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Teaching basic life support for medical students: Assessment of learning and knowledge retention

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Abstract:

BACKGROUND: Education mediated by simulation is a widely used method for teaching basic life support (BLS). The American Heart Association recommends protocols based on scientific evidence to reduce sequelae and mortality. We aimed to assess learning and retention of knowledge of BLS in students of the first semester of the medical course using teaching methods of dialogic expository class (group 1), expository and demonstrative class (group 2), and the two previous methodologies associated with simulated practice (group 3), and after 3 months, memory retention.

MATERIALS AND METHODS: This was an experimental, prospective, randomized study. Participants were assessed in terms of performance in theoretical and simulated practical tests, satisfaction with training (Likert scale), and knowledge retention.

RESULTS: The practical test results were analyzed by two experienced observers. Students had 20% progression in knowledge and 80% retention of knowledge after 3 months of exposure comparing the theoretical pre- and posttest. The students in group 3 performed better than the others ($P = 0.007$) in the posttest. With the simulated practice, the knowledge acquired was maintained after 3 months with a mean performance of 90%, but in the test of the infant age group, there was a loss of learning retention by 10%. There was no difference of the results between the two evaluators ($P < 0.001$). The training was positively assessed by the participants.

CONCLUSION: The use of different methodologies promoted knowledge progression, with emphasis on simulated practice. Learning retention was maintained after 3 months. In order to teach BLS to infants, it may be necessary to improve teaching techniques.

Keywords:

Basic life support, medical education, resuscitation

Introduction

The simulation-based education is useful to explore important components in the training of health professionals, allowing the repetition of procedures and reflection on the adopted actions. Medical students need training and teaching to find learning opportunities to build their confidence level during the learning process. It promotes the development of skills, competences, and better proficiency through the feedback provided to the student.[1]

Simulation is one of the teaching support techniques, which analyzes risk factors and strategies in decision-making, being important for the training of professionals who provide assistance in emergencies. The simulation promotes the progression of skills and abilities, which includes improving the speed of decision-making and the ability to communicate with team members.[2] Basic life support (BLS) measures should be taught early in undergraduate courses of medicine in order to ensure the development and improvement of skills.[3] Health students

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exposed to simulation-based teaching can replicate knowledge for the community in general, and this action is important from the point of view of public health.[4] The American Heart Association (AHA) periodically publishes documents based on scientific relevance to recommend the best practices to ensure increased survival and reduced sequelae in victims.[5]

The assessment process in medical education is essential to ensure that the necessary skills are developed and that learning objectives are achieved.[5] Gontijo *et al.* reported that learning by doing is an effective and enriching educational strategy as an experience.[6] There are still gaps in knowledge about the real ability to learn in simulated and memory retention activities. Ruijter *et al.*[7] demonstrated the low memory retention capacity of BLS measures at 1 and 2 years after training medical students, recommending frequent training, as has been reaffirmed by the AHA.[5]

The present study aimed to assess the learning and retention of knowledge about BLS and the use of AED in first-semester medical students at a public university exposed to different educational methods, addressing the age groups of infants, children, and adults. They were evaluated in terms of performance in pre- and posttheoretical and practical tests, satisfaction and self-confidence with the course, and progression and retention of knowledge.

Materials and Methods

Study design and setting

This is an experimental, retrospective, and randomized study carried out from August to December 2018 with first-semester medical students at a public Brazilian university.

Study participants and sampling

For the assessment of knowledge prior to the course, 30 randomly selected students from the first semester of the course, who had not yet been exposed to the course content, were selected to respond to a theoretical test. This group was called "baseline leveling."

As inclusion criteria, the students should not have participated in a BLS course before the study. The invitation to participate was sent by e-mail, along with the scanned instructional material for prior study. The composition of each group was performed randomly, using software, being submitted to the following teaching methodologies: dialogic expository class (group 1), expository and demonstrative class (group 2), and the two previous methodologies plus simulated practice (group 3), and after 3 months, in a convenience sample, memory retention was assessed.

