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Future perspective in BLSD training: The importance of peer-to peer education in high school students

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Abstract

Survival rate after a cardiac arrest strongly depends on the delay occurring from the onset of basic, and then advanced, life support procedures therefore a wide educational policy for all citizens to attend a BLSD training could improve survival on the territory. In this paper we presented the experience in BLSD training for adult. This work was a prospective observational study with an external blinded outcome evaluator to check the feasibility and efficacy of a peer to peer BLSD teaching to High school students compared to a professional led teaching.

Between 2010 and 2013, 320 High School 15-18 years old students were enrolled to receive a BLSD training for adult and then randomized into two groups (A and B): Group A (n=156) had a peer to peer teaching while Group B (N=164) was trained in conventional way by a professional American Heart Association (AHA) certified instructor. At the end of training course, a final examination by a blinded instructor was held and results were analyzed. The item values were the percentage of the following parameters between two groups: check responsiveness, amount of calls to Territorial Emergency Service (118 for Italy), chest compressions with a correct hand position, adequate depth, correct rate, complete chest recoil by means of a Q-CPR (Quality cardiopulmonary Resuscitation) on the manikin used for CPR training, opening the Airway and giving breaths (head tilt-chin lift, mouth-to mouth breaths, mouth-to mask breaths), use of semiautomatic external defibrillator (AED) and retention of BLSD knowledge as assessed by 20-point questionnaire.

The analysis of results demonstrates that check responsiveness percentage was 97.6% in the peer-led group vs 96.7% in the professional-led group (p-value ns), that call 118 percentage was 95.8% in the peer-led group vs 96.8% in the professional-led group (p-value ns) and chest compressions (position hand, adequate depth, correct rate, complete chest recoil) percentage was 73.9% in the group A and 76.4% in the group B (p-value ns). Open the airway and giving breaths percentage was 30.4% in the Group A and 21.7% in the Group B (p=0.05). The automatic external defibrillator (AED) correct use percentage was 53.5% in the peer-led group and 52.4% in the professional-led group (p-value ns). On the questionnaire administered after training, the peer-led group scored an average of 47.2 % right answers in the Group A and of 49.8 % in the Group B (p-value ns). The high school students who were trained by peer-instructors showed comparable skills in CPR for adult to those who were trained by professional instructors.

Introduction

Training CPR is a tough task especially in a common people that not have experience or knowledge about medicine and when the subject includes a practical skill and has an emotional feedback such as lifesaving. For these reasons, to extent BLSD training could be very challenging, especially if addressed at non-medical population and even more challenging when addressed to school students.

Sudden Cardiac Arrest (SCA) is a leading cause of death in the United States. Even if the estimated annual number of deaths due to out-of-hospital SCA vary widely, data from the Center for Disease Control and Prevention reports that in the United States approximately 330.000 people die annually from coronary heart disease before reaching hospital or emergency room; about 250.000 of those deaths occur in the out-of-hospital setting [1]. In Italy, this occurs in about 75.000 people [2].

CPR and defibrillation could really save lives when a cardiac arrest occurs, but in order to be effective they should be started as soon as possible and executed as best as possible. In fact, it is well known that survival decreases by 10% for each minute since the onset of a cardiac arrest. A lot of studies had shown a twofold increase in survival rate when a bystander provides an early CPR [1], so in order to improve survival rate more bystanders should be trained to BLSD organizing a social program to fight sudden cardiac death. Training people requires time, money and support from the Institution. In the latest years some experience in peer education and peer Medical education in schools have been carried out [3], so far it has been reported even training in primary School [4-10] and even in advanced cardiac life support [10]. In this study we wanted to compare a conventional teaching approach with a peer teaching approach for the training to BLSD of high schools students. In order to compare the two teaching methods, a QCPR feedback system for CPR quality was used and a questionnaire about the quality and efficacy of the teaching strategy was administered.

