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Impact of cardiac life support training on retention of knowledge measured by pretest, immediate posttest, and 6-months posttest

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ABSTRACT

Introduction: Cardiac resuscitation skills are a necessity for newly graduated doctors as they are first responders during a crisis. Despite undergraduate exposure, interns still struggle in an actual crisis. We evaluated final year medical students' long- term retention of knowledge following cardiac life support training prior to exit from medical school to determine the need to revise and re-strategize.

Methods: Thirty-seven final year medical students participated in a quasi-experimental research after a cardiac life support (CLS) course where results of their one best answer assessment-pretest, immediate posttest and 6 months posttest were analyzed.

Results: A repeated measure ANOVA was conducted on mean test scores of 30-items one best answer (OBA) questions, measured as pre-test, immediate and 6 months posttests after the course. The result showed significant time effect, Wilks Lambda = 0.126, F (2,35) = 121.468, *P* = <.001. Follow up comparison indicated that each pairwise comparison difference was significant (p ≤ 0. 05). Both immediate and after 6 months post-course test scores were statistically better than the pretest scores suggesting that there was improvement in knowledge after the course despite the decay.

Conclusion: Our results showed that retention of knowledge as a short-term memory worked well immediately after the hands-on cardiac resuscitation course. However, though there was improved knowledge even after 6 months compared to before the course, there was decay in knowledge. There is a need to re-strategize to improve knowledge retention.

Keywords: *Long term retention, knowledge, cardiac resuscitation, strategy, simulation*

INTRODUCTION

There are some skills that students must master before graduating from medical school and resuscitation of a collapsed or acutely ill patient is one of them. Medical students in the final year are expected to be able to take history, perform clinical examination and suggest management of a condition or disease to be able to graduate. However, when they graduate, they are expected to also identify and initiate some form of management especially during a crisis since they are, as house officers, the first responders.[1-4]

In the recent years, there has been an increase in the number of medical graduates in Malaysia beyond the available posts in the country thus causing a delay in starting work as interns, with waiting time now reaching almost a year. Considering this and the fact that there is a 6 months' period of none or minimal exposure to cardiac resuscitation situations during the clinical postings, before exiting medical school, we feared a significant decay in knowledge and practical skills. Our aim was to determine the long-

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term retention of knowledge of final year students on cardiac resuscitation 6 months following completion of CLS training and identify if there was a need to revise or re-strategize. We hoped to obtain an insight on the effectiveness of the one-and-a-half-day course conducted to prepare students on resuscitation skills.

METHODS

A pretest posttest experimental research method was designed to analyze the effectiveness of a CLS hands-on training using simulations (high and low fidelity). The hypothesis was that there is a significant change in students' mean achievement scores before, during and after attending the cardiac life support training.

Participants' pre and post course knowledge was measured using a 30-items OBA test administered at three different times - pre-course, immediate post-course, and 6 months post-course. A convenience method of sampling was used and 37 participants who met the inclusion criteria were recruited in the study. Data collected as OBA test scores at the three different times was analyzed using one-way repeated ANOVA statistical method in Microsoft SPSS version 20 and result is reported.

The research was carried out in accordance with the Declaration of Helsinki, there was no potential harm to students, the anonymity of participants was ensured, and informed consent was obtained. As this was a study evaluating quality of an ongoing curriculum delivery, it was not brought to the ethical board for approval.

Course framework/programme

The CLS course is compulsory for all final year students and is conducted in the clinical skills and simulation labs at the clinical campus of International Medical University during the anesthesia posting. A cardiac life support manual prepared with reference to the latest American Heart Association (AHA) guidelines is provided online in the university's e-learning portal to help students prepare for the test and course.[5] Also available on the e-learn portal are videos on the right and wrong ways to resuscitate a patient and practice quiz to help students prepare for the course.

Students generally complete a pre-test, an introductory lecture, video demonstration of a right and wrong team resuscitation followed by rotation through 4 stations manned by faculty: (1) airway devices and part-trainer for chest compression (2) defibrillator (3) drugs and delivery (4) Mega code – hands-on training on human patient simulator (high fidelity). Included in the course on the same day is an interactive practice session on interpretation of ECG of commonly encountered cardiac emergency rhythms and mega code practice session where students are given sample scenarios to practise among themselves under the guidance of an instructor.

For this research, assessment was carried out 1-week post-course using a checklist to assess performance during mega code (practical skills) and post-course OBA (knowledge). Six months after the course and not having had any interventions in place to maintain knowledge and skills in resuscitation, the students completed the same 30-items OBA test.