Data collection tool and technique

On the first day of class, students answered a theoretical pretest. Groups 2 and 3 attended a demonstration class on BLS measures with mannequins, AED, and self-inflating ventilatory unit with mask and reservoir. Group 2 students, selected by convenience sample, were invited to take a practical skill test before starting the activities involving the simulation, in order to assess their skills prior to the simulated practical class. Students from all groups answered a theoretical posttest and a satisfaction questionnaire at the end of the proposed activities. Groups 1 and 2 participated in practical activities but were not assessed in this regard. Figure 1 shows the sample and the way in which participants were allocated in each group.

The stations were divided into BLS and the use of AED in infants, children, and adults. The following were used: Laerdal brand simulators, these being SIMBaby®, MegaCode®, and MegaCodeKid®, all with a SimPad®-type feedback system; AED simulation equipment; image and sound capture system to record the activity.

The assessment instruments were theoretical test (14 multiple choice questions); practical assessment checklist validated by the AHA[5] (performed by two experienced observers); and satisfaction questionnaire, using a 5-graded Likert scale (ranging from totally disagree to totally agree). The following questions were asked, according to the group in relation to the expository class, demonstration, and practice: (a) the class achieved the proposed learning objectives; (b) the teacher demonstrated adequate didactics; (c) the class allowed the acquisition of knowledge of the BLS (infants, children, and adults, and the use of AED); (d) I feel prepared and confident to assist a patient in cardiac arrest with regard to BLS. The same theoretical test was applied in the pre- and posttest, changing the order of the alternatives of the questions.

After 3 months, students from groups 1, 2, and 3, in a convenience sample, performed the practical and theoretical tests, representing the memory retention assessment group.

Data were analyzed by the tests: Pearson's Chi-square; frequency analysis; Kappa test; percentage of correct answers, with mean and standard deviation; Kolmogorov–Smirnov normality tests, Mann–Whitney, and Kruskal–Wallis. To record the collected data, the SPSS statistical package, version 25, was used. $P < 0.05$ was considered as statistical significance. The sample of 20 volunteers per group as an acceptable minimum was calculated to allow the detection of a minimum difference of 0.6 standard deviation between the groups, with statistical power of 80% and confidence of 95%.

