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Research Article

The Assessment of Effectiveness of Anesthesiology Rotation in Acquiring Proficiency in Cardiopulmonary and Cerebral Resuscitation for Medical Students at Tehran University of Medical Sciences in the Years 2021-2022

Ali Reza Montaseri[1], Abdul Hassan Jammoul[2]*, Seyed Mohammad Mireskandari[1], Nima Nazari[1], Babak Eslami[1], Ali Jammoul[3]

[1]Department of Anesthesiology, School of Medicine, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran.

[2]School of Medicine, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran.

[3]School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

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ABSTRACT

Background: Whether in a hospital setting or in the community, medical students are exposed to cardiac arrests. Fast response and effective resuscitation are main determinants for decreasing mortality and morbidity due to cardiac arrests. We assessed the effectiveness of anesthesiology rotation in acquiring cardiopulmonary and cerebral resuscitation for medical students.

Methods: A pre-test/post-test quasi experimental design was undertaken, comprising A fortuitious sample of medical students who were undergoing anesthesiology rotation at Tehran University of Medical Sciences hospital complexes during the academic year 2021-2022 using a self-administered questionnaire to evaluate their theoretical comprehension, knowledge, skills and before and after the rotation.

Results: The study revealed an increase in theoretical scores (mean dif +2.6/20), increased in self-assessment knowledge scores (mean dif + 0.84/5), as well as an increased in self-assessment skill scores (mean dif +0.96/5). The highest scored were witness in students with previous cardiopulmonary resuscitation (CPR) experience.

Conclusion: It is of extreme importance for medical students to participate in anesthesiology rotations. It is essential for possessing the appropriate knowledge and skills to provide effective resuscitation care and gain confidence to perform CPR.

Introduction

1960 was the year closed chest cardiopulmonary resuscitation (CPR) was introduced to the world after passing through multiple stages of technique development and evolution [1]. Since then, it has become a series of emergency synchronized actions, and the correct execution of these steps has led to an effective result decreasing the mortality rate and improving the prognosis in cardiac arrest patients [2]. However, despite the breakthrough in CPR, its outcome remains inadequate [3]. Not receiving resuscitation has shown similar results to performing poor quality CPR, reflecting the importance of knowledge behind this life-saving procedure [4]. Therefore, numerous studies have been conducted to enhance the quality of CPR focusing on different aspects of the process. First-aid training and recognizing cardiac events are being taught at multiple facilities to prevent deaths due to heart attacks because handling these events goes hand in hand with improving our knowledge towards CPR [5], and although CPR

The authors declare no conflicts of interest.

*Corresponding author.
E-mail address: abedjammoul@gmail.com

teaching plans were developed years ago, the implementation of these plans still faces multiple difficulties which are mainly represented by the frequency and consistency of training [6]. Cardiovascular mortality forms the highest percentage of global deaths (30 %) recording 17 million deaths annually, with sudden cardiac deaths forming about half of them [7]. Thus, the need for teaching medical students basic life support (BLS) and advanced cardiovascular life support (ACLS) is crucial. It was learned that a high number of cardiac arrests occur in public places such as sports complexes, public transportation means, malls, and shopping centers, all of which mostly host the young people of the community, and with medical students being around that age group and in those locations [8], out-of-hospital cardiac arrest patients' (OHCA) outcome can be drastically improved; that being said having CPR educated medical students inside hospitals adds an increased value. In addition to that, CPR education grows medical students' confidence to perform resuscitation substantially, especially when attractive methods are used [9]. All things considered, and with doctors and nurses finding anesthesiologists to be suitable mentors for CPR training, integrating the latter into the anesthesiology curriculum holds a promising outcome [10].

According to statistics from the World Health Organization, cardiovascular diseases currently happen to be the most important and most common cause of mortality and morbidity worldwide; in 2012, approximately 17.50 million people died because of cardiovascular diseases [11]. In the Islamic Republic of Iran, 50% of all deaths per year and 79% of deaths related to chronic diseases are attributed to CVDs [12]. Cardiopulmonary arrest (CPA) constitutes a major part of these fatalities. In simple terms, cardiopulmonary arrest (CPA) can be defined as the abrupt stoppage of breathing or effective blood circulation, but this definition does not apply to patients with advanced chronic diseases and cancer [13]. It has been well established that most of the people that suffer a CPA do not make it till they get to the hospital [14]. The reason for this is the lack of an immediate Cardiopulmonary Resuscitation (CPR) that could buy time for the patient till he/she reaches the hospital. These staggering facts make it evident that CPA fatalities contribute to a huge part of the disease burden and thus, every individual must be able to perform a timely and effective CPR, especially medical students.