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Project organization and methods

Between years 2010-2013 in the cities of Naples and Sorrento a School program for BLSD training was started. A total of 11 courses had been used to compare peer-teaching and professional-teaching in 320 students (15-18 years old, 156 male and 164 female) from four high schools. None of them had been previously trained to BLSD, as confirmed by a pre-test administered to the students before the course. Pre-test was made up of 20-points questions regarding BLSD according to AHA and ILCOR (International Liaison Committee on Resuscitation) 2010 Guidelines for adult CPR [11]: both group obtained a very low score before the course, averaging between 3 and 5 correct answers (30% c/a)**.** Inclusion criteria were volunteering to participate in the study and a minimum age of 15 years. The examinations of the students who suffered from any cognitive or physical disorder that made not safe and effective BLSD were excluded. Ten potential peer-instructors of 18 years old were recruited among the senior pupils and then attended a 2 day CPR Instructor Course at Federico II University (Naples). Instructors of the professional-led group were recruited from cardiologists and anesthesiology clinicians that have a AHA&BLSD-Istructor certification. Informed consent was obtained from the students and their parents before the start of training program that was approved by Sanitary Board Director of A.O.U. "Federico II". Almost 30 days before the course, ten students (belonging to another class from the training groups) were trained in a conventional way by BLSD instructor and their skill was confirmed by an exam after 21 days and one week before the School program was started. Two groups were formed and participants were randomized to Group A (peer Training) and Group B (conventional Training): each instructor had a 6 students group and a single training room. The course was organized according to AHA and ILCOR 2010 Guidelines [12] with 2-hours frontal lessons, videos and skill training (accounting for a total 6 hours lasting course). At the end of the course a theoretical exam with the same pre-test and a questionnaire referring to the BLSD course quality were administered. Skill exams were carried on by two different instructors blinded to the study. In addition, for CPR performance measures, a QCPR by Resusci Anne manikin (Laerdal Medical-Stavanger, Norway) was used that, through a Wireless SimPad SkillReporter, can report compression rate and depth, complete release, limited interruptions and appropriate ventilation volume.

Resusci Anne manikin skill tool was used in order to evaluate the quality of Check phase (i.e. responsiveness or no movement, Call EMS 118 - get AED), Opening Airway phase (i.e. head tilt chin lift maneuver, place ear near the victim's mouth and nose and look, listen and feel for breathing-take at least 5 and no more than 10 sec), Checking Breath phase (i.e. head tilt-chin lift, moth-to-mouth 2 breaths) efficacy of compressions over a full 2 minute CPR cycle (i.e. position hands, rate, depth and complete chest recoil). The safety algorhytm during the use of AED (i.e. list the steps common the operation of all AED, proper placement of the AED electrode pads, recall when pressing the shock button, no one should touch the victim while the AED is analyzing the heart rhythm or delivering a shock) (AED Philips HS1 trainer model) was checked.

Course organization

At first, students were trained to handle with an unconscious person using the "*shake and shout*" *method* to confirm unresponsiveness and then teached to immediately call the emergency number. Students were trained to procedures involving both one or two rescuers, teaching them to get AEDs when available, to start CPR immediately when an asphyxia arrest was expected and to act as leader or second rescuer.

Students were then trained to Head-tilt-chin-lift maneuver. Regarding to breathing assistance, they were taught just to search for life signs (cough, movement and breath). At the same time they were explained how to provide mouth to mouth breathing and mouth to mask breathing in a 30:2 odd. A significant attention was given to chest compression's teaching, suggesting the middle part of the chest as target for hand positioning and paying big attention on the concept "push hard and push fast": in fact, guidelines suggest a chest compression of at least 5 cm [12] checked through CPR. The correct use and timing of AED was explained and each of them was separately trained to its use.

Statistical analysis

Data were analyzed using a statistical software (SPSS for Windows, version 21, SPSS Inc, Chicago, IL). Results were expressed as mean ± SD or percentage of students (%) as appropriate. Paired t-test was used for within-group comparison of continuous variables between Group A and Group B. Groups differences were assessed by one way analysis of variance with post hoc Scheffe's test or Pearson X^2 test as appropriate. Correlations of continuous variable were tested by Pearson's coefficient. A variable is entered into the model if $p \leq 0.05$ and is removed if $p \leq 0.10$. P-values are two sided with $p \leq 0.05$ considered to be statistically significant. A logistic regression model was used to detect the relationships between the primary endpoint and the demographic data.