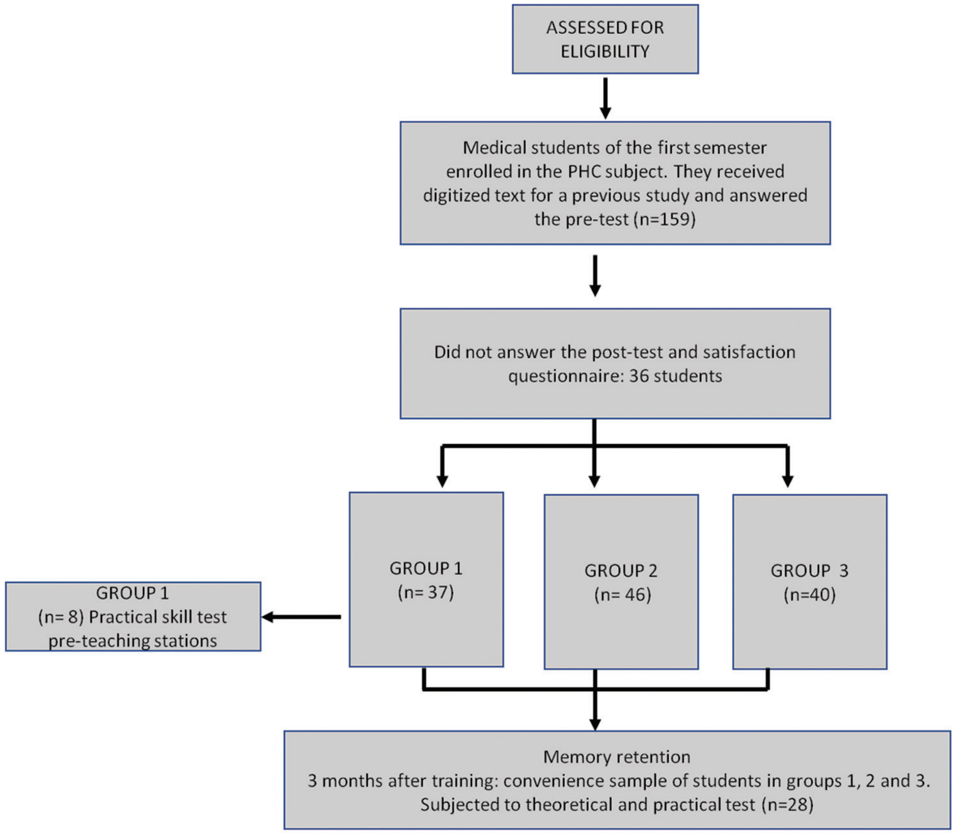

Figure 1: Study flowchart

Ethical consideration

The project was submitted and approved by the Ethics and Research Committee of MF-UFMG under the number CAAE 71487317.0.0000.5149 on 07/13/2017 and the Informed Consent Term was read, accepted, and signed by all participants.

Results

Thirty-seven students were allocated to group 1 and 122 to groups 2 and 3. Thirty-six students from these last two groups were excluded from the analysis because they did not complete the theoretical posttest and the satisfaction questionnaire, totaling 46 students in group 2 and 40 in group 3.

Table 1 shows the mean and standard deviation of the grades obtained in the theoretical pre- and posttest.

Table 1: Mean and standard deviation of the grades obtained in the theoretical pre- and posttest in the groups of baseline leveling, 1, 2, 3, and retention assessment

Groups	Moment			
	Pretest		Posttest	
	n	Mean	*n*	Mean
Baseline leveling	30	0.40±0.15		
1	39	0.65±0.23	37	0.81±0.09
2	80	0.60±0.19	46	0.83±0.11
3	40	0.61±0.22	40	0.84±0.11
Retention assessment			28	0.80±0.12

Lower proficiency was observed in the baseline leveling group (pretest) in relation to the other test groups ($P < 0.001$), with a mean of 40% correct answers (six questions). In the question, "the objective of Basic Life Support in the situation of cardiac and/or respiratory arrest consists of," for example, 46% ($n = 14$) of the participants of the baseline leveling group marked the correct alternative, and in the other groups at least 60% of the participants were correct. Students in groups 1, 2, and 3 had similar pretest results, with mean proficiency ranging from 60% to 65%. In most items, these students had a significant gain ($P < 0.05$) in relation to the baseline leveling group.

Table 2 shows the percentage of correct answers in theoretical the pre- and posttest in each group. The method to which the students were exposed did not influence the proficiency according to the posttest result, varying between 80% and 84%, even though group 3 obtained a mean above the others, although there was no statistical significance ($P = 0.146$). Analyzing the questions, it was identified that in some, such as "correct

Table 2: Questions, number, and percentage of correct answers in the theoretical pre- and posttest in the baseline leveling groups, 1, 2, 3, and memory retention