It is known that the Central nervous system can suffer irreversible damage in case of hypoxia and/or anoxia lasting more than 3-4 minutes and thus, the provision of an adequate high-quality and non-delayed BLS by a trained medical student can improve the patient's chances of survival exponentially [15]. The fact that a delay of mere 10 minutes can lead to brain death despite a successful heart resuscitation further adds to the significance of a prompt CPR [16].

There are two main components of CPR; BLS and ACLS [17]. BLS is the foundation of the resuscitation process and can greatly ameliorate the chances of survival as well as hospital discharge rates in patients stricken with a cardiac arrest. According to the AHA (American Heart Association), Basic life support is a series of steps taken by skilled health-workers during a cardiac or respiratory arrest, and in general is a combination of artificial respiration and chest massage to restore cardiac function, blood circulation and respiration.

Granted that the circumstantial approach to CPR may distribute over a wide range, based on the rescuer, the patient, and the accessible resources, the elemental challenge continues to be the same: how to attain a timely and effective CPR. A precept course of action to ensure immediate recognition and implementation of the required steps is vital for a beneficial CPR. Hereinafter, the American Heart Association proposed the use of 'AHA Chains of Survival for adult IHCA and OHCA' for all patients requiring cardiopulmonary resuscitation (CPR). The various links in the chain include early recognition and prevention and activating the emergency response system, high-quality CPR, rapid defibrillation, advanced resuscitation by emergency medical services and other healthcare providers, post-cardiac arrest care and recovery, including additional treatment, observation, rehabilitation and psychological support. Although each link holds its own eminence, early defibrillation is considered one of the most important elements in the Chain of Survival [18]. The AHA states that with meticulous implementation of the aforementioned steps, the number of people losing their lives to cardiac arrest can be brought down significantly if 20% of the population are trained [19].

Studies have shown that if CPR is performed by trained personnel with minimal delay, the mortality rate will surely be reduced [20]. A thoroughgoing, good cardiopulmonary resuscitation (CPR) training for medical students has always been the focus of medical educators [21]. As a result, Cardiopulmonary Resuscitation training is an increasingly popular concern in undergraduate medical education curricula [22]. Many studies have implied that the CPR skills of medical graduates and beginning physicians are unsatisfactory, partially due to shortcomings and defects in training [23]. In a study conducted in the Islamic Republic of Iran, it was demonstrated that there was a significant difference between dentistry students who participated in CPR training course and those who did not, with only 3.75% being able to perform a proper CPR among the non-participants [24]. Given the nature of the jobs of medical students, it becomes even more cardinal for them to have the right knowledge and proficiency for performing a

CPR. Interns' deficiencies in CPR-related knowledge, attitude, and practice have been shown to affect initial assessment, treatment options, and inpatient outcomes [25]. A systematic CPR training method is essential to attain the prerequisite skills. A 4th year medical student is expected to be able to perform CPR for all patients in all situations and to mentor other members of the medical team and educate them and the community about the significance of having this life-saving skill. In order to master the dexterity in cardiopulmonary resuscitation, one needs to exercise skills in a real (or simulated) environment. As most of the present education in the field is observational and class - restrictions including inadequate assessment does not allow good practical learning, it seems that both practical and observational courses are essential for medical students before the start of their internship [26]. This further reinforces the importance of inclusion of Skill/Simulation laboratory for CPR training in the medical curriculum.

Previous studies have indicated that CPR training should be included in the medical curriculum, but there is a lack of evidence to show where CPR training for medical students needs to be introduced into the curriculum [27]. It appears that the lack of a specific rotation devoted to CPR training, medical students may not be able to attain the confidence and expertise that is called for to correctly perform CPR. Furthermore, devoid of a designated curriculum, multiple departments take the responsibility for CPR education and training, thereby participating in it in a sketchy manner. On that account, it is of utmost importance to appoint a specific department (The Department of Anesthesiology) to impart the necessary knowledge and skills to medical students during their rotation so they can be capable of providing the services that are expected of them in emergency situations.

Methods

A pre-test/post-test single group quasi experimental design study involved a random sample of medical students during their anesthesiology rotation in the year 2021-2022 at Tehran University of Medical Sciences Hospital Complexes. A sample of 90 5th, 6th and 7th year medical students were included. A self-administered structured questionnaire developed after reviewing previously conducted studies, directions of AHA 2015 guidelines

The questionnaire was completed by each student before they began the anesthesiology rotation and after they complete the rotation. The questionnaire included demographic questions, questions to assess the medical student's knowledge of basic life support (BLS) and advanced cardiac life support (ACLS), and self-evaluation questions which were completed by medical students.

The rotation included a 14-day CPR training provided by two experienced anesthesiology faculty members, and it included theoretical and practical training.

the students were introduced for the rotations in groups, after the application of inclusion/exclusion criteria and obtaining an informed consent, explaining the purpose of the study for the participants, an online questionnaire was filled by participating students at the beginning and end of the rotation.

