Retention of cardiopulmonary resuscitation skills in medical students utilizing a high-fidelity patient simulator

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Objective: *To evaluate the difference in retention of cardiopulmonary resuscitation (CPR) skills between first and second year medical students in accordance with American Heart Association (AHA) recommended basic life support (BLS) guidelines from 2005.*

Introduction: *Cardiopulmonary resuscitation has a narrow window of opportunity. It must be started early and followed by defibrillation in a timely manner for maximal benefit. Many studies have demonstrated that health care providers trained in CPR lose their skills quickly. However, little research has been done to evaluate the retention of CPR skills in pre-clinical medical students prior to beginning their clinical training.*

Methods: *22 first-year and 19 second-year medical students were voluntarily enrolled in the prospective cohort study. Participants were queried regarding BLS training, familiarity with the computerized mannequin simulator (SimMan®), and CPR experience. Each participant was then introduced to SimMan® and a standardized cardiac arrest scenario was read to them. Data was collected manually behind a two-way mirror. Participants were scored on their compliance with BLS criteria.*

Results: *Overall, key steps in CPR were omitted by many participants. One out of five subjects began CPR without first checking for a response, two out of three subjects did not request a defibrillator, and an average of 35.9 (0.0, 100.7) seconds elapsed before CPR was initiated. The average compression rate per minute in first-year medical students (MS1s) (22 subjects) was 63.6 (37.2, 90.1) compared to 52.5 (13.4, 91.6) in second-year students (MS2s) (19 subjects) with a BLS recommendation of 100 (*P *=.04). There were 84.2% of MS1s and 68.2% of MS2s that completed an average compressions to two breaths ratio of* $\geq$*27 with BLS recommendation of 30 compressions for every two breaths (*P *=.04).*

Conclusion: *Despite their training and proximity to a health care environment, medical students quickly forget important CPR rates and maneuvers. This deterioration of skills occurs regardless of training latency, a potential problem as they enter the patient care environment. Simulation provides a more real-life scenario in which to both train and evaluate medical student CPR skills.*

Keywords: *CPR; simulation; medical education; medical students; skills retention.*

INTRODUCTION

Cardiopulmonary resuscitation (CPR) is an important link in the chain of survival for the 300,000 people who suffer cardiac arrests annually in the United States.[1] Cardiopulmonary resuscitation has a narrow window of opportunity. It must be started early and followed by defibrillation in a timely manner. With inadequate or delayed CPR, the entire chain of survival is weakened and positive outcomes deteriorate rapidly.[2] However, when performed as recommended by the American Heart Association (AHA) and delivered quickly, CPR can double – even triple – a victim's chance of survival.[3]

Many studies have demonstrated that health care providers, such as registered nurses, trained in CPR have nearly a 50% degradation of their skills and knowledge within 3 months of training.[4,5] However, little research has been done to evaluate the retention of CPR skills in pre-clinical medical students. Prior to entering the hospital wards during their clinical phase of training, it is important to ensure every medical student possesses the skills needed to perform CPR successfully within a real-world environment – often more chaotic and unpredictable than the training environment. Although every medical student at our institution must complete the basic life support (BLS) for Health Care Providers (CPR and AED) course set forth by the AHA, this may not correlate well with resuscitation performance in the hospital setting.

The aim of this study was to evaluate the retention of CPR skills between first and second-year medical students and to identify specific strengths and weaknesses of student performance.

METHODS

Study design

Prospective cohort study.

Population and setting

First and second-year medical students at a large, state medical school in a university setting.

Human subjects committee review

IRB approval was obtained for participants to enroll in this study with a gift card incentive.