Perguntas	Pretest				Posttest			
	BL (*n*=30)	Group 1 (*n*=39)	Group 2 (*n*=80)	Group 3 (*n*=40)	Group 1 (*n*=37)	Group 2 (*n*=46)	Group 3 (*n*=40)	MR (*n*=28)
The purpose of BLS in cardiac and/or respiratory arrest is to	14 (46.7%)	24 (61.5%)	50 (63.3%)	22 (55.0%)	29 (78.4%)	41 (89.1%)	29 (72.5%)	26 (92.9%)
The BLS must follow the correct sequence of actions established by the protocol with the chain of survival	8 (26.7%)	18 (47.4%)	27 (33.8%)	15 (37.5%)	11 (29.7%)	11 (23.9%)	18 (45.0%)	15 (53.6%)
For CPR in children with 2 rescuers, the compression/ventilation ratio should be	12 (40%)	30 (76.9%)	67 (83.8%)	34 (85.0%)	35 (94.6%)	45 (97.8%)	36 (90.0%)	22 (78.6%)
For high-quality CPR, mark T for true answers and F for false answers	12 (40%)	23 (59.0%)	53 (66.3%)	27 (67.5%)	33 (89.2%)	41 (89.1%)	38 (95.0%)	28 (100.0%)
For the recognition of CPR, it is important	9 (30%)	16 (41.0%)	31 (39.2%)	17 (42.5%)	25 (80%)	36 (80.0%)	25 (62.5%)	16 (57.1%)
Regarding high-quality CPR, check the incorrect alternative	10 (34.5%)	20 (52.6%)	41 (51.3%)	16 (40.0%)	33 (89.2%)	33 (71.7%)	34 (85.0%)	25 (89.3%)
Regarding BLS in infants, it is incorrect to say that	6 (20.0%)	25 (64.1%)	36 (45%)	16 (40%)	33 (89.2%)	39 (84.8%)	37 (92.5%)	23 (82.1%)
In the figure, it is possible to observe one of the stages of the BLS algorithm in children. Mark the alternative with the sequence of correct answers	18 (60.0%)	34 (87.2%)	66 (82.5%)	35 (89.7%)	34 (91.9%)	45 (97.8%)	35 (87.5%)	25 (89.3%)
About AED, check the correct alternative	15 (50.0%)	23 (59.0%)	49 (62.2%)	23 (62.2%)	33 (89.2%)	40 (87.0%)	32 (80.0%)	19 (67.9%)
Regarding the use of the AED, check the incorrect alternative	13 (43.3%)	31 (79.5%)	54 (70.1%)	25 (65.8%)	35 (94.6%)	42 (91.3%)	38 (95.0%)	27 (96.4%)
In an infant's CPR situation, the rate of chest compressions per minute should be	18 (60.0%)	32 (82.1%)	58 (74.4%)	33 (91.7%)	36 (97.3%)	43 (93.5%)	40 (100.0%)	27 (96.4%)
You are single-handedly performing a cardiac arrest on a 6-month-old infant. The chest compression/ventilation ratio is	7 (23.3%)	26 (68.4%)	47 (60.3%)	25 (65.8%)	24 (64.9%)	39 (84.8%)	39 (97.5%)	17 (60.7%)
You are assisting with other rescuers a cardiac arrest in children, it is correct to say that	12 (40.0%)	25 (65.8%)	47 (60.3%)	23 (62.2%)	31 (83.8%)	42 (91.3%)	31 (77.5%)	22 (78.6%)
Regarding high-quality chest compressions, it is correct to say that	14 (46.7%)	26 (66.7%)	49 (62.8%)	29 (76.3%)	28 (75.7%)	40 (87.0%)	39 (97.5%)	22 (78.6%)

CPR: Cardiopulmonary resuscitation. CRA: Cardiopulmonary arrest. BL: Baseline leveling. MR: Memory retention

sequence of actions to be followed by the protocol to guarantee the chain of survival," students showed lower performance (23.9%, 29.7%, and 45%), even after exposure to the various methods. In groups 1, 2, and 3, there was a mean progression of knowledge of 20%. With the dialogic expository class, the students obtained an additional 20% gain in the score. After 3 months, the memory retention assessment group got to maintain a mean grade of 80% [Figure 2].

Figure 3 shows the results of the practical assessment in students in groups 2 (practical ability; $n = 8$), 3 ($n = 46$), and memory retention ($n = 28$). In the memory retention group in the practical assessment of infants, the grade of group 1 was higher than that of group 2, but lower than that of group 3 ($P = 0.006$), and in the assessment in mannequins of children and adults, group 2 obtained a similar grade to group 3 ($P = 0.502$). The result of the checklist of the practical evaluations of the two evaluators showed high agreement in all items ($P < 0.001$) by the Kappa test.

The satisfaction questionnaire showed a very good evaluation by the participants. The item "The theoretical material digitized and made available for previous study achieved the proposed objectives" was the one with the lowest satisfaction, but without statistical significance ($P = 0.167$). Regarding the theoretical class, the item "The theoretical class presented achieved the proposed learning objectives" in group 1, some respondents did not agree or were indifferent to the statement, while in group 3 all agreed ($P = 0.026$). The students' opinion regarding the item "I feel prepared to assist a patient in cardiorespiratory arrest with regard to basic life support" showed a difference between the groups, demonstrating that in group 3, there was a greater proportion of respondents who agree with the statement (55.6%; $P = 0.011$). Regarding the students exposed to the demonstration class (groups 2 and 3), only the item "I feel prepared to care for a patient in cardiorespiratory arrest with regard to basic life support" depended on group and, in group 2, 63.6% of the students agreed with the statement presented and in group 3,