The questionnaire included 5 demographic questions about the participating students (age, gender, GPA, previous CPR experience, academic year), 20 adult ACLS and BLS questions mostly about the chain of life, pace of CPR, time allowed to check the pulse of a patient that had collapsed, hand positioning during CPR, number of chest compressions relative to breaths given, duration of a CPR cycle, CPR cycles before switching individuals carrying on the resuscitation, when to defibrillate, drug used and it's dosage during CPR, causes of cardiac arrest, tools to evaluate a cardiac arrest patient, post cardiac arrest care, CPR termination, etc. And 2 self-evaluation questions for student's knowledge and skill respectively regarding adult ACLS and BLS and the same questionnaire was filled at the end of the rotation for comparison.

To ensure better understanding and dissemination, the questionnaire (in Persian) was sent as a link as an online link via various social media platforms. Assistance was offered via direct or indirect contact upon request. The questionnaire was developed based on AHA guidelines of cardio-pulmonary resuscitation and its reliability was assessed through a pilot study on interns leading to a Cronbach's á of 0.75.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 22 (SPSS Inc., Chicago, USA). Categorical variables were compared using Fisher's exact or χ 2 tests, and continuous variables were compared using student's t-test, ANOVA, and Chi-Square. Univariate analyses and multivariate analyses performed. Data were presented as mean ± standard deviation (SD) for continues variables and P value <0.05 was considered statistically significant.

Ethical Considerations

An informed consent was obtained from the participants in the study. The participation in research was optional. All research objectives were explained to the participants and they were given the necessary assurance regarding the confidentiality of information. Ethical principles were considered in writing articles and using books and scientific sources. In conducting this research, no additional costs were imposed on participants.

Results

The total number of respondents was 146. 90 participants' questionnaires were included in the study and the others were excluded due to not meeting our

inclusion criteria. The participants' response to each question was examined and, in some cases, a statistically significant difference was found between the answers of different groups of respondents. Then we ran statistical tests to investigate differences in behavior between these two groups as well, which we are discussed below.

Age

The average age of the responders was 24.8 years. The youngest and oldest respondents were 22 and 30 years old respectively. In our study the age of the respondents did not show any significance.

Gender

Of the 90 students that were included in our study, 40 (44%) were males and 50 (56%) were males (Figure 1).

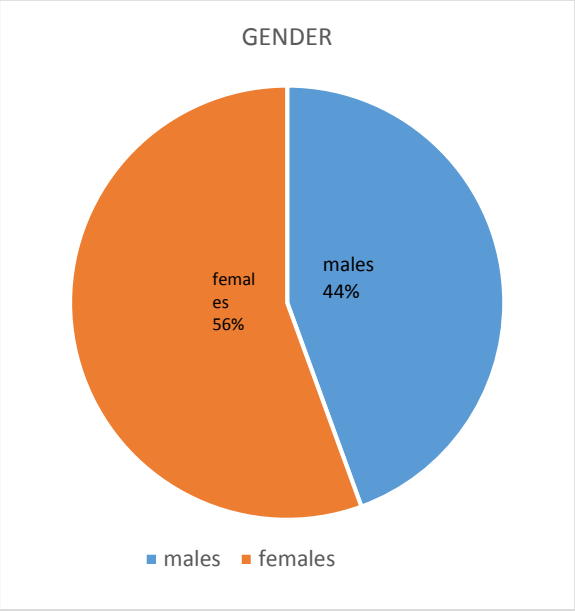

Figure 1- Distribution of respondents according to gender.

The mean score for females before the anesthesiology rotation (pre-score) was 10.6/20 and the mean score for females after the anesthesiology rotation (post-score) was 12.9/20 with a p value = 0. The pre-score of males was 9.6/20 while the post-score was 11.8/20 and its p value=0.007 (Table 1).

Both results showed significant improvement after our intervention.

The mean score for females' knowledge before the anesthesiology rotation (pre-knowledge) was 2.7/5 with and the mean score for females' knowledge after the anesthesiology rotation (post-knowledge) was 3.6/5 with p value = 0. The pre-knowledge for male students was 3/5 and the post-knowledge was 3.8/5 and the p value = 0.03 (Table 2). Both of these results showed a significance in relation to student's assessment of their knowledge before and after our intervention

The mean score for females' skill before the anesthesiology rotation (pre-skill) was 2.5/5 and the mean score for females' skill after the anesthesiology rotation (post-skill) was 3.7/5 with p value = 0. The pre-skill of male students was 3/5 and the post-skill was 3.8/5 p value= 0.009. The assessment of medical students of their skills significantly changed in an upward manner.

Academic Year

In our study students were divided according to their academic year into interns and stagers. 41 respondents were interns and 49 were stagers (Figure 2).