Experimental protocol

Twenty-two first-year and 19 second-year medical students at our institution were voluntarily enrolled in this study. Information was gathered prior to simulation by questionnaires regarding if and when the participants were trained in BLS, had previous exposure to SimMan® (a high-fidelity simulator), performed CPR on SimMan®, or performed CPR in a real-life scenario. After completion of the questionnaire, participants were introduced to SimMan®. The simulator's most relevant functions to our study, including a rising chest with inspiration, carotid and radial pulses, and the ability to communicate verbally were demonstrated to every study subject. A simulated cardiac arrest scenario involving a patient suddenly losing responsiveness in a hospital setting was presented to subjects. Twice, subjects were explicitly told to call out for anything they might need that was not provided in their immediate surroundings. Subjects were observed behind a two-way mirror using multiple cameras positioned around the simulation room.

Measurements

Data were collected regarding each subject's compliance with AHA recommended BLS guidelines from 2005. Subjects were qualitatively scored on whether they attempted to elicit a response from SimMan®, checked for pulse and signs of breathing, requested a defibrillator, performed an airway patency maneuver, and gave two rescue breaths. A participant's time to first compression, compression rate, and average compressions to two breaths ratio were also quantitatively recorded. Study coordinators and data collectors were not blinded to subjects' year in medical school.

Statistics

Intragroup comparisons of qualitative parameters for various measures were performed using the Yates corrected chi-square test for two-by-two contingency tables. Use of the Fisher exact test (two-tailed) was necessary when a null-hypothesis expected value was below five occurrences. Continuous quantitative parameters were compared between groups using a two-tailed *t*-test. *P*-values equal to or below .05 were considered significant. All statistical analyses were performed using Microsoft Excel® software.

Table 1. MS1 and MS2 background information.

Survey question	MS1 ($n = 22$)	MS2 ($n = 19$)
(A) AHA BLS certification	20 (90.0%)	19 (100%)
(B) OHSU-sponsored certification	19 (86.4%)	17 (89.5%)
(C) Certification <12 months prior	15 (68.2%)	7 (36.8%)
(D) Previous experience with SimMan®	5 (22.7%)	12 (63.2%)
(E) Performed CPR on SimMan®	2 (9.1%)	3 (15.8%)
(F) Performed CPR on real individual	2 (9.1%)	4 (21.1%)

RESULTS

The characteristics and survey results of the 41 study participants are outlined in Table 1. Previous CPR experience on SimMan® and previous real-life experience did not correlate with statistical differences among performance scores.

Nearly every subject checked for a pulse and breath before initiation of CPR. One out of five subjects began CPR without first checking for a response; two out of three subjects did not request a defibrillator; and an average of 35.9 (0.0, 100.7) seconds elapsed before CPR was initiated (Table 2).

The average compression rate per minute in first-year medical students (MS1s) (22 subjects) was 63.6 (37.2, 90.1) compared to 52.5 (13.4, 91.6) in second-year students (MS2s) (19 subjects) with a BLS recommendation of 100 ($P = .04$). MS1s (84.2%) and MS2s (68.2%) completed average compressions to two breaths ratio of ≥ 27 with a BLS recommendation of 30 compressions for every two breaths ($P = .04$) (Table 2).

There were 94.1% of the subjects who had previous experience with SimMan® (17 subjects) and 54.2% of those who did not (24 subjects) successfully performed an airway patency (head-tilt and chin-lift) maneuver ($P = .02$). Also, 29.4% of those with experience and 66.7% of those without completed an average compressions to two breaths ratio of ≥ 27 ($P = .04$) (Table 3).

DISCUSSION

Skill atrophy is a well-documented phenomenon among health care practitioners of all levels of expertise.[6] Therefore, it comes as no surprise that second-year medical students with a greater time interval since BLS training exhibit greater skill atrophy.

Although the observed differences between first and second-year medical students in this study may be confounded by prior simulation experience, the fact remains that despite training, medical students are unprepared for resuscitation emergencies.

Table 2. Difference in skill retention between MS1s and MS2s.