Results

A total of 320 students were recruited from 4 high school for BLSD training during three CPR-awareness weeks and randomly assigned to the two groups. Four of the students left the event before their hands-on training. The data demonstrated that the two groups (peer-led training and professional-led training) were comparable for age, gender, height, weight and previous knowledge about CPR (Tables 1 and 2).

The principal outcome was the rate of passed skill examinations for each group. In the Group A 81,5% of students passed the examination while in the Group B was 85,4% (p-value = n.s.). The logistic regression within the two groups showed no significant effect for the age, gender, height, weight, no CPR-training ever. On the contrary, regarding to the breathing-assisted phase the analysis of skill tests show that the pupils didn't ventilate correctly: the item failed in both groups regarding in particular the placing ear near mouth and nose (30.4% vs 21.7%, $p \leq 0.05$), mouth to mouth breaths (31.0% vs 26.9% $p \leq 0.05$) maneuvers. On the other hand, there was a significant difference in ensuring continues effective chest compression between two groups (21.9% vs 18.5%, $p \leq 0.05$) (Table 3). The other results demonstrate that the rate of passed examination between the groups at all the items were comparable and did not differ significantly. Check responsiveness failed in 3.0% in the peer-led group and 3.8% in the professional-led group ($P \leq 0.86$). The call 118 percentage failed in 4.2% in the peer-led group and 3.2% in the professional-led group ($P \leq 0.35$). The percentage of chest compression in particular for ensure continues effective chest compression failed in 21.9% in the peer-led group and 18.5% in the professional-led group ($p \leq 0.05$.). The percentage of failed use of AED, in particular analize no one should touch the victim was 6.0% in the peer-led group and 3.2% in the professional-led group ($p \leq 0.05$). On the questionnaire administered after training, the peer-led group failed scored an average of 53.8 % in the Group A and 47.2 % in the Group B ($P \leq 0.001$). The 95% CI of difference of the means was −1.72 to 0.57. Results are summarized in Table 3.

Table 1. Items of the skill examination

Check	responsiveness or no movement
Call EMS	calls 118 - get AED
Open Airway	head tilt-chin lift maneuver
	place ear near the victim's mouth and nose
Breaths	head tilt-chin lift
	moth-to-mouth breaths (2 breaths -1 sec each)
Locating the Carotid Artery Pulse	unnecessary
Compress	starts immediately
	position hands
	right compression frequency of 90-110 bpm
	right compression depth (5 cm)
	complete chest recoil
	ensures continues effective chest compression (No brake of more than 10 s)
AED	list the steps common the operation of all AED
	proper placement of the AED electrode pads
	recall when to press the shock button
	no one should touch the victim while the AED is analyzing the HR or delivering a shock
Questionnaire	20 point

Table 2. Demographic data

Characteristic	Group A (n=164)	Group B (n= 156)	P-value
Age yr (SD)	16,8+1.8	15.9+2.1	n.s.
Height-cm (SD)	165,5+8.8	163+7.4	n.s.
Weight-kg (SD)	66.7+10.1	63.7+9.8	n.s.
Male	75 (46%)	79 (50,6%)	n.s.
No CPR training ever no	157 (95,7%)	155 (99.3%)	n.s.