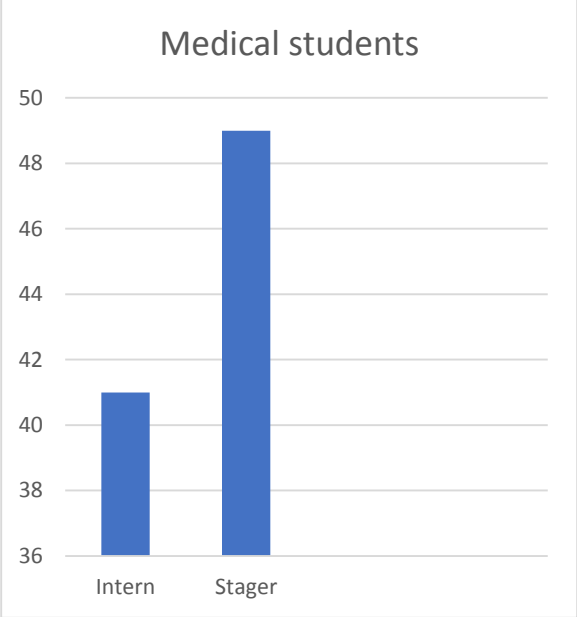

Figure 2- Distribution of medical students according to academic year.

The interns' pre-score was 11.2/20 and their post-score was 13.2/20 with p value = 0.001. The stagers' pre-score was 9.2/20 and their post-score was 11.8/20 with p value= 0.001 (Table 1).

Both results showed significant improvement after our intervention.

The inters' pre-knowledge was 3/5 and their post-knowledge was 3.9/5 with p value = 0. The stagers' pre-knowledge was 2.7/5 and their post-knowledge 3.6/5 was with p value = 0.001.

Both of these results showed a significance in relation to student's assessment of their knowledge before and after our intervention

The Interns' pre-skill was 3.2/5 and their post-skill was 3.8/5 with p value = 0. The stagers' pre-skill was 2.4/5 and their post-skill 3.7/5 was with p value = 0.001 (Table 2).

The assessment of medical students of their skills significantly changed in an upward manner.

In regression, the academic year held no significant value on the results change despite the improvement (Table 4).

Experience

We asked students if they've had an experience watching or performing CPR and divided them into two groups, those who have witnessed CPR once or more and we labeled them as "experienced" and those who haven't witnessed CPR were labeled as "unexperienced".

Experienced students before the rotation were 61 and after the rotation, they increased to 70.

Experienced students' pre-score was 10/20 and their post-score was 12.4/20 with p value= 0 (Figure 3). Unexperienced students' pre-score was 10.3/20 and their post-score was 12.5/20 with p value = 0.01 (Table 1).

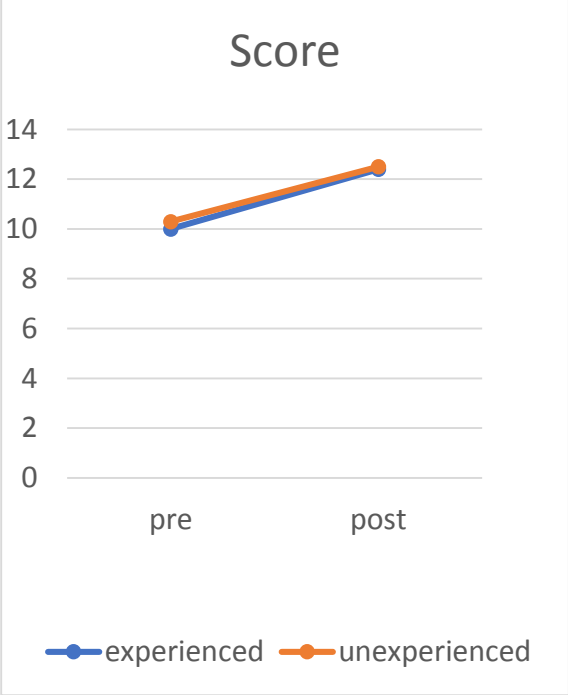

Figure 3- The change in the scores of experienced and unexperienced medical students after the anesthesiology rotation.

In both groups there was a significant improvement in students' scores after the anesthesiology rotation.

Experienced students' pre-knowledge was 3/5 and their post-knowledge was 3.8/5 with p value = 0.

Unexperienced students' pre-knowledge was 2.5/5 and their post-knowledge was 3.4/5 with p value= 0.007 (Table 2). Both these values showed meaningful increase in student's knowledge self-assessment.

Experienced students' pre-skill was 3.2/5 and their post-skill was 3.8/5 with p value= 0.002. (Figure 4). Unexperienced students' pre-skill was 1.9/5 and their post-skill was 3.5/5 with p value = 0 (Table 3). Both these results were meaningful which means the anesthesiology rotation has increased students' skill self-assessment.