Procedure	MS1 ($N = 22$)	MS2 ($N = 19$)	P value
Checked for response	77.3%	84.2%	>.50
Requested defibrillator	27.3%	47.4%	>.25
Airway patency maneuver	59.1%	84.2%	.16
Checked for breathing	90.9%	94.7%	>.50
Checked for pulse	95.5%	100.0%	>.50
Average time in seconds to first compression (min, max)	29.1 (0.0, 89.6)	43.7 (0.0, 111.4)	.16
Average compressions per minute (min, max)	63.6 (37.2, 90.1)	52.5 (13.4, 91.6)	.04
Average compressions to two breaths ration ≥27	84.2%	68.2%	.04

Table 3. Difference in skill retention with and without SimMan® experience.

Procedure	Experience ($N = 17$)	No experience ($N = 24$)	P value
Checked for response	94.1%	70.8%	.11
Requested defibrillator	52.9%	25.0%	.13
Airway patency maneuver	94.1%	54.2%	.02
Checked for breathing	100%	87.5%	>.25
Checked for pulse	100%	95.8%	.50
Average time in seconds to first compression (min, max)	47.5 (0.0, 144.8)	27.6 (0.0, 86.6)	.06
Average compressions per minute (min, max)	59.5 (27.6, 91.5)	57.7 (21.1, 94.3)	>.50
Average compressions to two breaths ration ≥27	29.4%	66.7%	.04

Most importantly, both first and second-year medical students failed in some of the most critical aspects of CPR. Use of an AED is the number one predictor of survival,[7,8] but less than one in three students requested one. Cardiopulmonary resuscitation is necessary but not sufficient to save a life; it merely sustains a patient until an AED can be obtained. Additionally, approximately one in five students began CPR without first assessing the patient, potentially increasing the risk of improper compression maneuvers and reducing the benefit of CPR.

Inadequately adhering to AHA guidelines illustrates several key factors. First, recall of BLS protocol may be difficult under stress, as demonstrated by poor CPR performance in both groups. Second, it may be difficult for inexperienced practitioners, such as medical students, to translate proper protocol into actual clinical performance.

The results in this study may not be applicable to all other medical schools due to several reasons. Medical students at our institution interact with patients (take history and perform basic physical exam) starting in the second week of medical school. At the time of this study, the first and second-year medical students have had more than 6 or 18 months of practical clinical experience, respectively. Additionally, they are also observed examining standardized patients in multiple clinical scenarios three times per year as part of their evaluation. Finally, the average age of matriculation at this institution is 27 and may differ significantly from other medical schools. Thus, the interpretation and application of our study results should be made with these possible differences in mind.

LIMITATIONS

The small number of subjects enrolled in our study limits some of the conclusions that can be drawn from our results. Of note, since all study subjects volunteered to participate, there is potential for a selection bias toward students most comfortable with their CPR skills. Thus, our results may have underestimated BLS skill atrophy in medical students in general. The majority of each medical school class cohort were trained within a two week interval; however, a small percentage of students were certified previously (see Table 1). This inconsistency limits the comparisons that can be made between classes. Finally, the authors who assessed the study subjects were all first-year medical students at the time of this study and, therefore, could not be blinded to the study subjects' class level making observer bias inevitable.

To minimize such limitations, future studies should involve larger sample sizes, blinded observers, and control for pre-test confidence levels with pre-enrollment questionnaires. An alternative solution may be to evaluate BLS skills of the same group of medical students

at regular intervals with students serving as their own controls.

CONCLUSIONS

Despite their training and proximity to a health care environment, medical students quickly forget important CPR rates and maneuvers, a potential problem as they enter their clinical rotations. It is our belief that timely and recurrent incorporation of simulation training into medical education may bridge the gap between what is taught in the classroom and what is needed in emergent clinical situations.

We recommend that a BLS certification or recertification course be offered every year in medical school, followed by simulated scenarios within 6 months. We feel strongly that all students must be proficient at this life-prolonging skill upon graduation.

There is much research yet to be done in CPR performance and skill retention among medical students. Simulation offers itself as a model to assess student knowledge and ability, though it requires a significant investment of both time and resources. Recent research has shown video-based self instruction to improve CPR skill retention with less investment a potentially advantageous alternative within a demanding medical school curriculum.[9] Future study possibilities remain endless as more medical schools and residency programs begin to utilize simulation.

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