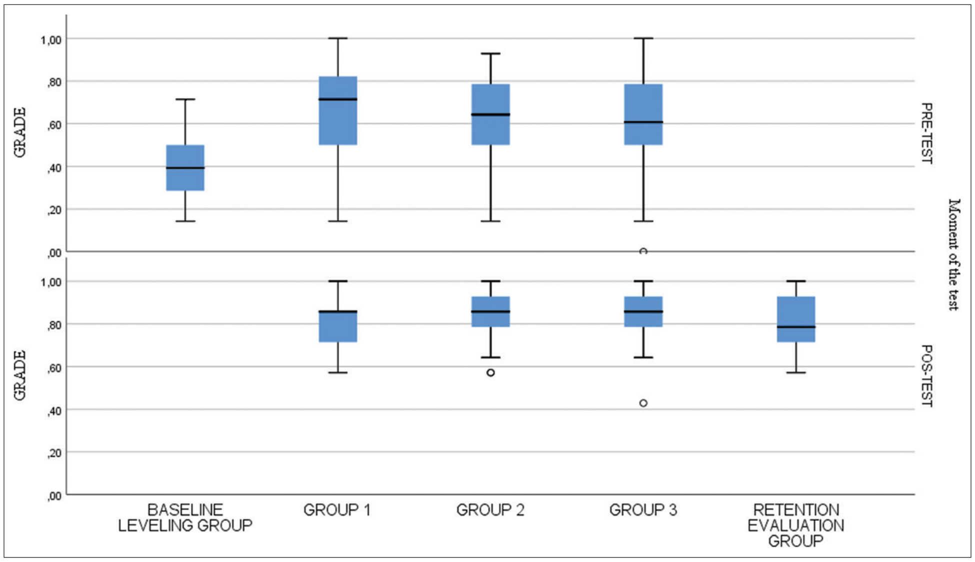

Figure 2: Grades obtained in the theoretical pre- and posttest of the basal leveling groups (n = 30), 1 (n = 37), 2 (n = 46), 3 (n = 40), and memory retention (n = 28)

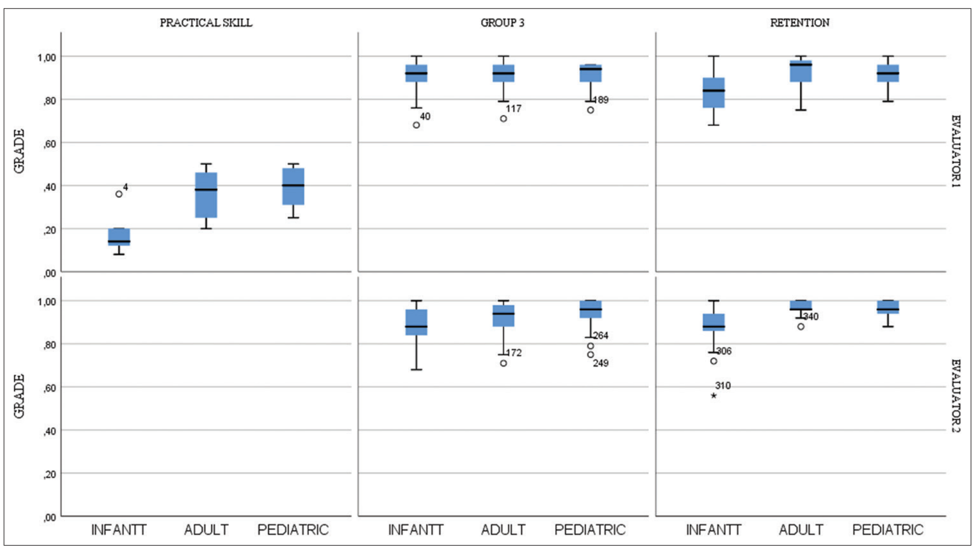

Figure 3: Grades obtained in the checklist of the practical evaluation on the infant, child, and adult mannequins by the students in group 2/practical ability (n = 8) analyzed by 1 evaluator: and in groups 3 (n = 40) and memory retention (n = 28) by two evaluators

82.5% (P = 0.109). As for the simulated practice (group 3), the participants showed a degree of satisfaction greater than 97.5%, except for the item "I feel prepared to assist a patient in cardiac arrest with regard to BLS," in which the percentage was 92.5% (higher than in groups 1 and 2; P = 0.109).