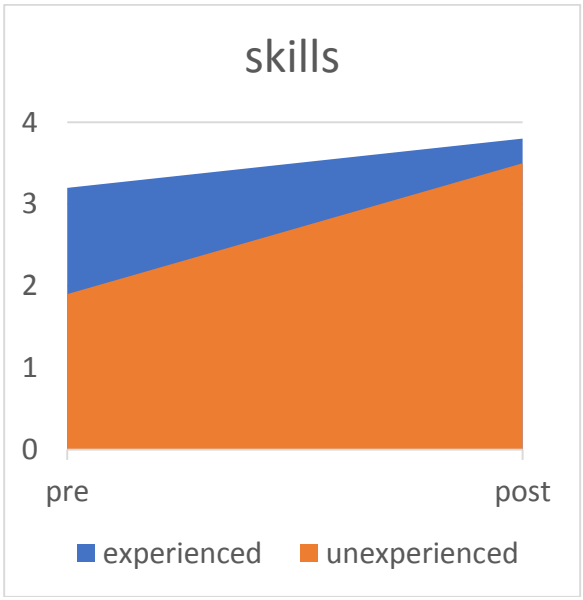

Figure 4- The increase of self-assessment of skills among experienced and unexperienced students.

In regression experience was the main factor affecting students' assessment to skill (Table 4).

GPA

We asked the participants their GPA and we classified them into two groups; those who have GPA above or equal to 17 (>17) and those who have a GPA of below 17 (<17) at the time of the conduction of the study. 39 respondents had a GPA equal to or above 17 and 51 students had GPA lower than 17.

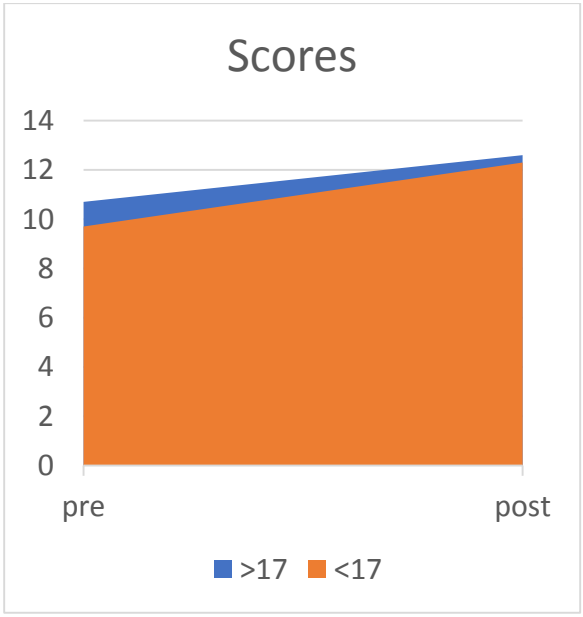

Figure 5- The change in the scores of medical students with >17 GPA and <17 GPA after the anesthesiology rotation.

The >17 group had a pre-score was 10.7/20 and their post-score was 12.6/20 with p value =0.019. (Figure 5). The <17 group had pre-score was 9.7/20 and their post-score was 12.3/20 with p value= 0 (Table 1). In both groups there was a significant improvement in students' scores after the anesthesiology rotation.

The >17 group had a pre-knowledge of 2.9/5 and their post-knowledge was 3.6/5 with p value =0.007. The <17 group had pre-knowledge was 2.9/5 and their post-knowledge was 3.8/5 with p value = 0 (Table 2).

The >17 group had a pre-skill of 2.6/5 and their post-skill was 3.6/5 with p value =0.001. The <17 group had pre-skill was 2.9/5 and their post-skill was 3.8/5 with p-value= 0 (Table 3). The assessment of medical students of both their skills and knowledge significantly changed in an upward manner.

In regression, it was concluded that GPA was not the key element affecting the improvement of the results (Table 4).

Table 1- T-test results by Questionnaire Score: H1: dif= 0

Groups	Obs Post	Obs Pre.	Mean Post	Mean Pre	dif	St Err	t value	P value
All Students	90	90	12.400	10.133	2.267	.484	4.7	0
Female Students	50	50	12.900	10.592	2.308	.581	4	0
Male Students	40	40	11.775	9.585	2.19	.798	2.75	.007
Interns	41	41	13.171	11.244	1.927	.552	3.5	.001
Stagers	49	49	11.755	9.204	2.551	.727	3.5	.001
Experienced	70	61	12.386	10.033	2.353	.593	3.95	0
Unexperienced	20	29	12.450	10.345	2.105	.848	2.5	.017
GPA above 17	38	39	12.606	10.744	1.861	.779	2.4	.019
GPA below 17	52	51	12.250	9.667	2.583	.612	4.2	0