RESULTS

There was a significant change in participants' mean achievement scores before (16.62) and after (23.59) attending the cardiac life support workshop. However, the mean score (18.54) at 6 months posttest was lower than at immediately after training but higherthan the pretest score. (Table I)

Table I: Descriptive statistics with mean and standard deviation

Test time	n	Test Scores	
		Mean	SD
Pretest scores	37	16.62	3.538
Immediate posttest scores	37	23.59	1.723
6 months Delayed Posttest Scores	37	18.54	2.950

To check the assumption of repeated measure ANOVA, we referred to Mauchly's test of sphericity and the output data of this condition showed that the variance of repeated measure is equal across time ($p = 0.233$), which means homogeneity of variance is not violated (Table II).

Table II: Homogeneity of variance using test of sphericity

Mauchly's Test of sphericity							
					Epsilon[b]		
Within Subject Effect	Mauchly's W	Approx Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.920	2.917	2	.233	0.926	.974	0.500

Having met the equality of variance across the dependent variables using sphericity test, multivariate output data of Wilk's Lambda was chosen to determine the test significance and its effect size. (Table III)

Table III: Inferential statistics as multivariate test of Wilk's Lambda and its effect size

Multivariate Test[a]							
Effect		Value	f	Hypothesis df	Error df	Sig.	Partial Eta Squared
Time	Wilks' Lambda	.126	121.468[b]	2.000	35.000	<0.001	0.874

In the pairwise comparison table, numbers 1, 2 and 3 represent the pretest, immediate posttest and delayed posttest respectively (Table IV).

Table IV: Pairwise comparison of mean difference and the 95% confidence interval

(I) Test Time	(J) Test Time	Mean Difference (I-J)	Std Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-6.973	488	< .001	-8.198	-5.748
	3	-1.919	.602	.009	-3.431	-.407
2	1	6.973	.488	< .001	5.748	8.198
	3	5.054	.498	< .001	3.804	6.304
3	1	1.919	.602	.009	.407	3.431
	2	5.054	.498	< .001	-6.304	-3.804

DISCUSSION

Participants demonstrated good short-term memory as shown by the immediate post-test scores that had good correlation with the pre-test score. The main effect of time was statistically significant (Table III) showing that a difference existed along the time span of achieved scores.

In the current study, the passage of time had a significant effect on the participants' knowledge as measured by pretest and two posttests scores at different times. A high effect size was found (Table III) with partial Eta squared = 0.874 using the Cohen's criteria (Cohen's large effect size = 0.18).[6]

Course design and delivery influences cognitive retention of long-term memory especially if designed in keeping with the principles of experiential learning. Experiential learning practised with features of brainstorming of prior knowledge, experience and reflective practice during the course followed by immediate feedback to identify gaps in knowledge and skills to acquire new knowledge for a contextualised future practice will improve the likeliness that information gathered move into the long- term memory.[7]

Pairwise comparison also indicated a significant difference between pretest and the immediate posttest (Time 1 and 2), pretest and delayed posttest (Time 1 and 3) as well as between the immediate posttest and the delayed posttest (Time 2 and 3), significant at $p \leq 0.05$. (Table IV) The loss of effect between Time 1 and 3 compared to Time 1 and 2 suggests that effective design implementation strategies will be needed as an interphase to move the acquired knowledge and skills from short term memory to long term memory. One such strategy would be to utilize the principles illustrated by Gibb's reflective cycle which offers a framework for examining experiences. Currently, immediate feedback is provided to students as soon as they complete the mega-code assessment, and they are encouraged to reflect and apply the skills when they are in the wards. However, in the actual environment, a chance to assist or observe management of cardiac resuscitation is rare and inconsistent. This lack of follow through and consistency of exposure after the course will contribute to the decay in the knowledge and skills as students progress through all postings to complete medical school as noted in our study and several others.[8]

Resuscitation skills are important skills that are required to be achieved upon graduation from medical school as part of preparation for real life practice. These skills will translate to better patient outcome when a crisis is encountered in the wards.[2] Universities are not uniform in the weightage provided in honing these skills.[9] Cardiac resuscitation is not a skill to be learnt after graduation and practised on patients for the first time. Exposure at an early stage in the medical school will prepare them for challenges as junior doctors.[1,10]

The results of our study clearly show that the CLS course has an impact on knowledge and skills immediately after the training. The available evidence suggests that acute life support (ALS) knowledge and skills decay by 6 months to 1 year after training and that skills decay faster than knowledge.[7,11-14] Looking into the possible causes for this decay, we note that our course is conducted in the first half of the final year of study and the exposure in the second half

is random and opportunistic. Students do not get to observe or participate in a cardiac resuscitation situation consistently until they exit medical school. They do not start working as doctors immediately and while waiting for work placement there is complete cessation of exposure to clinical work which will undoubtedly contribute to the continued decay of the knowledge and skills of resuscitation.