Table 3. Results for each failed item of the skill examination

Item	Failure-rate Group A (n= 164)		Failure-rate Group B (n= 156)		p-value
	no	(%)	no	(%)	(%)
Check responsiveness	5	3.00%	6	3.80%	0.86
Call EMS 118 - get AED	7	4.20%	5	3.20%	0.35
Open Airway head tilt-chin lift maneuver	18	10.90%	15	9.60%	0.9
Place ear near mouth and nose	50	30.40%	37	21.70%	0.05
Breating head tilt-chin lift	20	12.10%	15	9.60%	0.52
Moth-to-mouth 2 breaths	51	31.00%	42	26.90%	0.05
Compressions Starts immediately	4	2.40%	2	1.20%	0.8
position hands	10	6.00%	7	4.40%	0.41
Right compression frequency of 90-110 bpm	19	11.50%	14	8.90%	0.86
Right compression depth (5 cm)	23	14.00%	19	12.10%	0.69
complete chest recoil	21	12.80%	19	12.10%	0.82
ensures continues effective chest compression	36	21.90%	29	18.50%	0.05
AED power on	5	3.00%	4	2.50%	0.8
placement of the AED electrode pads	7	4.20%	5	3.20%	0.71
analize- no one should touch the victim	10	6.00%	5	3.20%	0.05
clear and recall when to press the shock button	7	4.20%	5	3.20%	0.82

Discussion

Delivery of chest compressions is tiring, and the emphasis on fast, hard compressions makes it even more tiresome. Research has shown that compressions can become ineffective after to 5 minutes [11]. After their technique has deteriorated, rescuers may mistakenly believe they're still doing effective compressions for several minutes. In order to get the best and most effective compressions, AHA and ILCOR recommend that first responders rotate every 2 minutes, or at the end of every fifth cycle [11]. Healthcare providers have had "A-B-C" (airway, breathing, circulation) drilled into them, from the beginning of their career. It is thus common to prioritize the same way. Some suggest that rescuers should think the other way around. Researchers at the 2015 Consensus Conference reached several conclusion about chest compressions and the new AHA and ILCOR 2015 guidelines change the steps of CPR on "C-A-B" [12]. The highest priority is to maintain circulation with high-quality chest compressions, then breathing, and then attention to airway as needed to facilitate breathing [12]. The order in which we approach unconsciousness should change the process. If a victim collapses due to a sudden cardiac event, high-quality compressions should be started while an AED is brought to their side whether the patient is pediatric or adult. Consider the circumstances of the collapse. If the victim is unresponsive from a respiratory event (most common in pediatrics) or from an airway obstruction, such as drowning, CPR should be performed for a period of 2 minutes prior to the application of an AED. The AED should be applied without interrupting compressions until it is possible to analyze the cardiac rhythm by the AED. Emergency Medical System (EMS) providers will seldom arrive in cardiac arrest while the

victim is still in the electrical phase, unless bystander rescuers have provided immediate and continuous high-quality chest compressions, before attempting the defibrillation [11]. The recommendation for a defibrillation is one shock a time for patients in a shockable rhythm [11,12]. Research shows that the average hands-off time to deliver three shocks is about 40 seconds, which allows the coronary artery pressure to fall greatly [11]. This makes it important to continue compressions until you are ready to deliver a shock. There should be no more than 5 seconds from the time of the last compression to shock delivery for the most effective outcome. The increased coronary artery pressure will make the conversion more likely. After delivering a shock, there is no pulse check. Chest compressions should be started immediately and 2 minutes of CPR performed before a pulse check is done: in fact, even if the victim has an organized rhythm, the compressions will not harm the victim but, on the contrary, the victims benefits from the assistance because in the most of the time that a rhythm is present, cardiac output is still too low to provide adequate perfusion [11].

A main problem, in CPR performance, concerns quality of chest compression effected on the victim. The bystander rescuer, without training for critical emergency situation, easily could be emotionally involved: in this way quality of CPR performance is strongly reduced. Chest compression of at least 5 cm and chest compression rate of 100-120 per minute make possible a good compression quality according new AHA and ILCOR 2015 Guidelines for BLSD [12]. Moreover, there is another important criterion in order to guarantee an effective performance: reducing as far as possible interruptions of chest compressions and reducing transition period from compressions to ventilations to a maximum of 10 seconds. Therefore, transition from compressions to ventilations (30:2) has to be as quick as possible in order to guarantee always at least 100-120 compressions per minute. By means of these directives CPR presents larger success probability and better recovery of vital functions [12]. Even knowing the sequences to perform a correct CPR, a bystander rescuer without training for CPR maneuvers, effecting transition from chest compressions to ventilations, takes a period longer than the 10 seconds which are necessary according to AHA and ILCOR Guidelines. Exceeding recommended period of 10 seconds, resuscitation success probabilities are reduced because recommended chest compression rate is not achieved.