Discussion

The students in the baseline leveling group correctly answered some of the questions (40%), perhaps from prior knowledge such as "The purpose of BLS in cardiac and/or respiratory arrest is...," but in relation to more complex items of the test, they failed to choose the correct answer. It is important to emphasize that some BLS principles are addressed in high school and driving school courses, and this may have contributed to the prior knowledge of these students. The pretest results in groups 1, 2, and 3 showed that the mean proficiency was higher than the baseline leveling group. All this shows that the theoretical material alone is not enough for learning in BLS, requiring complementary methods for the teaching-learning process. When we assess the results of the posttest, it is possible to identify that the method used for teaching did not influence proficiency. After being exposed to the theoretical material, students achieved a gain of approximately 20% in their performance, and after the dialogic expository class, the students achieved an additional gain of 20%. After 3 months of exposure to the training, the students still managed to maintain a mean performance of 80%. The demonstration class did not result in additional gain in the acquisition of theoretical knowledge. A study carried out in groups involving medical and nursing students showed similar results, analyzing pretest, course, posttest, and new test after 6 months using a checklist and theoretical test with 11 questions.[8]

Hansen *et al.* compared theoretical class and practice demonstration methods for teaching BLS and the use of AED and found no statistically significant difference in the pass rate. The lecture group was a little quicker in initiating BLS measures, but most participants reported preferring the demonstration method as an introduction to learning.[9]

Drummond *et al*.[10] showed, in a controlled study carried out with 806 medical students, that the association of previous video debriefing guaranteed better memory retention 12 months after training. Li *et al.* (2019)[11] demonstrated that video debriefing, with or without error identification, prior to practical BLS training for medical students produced greater knowledge gain compared to a control group (without video debriefing). Thus, it is important that more research be carried out in the future with this increase in teaching methodology.

In the present study, in relation to the learning of practical content in infants, children, and adults, there was a poor performance of the practical skills group (group 2), being worse in the mannequin simulating an infant. This age group proved to be the most difficult for students to learn, since in the medium term, students from all groups get to retain less content when assessed after 3 months of training.

According to Li *et al.*, the acquisition of skills is greater in groups of students who do simulation and receive feedback, as well as being able to retain these skills for up to 6 months.[12] Also, according to Veloso *et al.*, students who go through the teaching activity perform better than the others, demonstrating that the teaching activity can be an effective learning methodology.[4] Thus, it is important that the teaching of BLS is approached transversally in the curriculum of the medical course, with opportunities for retraining and the performance of the learner as instructor through monitoring and acting in academic outreach actions, as recommended by the AHA[5] and by Veloso *et al*.[4]

A study targeting pediatricians at a university hospital assessed the retention of cardiopulmonary resuscitation (CPR) skills in infant and adult mannequins demonstrated a decline in performance over time (1–3; 3–6; >6 months). The use of a chest compression adequacy feedback device improves skill acquisition.[13] The new AHA recommendations emphasize the importance of using mannequin that allow feedback, especially with regard to chest compressions.[5] Memory retention after 3 months, it showed that the acquisition of knowledge and skills was maintained. Mpotos *et al*. demonstrated that after 6 months, the success rate in CPR maneuvers is maintained, indicating that the use of simulation is a good method to update CPR skills.[14]

Students reported satisfaction with learning in general. Participants in group 3 responded more favorably to some questions, especially with regard to simulated practice, reporting greater confidence in relation to learning. Regarding theoretical material, student satisfaction is similar between groups. When we assessed the evolution in each level of exposure, we saw that the higher the level of exposure, the more confident the student feels in relation to the care of a patient in cardiorespiratory arrest—only with the theoretical class and demonstration; with theoretical classes, demonstrations and practical classes; and with theoretical classes, demonstrations and practical classes ($P = 0.011$). We did not find records in the literature of similar studies; however, a study carried out by Barr *et al.* showed that students subexposed to essential procedures feel uncomfortable in performing them.[15]

In the assessment of perception of the acquisition of knowledge of BLS in infants, children, and adults, the simulated practice was well assessed (82.5%, 82.5%, 87.5%). The teacher was well assessed by all groups when teaching the dialogical expository class, the demonstration class, and the practical class, with the latter 82.5% of the respondents fully agreeing regarding the appropriate didactics for the topic.