Table 2- T-test results by Self-Assessment (Knowledge): H1: dif= 0

Groups	Obs Post	Obs Pre.	Mean Post	Mean Pre	dif	St Err	t value	P value
All Students	90	90	3.711	2.867	.845	.163	5.2	0
Female Students	50	50	3.620	2.735	.886	.204	4.35	0
Male Students	40	40	3.825	3.025	.8	.263	3.05	.003
Interns	41	41	3.903	3.049	.854	.197	4.35	0
Stagers	49	49	3.551	2.715	.837	.247	3.4	.001
Experienced	70	61	3.815	3.049	.765	.19	4.05	0
Unexperienced	20	29	3.350	2.483	.867	.305	2.85	.007
GPA above 17	38	39	3.579	2.872	.707	.252	2.8	.007
GPA below 17	52	51	3.808	2.863	.945	.215	4.4	0

Table 3- T-test results by Self-Assessment. (Skill): H1: dif= 0

Groups	Obs Post	Obs Pre.	Mean Post	Mean Pre	dif	St Err	t value	P value
All Students	90	90	3.722	2.756	.967	.176	5.5	0
Female Students	50	50	3.680	2.53	1.149	.223	5.15	0
Male Students	40	40	3.775	3.025	.751	.279	2.7	.009
Interns	41	41	3.780	3.22	.561	.195	2.9	.005
Stagers	49	49	3.674	2.368	1.306	.269	4.85	0
Experienced	70	61	3.772	3.164	.608	.191	3.2	.002
Unexperienced	20	29	3.550	1.897	1.653	.338	4.9	0
GPA above 17	38	39	3.553	2.564	.989	.287	3.45	.001
GPA below 17	52	51	3.846	2.902	.944	.22	4.3	0

Table 4- OLS Regression of 3 Independent Variables and Post

Variables	(1) Dep. Var. Score	(2) Dep. Var. Knowledge SA	(3) Dep. Var. Skill SA
GPA	0.532***	0.0702	-0.0255
	(0.187)	(0.0643)	(0.0729)
Female	0.410	-0.304*	-0.297*
	(0.477)	(0.171)	(0.179)
Experienced	-1.028**	0.371*	0.658***
	(0.506)	(0.195)	(0.222)
Intern	2.082***	0.302*	0.330*
	(0.481)	(0.180)	(0.187)

Post	2.376***	0.812***	0.904***
	(0.456)	(0.159)	(0.165)
Constant	0.897	1.489	2.741**
	(3.026)	(1.074)	(1.170)
Observations	180	180	180
R-squared	0.235	0.195	0.248

Discussion

It is known that the universal cause of death is cardiovascular diseases. The economic burden that these diseases carry is enormous and numerous studies have been conducted to put a limit to the losses [11]. One of the main factors that put people's lives in danger is cardiac arrest. Until our Healthcare systems do not have properly trained staff and confident personnel that are able to intervene in life-death situations, we cannot control the horrible outcomes of these events. Our study focused on evaluating the degree to which a CPR training course in anesthesiology rotation can affect medical students. And try to analyze the group of students that could benefit the most from these courses and try to apply those variables to future groups.

The incidence of cardiac arrests that occur within hospital settings is remarkably elevated. Each year, it is approximated that a total of 290,000 cases of cardiac arrest occur in hospitals in the United States. Achieving a higher level of awareness in optimizing clinical care, coupled with further research endeavors, holds potential to advance overall outcomes [28]. Education is one of the methods to combat cardiac arrest mortality in hospitals and out of hospitals [20]. Medical students face death on a regular basis during their clinical rotations [29] and cardiovascular events form the major cause of the deaths11, considering that the benefits of early detection of a cardiac event are maximized when the responder is directly witnessing the event, the outcome of heart attacks can be improved with an appropriate intervention [30].

In our study we aimed to determine how important it is to assign a CPR education workshop for medical students during their anesthesiology clinical rotation with the purpose that this research can have a direct impact on lives of cardiac arrest patients and improve the assessment and decrease the time required to start an intervention to save patients' lives, moreover it can shield medical students' mental health by reducing the number trauma due to mortalities.

Age was not significant factor in our study because it did not affect the results in a meaningful manner.

Some local and national studies were conducted to evaluate the learning of CPR and factor contributing to it, for example one study assessing CPR knowledge among Allied Health Professionals students in the United Kingdom in the Faculty of Applied Medical Science concluded that there were no significant statistical differences were observed based on gender (p=0.7), or GPA (GPA; p=0.6) [31]. These results were compatible to our study (Table1), where in regression; gender was not the contributing factor to improving the scores of students. GPA not making a difference in regression is probably because considering how critical CPR is, students focus more on the clinical knowledge. For that reason, GPA differences could only have minimalistic effects on students' scores. However, several studies have demonstrated that patients receiving medical care at healthcare facilities with a higher number of staff with advanced educational qualifications tend to experience decreased rates of both mortality and complications [20]. Nevertheless, it's unknown whether these results would apply to medical students considering the higher incidence of error in the undergraduate stage and first-time encounters.