The problem could be overcome by introducing "Hands-Only" CPR which prescribes elimination of pulmonary ventilations and is based on single performing of chest compressions. In fact "pulmonary ventilation factor" implies that many people are worried to be in contact with unwanted body fluids by means of mouth-to-mouth resuscitation or, even more, are worried to receive infectious diseases. Lester C et al. [13] demonstrate by a questionnaire that the pupils expressed reluctance to resuscitate those with unpleasant physical characteristics: 160 (69%) probably or definitely would not if vomit was present, 115 (49%) if the casualty was dirty and 120 (52%) if there was an unpleasant smell. These characteristics were reiterated in responses to the open-ended question. Other deterrents mentioned were bleeding in or around the mouth (54 respondents), serious injuries, dangerous situations for the rescuer, HIV-positive status, other known disease, being in a public place or a casualty unknown to the life supporter. This uncertainty reduces velocity of CPR maneuvers because rescuer takes longer time in considering risks. Mouth-to-mouth contact could, at the same time, slow down CPR beginning and increase interruption period between pulmonary compressions (> 10 seconds). Introducing "Hands-Only" CPR would reduce waiting periods before starting operations and, consequently, would guarantee the minimum number of chest compressions per minute. Mouth-to-mouth pulmonary ventilation effected by rescuer person provides oxygen percentage (% O_2) of 16%. Oxygen percentage in environmental air is of 21 %, while that provided by Ambu bag is of 40 – 50%, up to a maximum of 90% if effected by supplementary mask with Reservoir. Oxygen percentage provided by Mouth-to-mouth ventilation is slight and, consequently, not necessary. In fact by means of simple chest compressions is possible to introduce a percentage of environmental air inside the lungs thanks to the difference of pressure due to the compressions themselves. This percentage would be sufficient until EMS rescue arrival and the study of Sayre RM, *et al*. [14] underlines that there are neither consequences nor neurological damages for lack of insufflations. There is a unique precaution to be considered: "Hands-Only" CPR is suitable just in case of pervious respiratory tract while, in case of respiratory arrest caused by mechanical obstruction or, for example, by acute asthma attack, the victim does not benefit from nontraditional CPR [12-15]. This demonstrates that First Aid maneuvers can be adapted and simplified depending on the context and on the victim. For a 15-18 aged student population, analyzed in our study, the omission of pulmonary ventilations is a further benefit because sequences are simplified and mouth-to-mouth risks are minimized. It is recommended as choice method for the untrained rescuer or those who are not proficient because it is easier to perform and instructions are easier to give over a phone. In adults with out-of-hospital cardiac arrest, compression-only CPR done by a common person has an higher success rate than standard CPR. The exceptions are cases of drownings, apnea associated with drug overdose, trauma, airway obstruction, acute respiratory disease and arrest in infants and children.