The AHA recommends that trainings should take place at shorter intervals and according to the needs of the audience to be involved.[5] One study assessed the results of a program of frequent CPR training and short sessions aimed at improving provider skills, demonstrating that in a mannequin with the possibility of feedback, monthly training is more effective than training every 3, 6, or 12 months.[16]

Teamwork improves the performance of professionals in dealing with critically ill patients and simulation allows teams to safely practice technical and nontechnical skills, ensuring better performance and communication in a safe environment.[17] An issue to be valued is teaching in small groups for simulated activities. In the practical activity, we used groups of 10 students supervised by 2 instructors and mannequins that allow feedback, which is in line with the recommendations.[5,18] Literature review carried out by García-Suárez *et al.* found 11 randomized controlled trials addressing BLS training in nursing and medical students. The authors found great heterogeneity in the training methods and assessment methods (use of feedback devices and quality of practical assessments). The authors highlighted the importance of using mannequins that provide feedback.[19] As for the practical evaluation checklist, in future studies, it is important to use the AHA[5] forms, in order to guarantee homogeneity in the results between different authors.

The AHA advocates for CPR education as a requirement of secondary school curriculum and community education as a form of preventive medicine. Improved AED use and CPR training are critical to the outcome of sudden cardiac arrest.[5] The AHA teaching algorithm is recommended to the community and would ensure extensive knowledge of CPR.[20] As simulation becomes increasingly prevalent in medical school and in the education of medical residents, further studies are needed to verify whether training via the simulation method improves outcomes from the perspective of impact on patients' care.[17]

The present study brings contributions to the literature because it is a randomized study and uses comparisons between three different methodologies and the identification of the importance of simulated practices for the teaching of BLS and the use of AED, addressing the age groups of infants, children, and adults. It is important to emphasize the student's sense of security and confidence to deal with the real situation in the future.

Limitation and recommendation

As limiting factors of this study, we emphasize that the collection of memory retention data was performed using a convenience sample and that there were losses in groups 2 and especially in 3. We suggest the importance of carrying out studies linked to sequential curricular subjects (in terms of quarters or semesters), with time dedicated to learning and collecting research data. Students in groups 2 and 3 failed to answer the satisfaction questionnaire and the theoretical posttest due to the need to attend other scheduled classes. Therefore, for the planning of future studies, we recommend a greater articulation in the subjects, according to the curriculum.

Conclusion

Given the above, we can conclude that simulation-based education promotes greater student satisfaction and greater security and confidence in learning about BLS measures. Exposure to different teaching methods leads to the progression of knowledge. Memory retention needs to be improved over time and due to the importance of the topic; it must be inserted transversally into the curriculum and outreach actions must be stimulated as a way for the learner to act as a multiplying agent of knowledge. The teaching of BLS practice in infants must be improved and the instructor/teacher must be aware of this issue.

Authors' contributions

Silva NLC, Melo MCB, and Ferri Liu PM were involved in all parts of this research. The other authors helped in the implementation of the project, data processing, and analysis of research data. All authors helped to write, read, and approve the final version of this article.

Ethics approval and consent to participate

The project was submitted and approved by the Ethics and Research Committee of MF-UFMG under the number CAAE 71487317.0.0000.5149 on 07/13/2017 and the Informed Consent Term was read, accepted, and signed by all participants.

Acknowledgment

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Conflicts of interest

There are no conflicts of interest.