A different study discussing the best time for learning CPR in medical school concluded that optimal experience in CPR is gained in internship [32]. This contradicts with the results of our study which had higher scores of interns compared to stagers but it was not significant. Interns did not have a significantly higher score although having more CPR experience was probably due to stagers being constantly in contact with theoretical examination which led to similar scores compared to their senior interns.

In our study, experience had the most important impact on the skills and knowledge of medical students. (Table 5) Rajaram N et al found a significant increase in BLS knowledge among medical students before and after COVID-19, a pandemic which held increased experience with cardiac arrests and motivation to learn more about BLS [33]. These results support our data obtained in our study. These data assist the overall practical goal of practicing medicine and undergoing those rotations to enhance the process of patient resuscitation.

Conclusion

We noticed that medical students were eager to learn these CPR techniques and they saw it as an interesting topic. The present study, along with others mentioned earlier, suggests that comprehensive training is imperative for medical students to augment their knowledge, and subsequently improve healthcare outcomes in hospitals through more efficient care. A significant advancement was witnessed across all three fields measured (Figure 1). The current study indicates

that encountering a previous CPR experience is substantial to retaining information and proficiency and providing the confidence needed to apply the CPR knowledge and skills.

Accordingly, attending doctors and medical education should focus on increasing the exposure of medical students to resuscitation scenarios while maintaining a good quality of education.

It is worth mentioning, that the study sample was obtained exclusively from different hospitals of Tehran University of Medical Sciences. Therefore, the study's outcomes should be interpreted in that context. It is reasonable to assume that the aforementioned findings may be generalizable to a broader range of medical universities.

Recommendations

Questions regarding medical students teaching what they have learned to people in their community and how improvements that could be done to the programs, these questions can be included in questionnaires of future studied to assess the exponential advantages of these training courses. A 3-month follow up assessment program could be helpful in determining the level of knowledge retention. A study across the nation may be deemed necessary to determine the veracity of the findings presented here in with regards to other medical universities and the assessment of level of CPR knowledge of medical students and training programs during medical school rotations across the country. A cohort study to compare medical students' CPR knowledge and skills of two independent groups before and after anesthesiology and emergency medicine rotations respectively might be recommended to isolate the benefits of each training program.

Limitations

Our study did not include a follow up assessment to evaluate the retention of CPR knowledge and skills. The problem of access to a wider sample and lack of cooperation are some of the limitations of the research.

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References

[1] DeBard ML. The history of cardiopulmonary resuscitation. Ann Emerg Med. 1980; 9(5):273-5.

[2] Lee K. Cardiopulmonary resuscitation: new concept. Tuberc Respir Dis (Seoul). 2012; 72(5):401-8.

[3] Field JM, Hazinski MF, Sayre MR, Chameides L, Schexnayder SM, Hemphill R, et al. Part 1: Executive summary: 2010 Guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2010; 122:S640–656.

[4] Wik L, Kramer-Johansen J, Myklebust H, Sørebø H, Svensson L, Fellows B, Steen PA. Quality of cardiopulmonary resuscitation during out-of-hospital cardiac arrest. JAMA. 2005; 293(3):299-304.

[5] Bakke HK, Bakke HK, Schwebs R. First-aid training in school: amount, content and hindrances. Acta Anaesthesiol Scand. 2017; 61(10):1361-1370.

[6] Zinckernagel L, Malta Hansen C, Rod MH, Folke F, Torp-Pedersen C, Tjørnhøj-Thomsen T. What are the barriers to implementation of cardiopulmonary resuscitation training in secondary schools?A qualitative study. BMJ Open 2016; 6:e010481.

[7] Mehra R. Global public health problem of sudden cardiac death. J Electrocardiol. 2007; 40(6 Suppl):S118-22.

[8] Dan Sebastian D, Natalia H, Theodor B, Loredana F,Sanda Maria C. Training in cardiopulmonary resuscitation provided by medical students, residents and specialists: A non-inferiority trial. Hong Kong Journal of Emergency Medicine 2018; 25(1) 20–26.

[9] Stirparo G, Gambolò L, Bellini L, Medioli F, Bertuol M, Guasconi M, et al. Satisfaction evaluation for ACLS training. Acta Biomed. 2022; 93(3):e2022260.

[10] Taniguchi T, Ohta K, Kawada M, Inaba H, Yamamoto K. [Role of anesthesiologists is the education of cardiopulmonary resuscitation in local hospitals]. Masui. 2005; 54(4):436-9. Japanese.