Cabrini, *et al*. [16] demonstrate several reasons that could explain the best efficacy of chest compressiononly CPR. It is well documented that both interruptions of chest compressions during ventilation and positivepressure ventilations have detrimental effects on survival rate. Oxygenation and ventilation could be allowed, at least initially, by passive ventilation during chest compressions, by spontaneous gasping and by the lungs capacity to act as a reservoir. In addition, compression-only CPR is easier to teach, to remember and to perform and it does not require mouthtomouth contact, so resulting in a better willingness to start CPR by bystanders. It is worth noting that in two of the three analyzed studies bystanders randomly assigned to standard CPR were significantly more likely to withhold CPR than bystanders assigned to compressiononly group. Results from our study, clearly shows that there is no difference in the quality of training between the two groups. But the only significative difference is on how the course is perceived. Students in Group A confirmed that they even enjoyed the course and most of them would participate to the retraining course. This such a difference could be as little for adults, but very significative whenever a School program should be started including even underage students and lasting 2-3 years with retraining. The comparison between the groups for the single item did not demonstrate any significant difference. Therefore, the CPR skills were equally effective in both groups. In addition such program, if started on a national base (including all High Schools), could represent a big problem for instructors, as they could result too few and not willing to do courses on each day of the year. In order to complete or to carry on such a big achievement, peer to peer education could prove very helpful, even though peer instructor should always be formed initially by professional instructors. This would avoid the perpetuation of mistakes and could be helpful to update peer instructor. Peer education is an interesting concept for the mass-training of students in CPR because it may reduce the costs and improve the students' learning. Involving peers in the training of

students has a multiplicative effect that reduces the requirement of professionals. We selected the training by peers as a new intervention focused on the additional benefits of lower cost, greater availability of peers, and the additional training effect of the peers. In the present study breathing maneuver with mouth-to-mouth or mouth-to-barrier device has achieved low percentage in both groups (32% vs 38%). This result confirms that in peer CPR training performing "Hands-Only" method provides more benefit [14-16]. They've probably learned the following for simple steps: check no movement or response, phone 118 EMS, push hard and fast in the center of the chest, get AED.

The reported errors in ventilation and compression indicate that more practice was needed, preferably with the Laerdal QCPR manikin which gives feedback via colored lights for correct and incorrect performance. Failure to ventilate adequately is often caused by not maintaining an open airway, whilst compressions are often poor because the hands are incorrectly positioned on the sternum. The relatively high scores recorded during internal CPR skills assessment do not therefore imply that a rescue attempt by a pupil would have been successful, but merely demonstrate the proportion who performed as taught.

There are already some other papers that shows how peer education is effective for adults, but there is very little knowledge if this could work for high school students too [3-9]. It only remains unclear if the final exam should be always performed by a professional instructor. In fact, in our opinion being taught by a companion or someone with same age is one thing, but being tested is another thing. In addition, we are worried that a student could not be as objective as a professional instructor with his own school mate or friends, where maybe a student from another school could prove more objective. In our paper we had chosen instructor from different classes per group, but not from different school. In our peer experience we have tried to understand the feasibility of such a program and whether it eventually could be used on a large-scale program in Italy. Our study clearly shows no difference from 4 high school student. In this connection, a recent study [17] conducted in Germany has showed that peer-led CPR training for high school students is as effective as training by professionals (40,3% in the peer-led group and 41% in the professional-led group passed the examination). Our study and that by Beck, *et al.* [17] are surprising because the professional instructors are characterized by having medical education and more previous experience in instructing others in CPR. Even though some paper already showed the feasibility of BLSD courses to young students and there is some data that even underage people could provide an effective chest compression for a limited time [10], we decided to test this system on 15-18 years old students, either because of informed consent either for body structure. Nonetheless we agree with previous experiences [18-51], and we strongly believe that younger high School students could provide a BLSD as good as last year high school students, but in this paper we have tried to avoid possible bias such as physical problem, consent problem, awerness and self-assessment. In fact, 15-18 years old students [10] are enough young to represent an high school student and are enough educated to understand the importance of an health care program especially for life savings technique. Recently, in Italy the Minister of Education, University and Research has included training CPR in Law n. 107 [52] for all seventh-grade students by the 118 EMS professional instructors. In this context, peer-led-training exceeds professional-led training due to its lower requirement of professional trainers and implying cost-savings for school-based CPR training.

Conclusions

Peer led training in BLSD for High school Students is feasible and could be as effective as a professional led course. Moreover, in our opinion and experience peer led training shows a better feedback and trainee attitude when compared to conventional teaching. Finally, our data support that peer-led BLSD training could be a part of the educational goals in the secondary schools in Italy.

Conflict of interest statement

None declared.

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