References

1. Sahu PK, Chattu VK, Rewatkar A, Sakhamuri S. Best practices to impart clinical skills during preclinical years of medical curriculum. J Educ Health Promot 2019;8:57.
2. Alsulimani LK. The feasibility of simulation-based high-stakes assessment in emergency medicine settings: A scoping review. J Educ Health Promot 2021;10:441.
3. Chandran KV, Abraham SV. Basic life support: Need of the hour—A study on the knowledge of basic life support among young doctors in India. Indian J Crit Care Med 2020;24:332–5.
4. Veloso SG, Pereira GS, Vasconcelos NN, Senger MH, de Faria RMD. Learning by teaching basic life support: A non-randomized controlled trial with medical students. BMC Med Educ 2019;19:67.
5. Soar J, Maconochie I, Wyckoff MH, Olasveengen TM, Singletary EM, Greif R, *et al.* 2019 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations: Summary from the basic life support; advanced life support; pediatric life support; neonatal life support; education, implementation, and teams; and first aid task forces. Circulation 2019;140:e826-80.
6. Gontijo ED, Alvim C, Megale L, Melo JRC, Lima M. Matrix of essential competences for the training and performance evaluation of medical students. Rev Bras Educ Médica 2013;37:526-39.
7. Ruijter PA, Biersteker HA, Biert J, van Goor H, Tan EC. Retention of first aid and basic life support skills in undergraduate medical students. Med Educ Online 2014;19:24841.
8. Castillo J, Gallart A, Rodriguez E, Gomar C. Basic life support and external defibrillation competences after instruction and at 6 months comparing face-to-face and blended training. Randomised trial. Nurse Educ Today 2018;65:232-8.

9. Hansen C, Bang C, Rasmussen SE, Nebsbjerg MA, Lauridsen KG, Bjørnshave Bomholt K, *et al*. Basic life support training: Demonstration versus lecture - A randomised controlled trial. Am J Emerg Med 2020;38:720-6.
10. Drummond D, Arnaud C, Thouvenin G, Guedj R, Grimprel E, Duguet A, *et al*. An innovative pedagogic course combining video and simulation to teach medical students about pediatric cardiopulmonary arrest: A prospective controlled study. Eur J Pediatr 2016;175:767-74.
11. Li Q, Zhou RH, Liu J, Lin J, Ma EL, Liang P, *et al*. Pre-training evaluation and feedback improved skills retention of basic life support in medical students. Resuscitation 2013;84:1274-8.
12. Li Q, Lin J, Fang LQ, Ma EL, Liang P, Shi TW, *et al*. Learning impacts of pretraining video-assisted debriefing with simulated errors or trainees' errors in medical students in basic life support training: A randomized controlled trial. Simul Healthc 2019;14:372-7.
13. Garcia-Jorda D, Walker A, Camphaug J, Bissett W, Spence T, Martin DA, *et al*. Bedside chest compression skills: Performance and skills retention in in-hospital trained pediatric providers. A simulation study. J Crit Care 2018;50:132-7.
14. Mpotos N, De Wever B, Cleymans N, Raemaekers J, Loeys T, Herregods L, *et al*. Repetitive sessions of formative self-testing to refresh CPR skills: A randomised non-inferiority trial. Resuscitation 2014;85:1282-6.
15. Barr J, Graffeo CS. Procedural Experience and confidence among graduating medical students. J Surg Educ 2016;73:466-73.
16. Anderson R, Sebaldt A, Lin Y, Cheng A. Optimal training frequency for acquisition and retention of high-quality CPR skills: A randomized trial. Resuscitation 2019;135:153-61.
17. Gonçalves BAR, Melo MCB, Ferri Liu PM, Valente BCHG, Ribeiro VP, Vilaça e Silva PH. Teamwork in pediatric resuscitation: Training medical students on high-fidelity simulation. Adv Med Educ Pract 2022;13:697-708.
18. Cho Y, Je S, Yoon YS, Roh HR, Chang C, Kang H, *et al*. The effect of peer-group size on the delivery of feedback in basic life support refresher training: A cluster randomized controlled trial. BMC Med Educ 2016;16:167.
19. García-Suárez M, Méndez-Martínez C, Martínez-Isasi S, Gómez-Salgado J, Fernández-García D. Basic life support training methods for health science students: A systematic review. Int J Environ Res Public Health 2019;16:768.
20. Watanabe K, Lopez-Colon D, Shuster JJ, Philip J. Efficacy and retention of basic life support education including automated external defibrillator usage during a physical education period. Prev Med Rep 2017;5:263-7.