Prior clinical experience could be a factor that affects retention of knowledge and skills acquired during the resuscitation course. Medical students during their clinical years, do not have the luxury of experiencing regular cardiopulmonary resuscitation exposure during all postings. Random and by chance opportunity to observe or participate in a resuscitation activity is the most many have. Our students, however, had completed the basic life support course early in year 3. That being so, many who come for the cardiac resuscitation course have had minimal if any exposure after that initial exposure in year 3 as they were then in the basic sciences phase and did not have much hospital exposures. Preparing for the course by reading the CLS manual and watching the videos of mega-code on the e–learning portal would be their first proper delve into the advanced theory component of the cardiac resuscitation knowledge.

Literature shows that attempts have been made by many researchers to overcome the problem of decay and reduced retention of knowledge and skills: (1) Planned re-test after 6 months; (2) Low dose spaced ACLS); (3) Timing of training; (4) Use of simulated training with or without high fidelity manikin or computer-based simulation; (5) Refresher training every six months.

1. Planned re-test

Su *et al* used re-test as a tool for knowledge retention but found that knowledge exam and mock resuscitation scenarios given after 6 months to some groups, resulted no difference in knowledge between intervention and non-intervention groups at 12 months.[15] The results suggested that periodic knowledge or skills retesting did not aid in the retention of pediatric resuscitation knowledge. Planned re-test may not be an appropriate sole strategy to be implemented for our students but it could be one component of a strategy.

2. Low dose, spaced, high frequency cardiac resuscitation

Some researchers found low dose spaced cardiac resuscitation training to be effective.[2,16] Short-duration, distributed CPR training on a manikin with real-time visual feedback is effective in improving CPR performance, with monthly training more effective than training every 3, 6, or 12 months.[17] However, there are other logistics that need to be considered like support staff, timetabling into an already packed schedule and availability of faculty since this has to be done regularly and consistently.

3. Timing of training

The timing of resuscitation training is important as maturity and exposure during ward learning may contribute to retention. Course conducted close to exit from medical school will reduce the period of no exposure to clinical work in our graduates. This is to pace training based on the workforce situation in our country now.

(4) Simulation based training

The effectiveness of simulation training for promoting retention of skills has been validated among other skills training courses.[18,19] Simulation based training for resuscitation has been shown to be highly effective by some researchers.[20-24] Simulation could range from low fidelity using task trainers to high fidelity manikins (human patient simulators). Computer based simulation is an example of high technology simulation that may be helpful for knowledge acquisition more than hands on skills. Computer based simulation or simulation using high fidelity manikin may be alternatives to help reduce the rate of decay after resuscitation course.[25,26] It has been suggested that timely and recurrent incorporation of simulation training may bridge the gap to emergent clinical situations.[25]

I) Computer based simulation

There is literature suggesting that computerized ACLS simulation program improves retention of ACLS guidelines better than textbook review.[23,24]

II) High fidelity manikin

Traditional training involving power point presentations and demonstration on a static manikin is an effective teaching strategy; however, study using simulation as a teaching tool found it significantly more effective than traditional training in helping to improve nursing students' knowledge acquisition, retention, and confidence about ACLS. [25,27]

(5) Repeat training/refresher

Repetition after initial learning stimulates retrieval of information from another part of the brain, which augments deeper processing of the information into memory.[18,28] A study with nurses who underwent cardiopulmonary resuscitation training indicates that a 6 monthly refresher may be needed to maintain knowledge and skills after training.[12]

In a systematic review of randomized controlled trials on improvement of skills retention, it was noted that simulation-based interventions, refresher courses and adjustments to the content of delivery of advanced structured resuscitation training courses were found to have the greatest impact on skills retention.[18]

One technique may not be the answer to improving retention of knowledge and skills. We will perhaps in future, resort to a combination of techniques; courses with high fidelity simulators, followed by a refresher using a computer-based simulation and a retest over intervals until exit from medical schools. Beyond this, faculty coaching is crucial, and instruction might benefit from gamification, social and digital media to help learners of this century retain what they are taught.[29,30]

After graduation, the onus is on students to continue to keep updated while waiting for placement as failing to do so will undo all the efforts put in during the final year of medical school to maintain knowledge and skills. What we can foresee are challenges in the implementation as the curriculum is already packed with a lot of other learning content and students may see this as added load and stress.

CONCLUSION

Cardiac life support course without doubt has an impact on acquiring skills of resuscitation among students. However, there was significant decay in

knowledge when reassessed after a period of 6 months. There is a high possibility of further decay, which will mean that the sessions conducted in medical school become futile unless some preventive measures are undertaken. The results of the study clearly indicate a need for intervention.

The plan underway is to have short intermittent online refreshers in the form of quizzes and cardiac resuscitation practice scenarios using simple virtual platform until students graduate. This would allow application of knowledge albeit online and promote retention. Future research will need to be conducted to evaluate the effectiveness of the measures currently being put in place to improve retention of knowledge and skills.

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