithm model for the improvement of the emergency trauma management capabilities $\alpha = 0{,}05 : N = 20$	0.000	3.45	There exists an influence.

TABLE 9. The result summary of *t*-test

Variable	Probability		Description
	P-value	Mean score	
Treatment group Control group $\alpha = 0{,}05 : N = 20$	0.000 0.186	1.150 0.150	Algorithm model is more effective than a learning methods using conventional information provision.

Source: primary data (processed using SPSS version 17.0, 2016)

DISCUSSION

THE EMERGENCY TRAUMA MANAGEMENT CAPABILITIES PRIOR TO TREATMENT

The result of the pre-test assessment of the ability of the management of trauma emergency in the treatment group mostly in the category of not able to be:14 people (70%), less capable: 5 people (25%), and capable: 1 person (5%). While the pre-test results in the control group mostly with the category of not able to 14 people (70%), and less capable of 6 people (30%). The results of pre-test on the emergency trauma management capabilities for both groups denote that most traffic volunteers did not get good achievement scores although they are familiar with it. The interview with all volunteers in pre-test resulted in their feedbacks on the causes, including: less understanding of knowledge on emergency trauma management, feeling of fear or discomfort when dealing with the emergency management for the first time, less understanding of appropriate emergency trauma management, and influence of their disjointed or unsystematic emergency response actions endangering victims.

THE EMERGENCY TRAUMA MANAGEMENT CAPABILITIES AFTER TREATMENT

The result of post-test analysis about the ability of trauma emergency management in the treatment group of most categories was able to be:11 people (55%), less capable: 8 people (40%), and not able to be: 1 person (5%). While the post test score of trauma emergency management capability in the control group was mostly in the category of disadvantaged and less capable of 10 persons (50%), and no category (0%). The average increase in trauma emergency management ability in the treatment group was 4.15 and the control group was 0.70.

The result showed that group treated with algorithm model for PHEC simulation makes an increase with mean score of 4.15, while improvement of emergency management capabilities in control group using module model shows mean score of 0.70. It signifies that simulation algorithm model presents benefits in real setting and interactive learning to assess volunteers' capabilities in emergency road accident trauma management, to improve volunteers' problem solving skills and performance in such aspects as skills, knowledge, and attitudes. Such findings are supported by a research conducted by Anderson, Gaetz, Masse, (2011). The research points out that those equipped with several PHEC trainings can perform better than those who learn from information once obtained.

THE INFLUENCE OF SIMULATION ALGORITHM MODEL

The results of analysis of t-test indicate that there is an influence of algorithm model for PHEC simulation on the improvement of the emergency trauma management capabilities of volunteers,' proved by p-value of 0.000 with mean difference of 3.45. It is in accordance with a research conducted by Mersal, and Aly, (2016) from Cairo which points out that the provision of PHEC trainings and disaster management can improve school teachers' knowledge and practical application.

A research carried out by Andreatta, Klotz, Hurst, (2014) explained that training programs using iPad app and SimMan3G™ simulator manikin enable to improve capabilities in identifying and managing mass victims of cholinergic crisis. Another conducted by Aebersold, and Tschannen, (2013) explained that the simulation method is very effective for training nurses practicing for new procedures, communication processes, and skills-based and non-skill technique.

THE EFFECTIVENESS OF ALGORITHM MODEL FOR THE IMPROVEMENT OF THE EMERGENCY TRAUMA MANAGEMENT CAPABILITIES

The results of analysis of t-test reveal that algorithm model for PHEC simulation is proved to be more effective in improving volunteers' emergency trauma management

capabilities than given first aid trauma emergency modules. The mean achievement score of emergency management capability in a group treated with algorithm model is 11.5%, higher than that using conventional method (0.15%). Such findings are in line with a research conducted by Suhandi, et al. (2008), indicating that the use of virtual simulation media for interactive conceptual learning allows to expand effectiveness in improving students' understanding and minimizing their misconception.

CONCLUSION

The results of the research reveal that algorithm model for PHEC simulation for volunteers gives positive and significant influence in the improvement of first responders' emergency trauma management capabilities with p-value of < 0.05 and mean difference of 34.5%. In addition, algorithm model for PHEC simulation is proved to be more effective in improving traffic volunteers' emergency trauma management capabilities with percentage of 11.5% compared to conventional method using first aid trauma emergency modules. Suggestions for further research and development are the need for up to date information on PHEC, the addition of variations of PHEC simulation scenarios to be more interesting and interactive, and the development of more interactive learning methods that facilitate learners.

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