[11] Organization WH. Global Health Observatory: non-communicable diseases mortality and morbidity. 2013.

[12] Sadeghi M, Haghdoost AA, Bahrampour A, Dehghani M. Modeling the Burden of Cardiovascular Diseases in Iran from 2005 to 2025: The Impact of Demographic Changes: IJPH. 2017; 46(4):506.

[13] Baduni N, Prakash P, Srivastava D, Sanwal MK, Singh BP. Awareness of basic life support among dental practitioners. Natl J Maxillofac Surg. 2014; 5(1):19-22.

[14] Goldman S, Johnson G, Cohn JN, Cintron G, Smith R, Francis G. Mechanism of death in heart failure: The vasodilator—heart failure trials. Circulation. 1993; 87:V124-31.

[15] Sasson C, Keirns CC, Smith D, Sayre M, Macy M, Meurer W, et al. Small area variations in out-of-

hospital cardiac arrest: does the neighborhood matter?. Annals of internal medicine. 2010; 153(1):19-22.www.annals.org.

[16] Song F, Sun S, Ristagno G, Yu T, Shan Y, Chung SP, et al. Delayed high-quality CPR does not improve outcomes. Resuscitation. 2011; 82 Suppl 2:S52-5.

[17] Kurz MC, Schmicker RH, Leroux B, Nichol G, Aufderheide TP, Cheskes S, et al. Advanced vs. Basic Life Support in the Treatment of Out-of-Hospital Cardiopulmonary Arrest in the Resuscitation Outcomes Consortium. Resuscitation. 2018; 128:132-137.

[18] Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015; 132(18 Suppl 2):S414-35.

[19] Thoren AB, Axelsson A, Herlitz J. The attitude of cardiac care patients towards CPR and CPR education. Resuscitation. 2004; 61(2):163–71.

[20] Plagisou L, Tsironi M, Zyga S, Moisoglou I, Maniadakis N, Prezerakos P. Assessment of nursing staff's theoretical knowledge of cardiovascular resuscitation in an NHS public hospital. Hellenic J Cardiol. 2015; 56(2):149-53.

[21] Graham CA, Guest KA, Scollon D. Cardiopulmonary resuscitation. Paper 1: A survey of undergraduate training in UK medical schools. J Accid Emerg Med. 1994; 11(3):162-4.

[22] Pishbin E., Bidar M., Eslami N, Akbari M., Ebrahimi M., Talebi Dalui M., et al. 'The Effect of Basic Life Support Workshop on Performance Skills of Iranian Undergraduate Dental Students'. Future of Medical Education Journal. 2015; 5(3):20-23.

[23] Graham CA, Scollon D. Cardiopulmonary resuscitation training for undergraduate medical students: a five-year study. Med Educ. 2002; 36(3):296-8.

[24] Jamalpour MR, Asadi HK, Zarei K. Basic life support knowledge and skills of Iranian general dental practitioners to perform cardiopulmonary resuscitation. Niger Med J. 2015; 56(2):148-52.

[25] Smith GB, Poplett N. Knowledge of aspects of acute care in trainee doctors. Postgrad Med J. 2002; 78(920):335-8.

[26] Isazadehfar K, Sadaghat M, Entezari asl M. Cardiopulmonary Resuscitation Training for Medical Students in Anesthesiology Rotation in Ardabil Medical University (Iran). J Med Edu. 2008;12(1 & 2):e105369.

[27] Nolan J. Advanced life support training. Resuscitation. 2001; 50(1):9-11.

[28] Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-Hospital Cardiac Arrest: A Review. JAMA. 2019; 321(12):1200-1210.

[29] Batley NJ, Bakhti R, Chami A, Jabbour E, Bachir R, El Khuri C, Mufarrij AJ. The effect of patient death on medical students in the emergency department. BMC Med Educ. 2017; 17(1):110.

[30] Larkin GL, Copes WS, Nathanson BH, Kaye W. Pre-resuscitation factors associated with mortality in 49,130 cases of in-hospital cardiac arrest: a report from the National Registry for Cardiopulmonary Resuscitation. Resuscitation. 2010; 81(3):302-11.

[31] Oteir AO, Almhdawi KA, Kanaan SF, Alwidyan MT, Williams B. Cardiopulmonary resuscitation level of knowledge among allied health university students in Jordan: a cross-sectional study. BMJ Open. 2019; 9(11):e031725.

[32] Ashoorion V, Changiz T, Sabri M. CPR Education before Internship. J Med Edu. 2006; 9(1):e105283.

[33] Rajaram N, Krishna H, Singh R, Narayan AK. Impact of COVID-19 on Basic Life Support Training Among Medical Students: An Experimental Study. Cureus. 2022; 14(4):e23775.