Cardiopulmonary Resuscitation without Ventilation

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Current basic life support techniques are difficult for lay persons to learn, retain, and correctly perform (1). The American Heart Association has recognized the need to simplify the current requirements for and teaching of cardiopulmonary resuscitation (2).

Can BLS CPR be simplified and still be effective? Handley et al found that by decreasing the number of sequential steps asked of lay people in responding to an unconscious victim that the remaining steps were better remembered and performed (3)

If such a simplification approach holds promise for better retention and subsequent performance of CPR, the important issue becomes what to eliminate in the simplification process. Certainly any step proving to make a significant difference in outcome from basic life support efforts must be retained, while conversely any step shown not to be critical to the patient's ultimate chance of survival can be removed. One area of consideration is the previously considered sacrosanct "**ABC**"s, specifically establishment of an **A**irway, artificial **B**reathing (specifically mouth to mouth breathing), and chest compressions for temporary **C**irculation. One of the major challenges of the current basic life support course is to learn and master the technique of artificial respiration. Mouth-to-mouth breathing is not only difficult to perform, but can be aesthetically unpleasant. One intriguing possibility in attempting to simply BLS is to do away with bystander/lay person attempts at ventilation

Several arguments can be made for this "drastic" step. First, numerous surveys show that when asked anonymously most individuals confide they would prefer not to do mouth-to-mouth breathing for a stranger (and probably would not). This attitude has been expressed by trained AHA BLS instructors (4), nurses and physicians (5) and lay people (6) alike. Table 1 summarizes these data. Though the reasons can be debated the consistency of the responses is striking.

Table 1. Survey Data Concerning Reluctance to Perform Mouth-to-Mouth Breathing

(Ornato et al. Ann Emerg Med 1990;19:151)
1,794 AHA BLS Instructors
Majority said they would not perform mouth-to-mouth breathing on a stranger
(Brenner et al. Arch Intern Med 1993;153:1763)
433 Internists and 152 Registered Nurses
45% of MDs and 80% RNs would not perform mouth-to-mouth breathing on a stranger
(Locke et al. Arch Intern Med 1995;155:938)
975 lay persons
15% would definitely do CC & V (mouth-to-mouth) for a stranger
68% would definitely do CC-only for a stranger

What are the consequences of not performing artificial ventilation during the initial minutes of resuscitation effort? There is generally sufficient oxygen within the blood prior to cardiac arrest that with the limited circulation (the most that even the best chest compressions can provide) reasonable oxygen saturation persists for at least 10 minutes and maybe even longer. Chandra et al found that in ventricular fibrillation cardiac arrest treated with chest compressions alone and no active ventilation that the average arterial blood saturation remained above 70% for 10 minutes of CPR (7)

In further experimental work Noc and Weil found that positive pressure ventilation was not necessary for successful resuscitation or 48 hour survival from ventricular fibrillation cardiac arrest. After 12 minutes of VF cardiac arrest, including an initial 4 minutes of untreated VF, no difference in 48 hour survival was noted between those animals receiving chest compressions and positive pressure ventilation and those receiving chest compressions and only passive oxygen supplied at the external end of a patent endotracheal tube (48 hour survival: 7/11 vs 8/11) (8)

The University of Arizona Resuscitation Research Group has found similar results in a series of experiments exploring the possibility of Chest Compression-Only CPR for bystander or lay public responders (9-14). Considering that resuscitation outcome is the most important endpoint we performed six prospective, randomized experimental trials comparing standard BLS CPR (including ventilation) with chest compressions-only CPR, and sometimes with a third control group receiving no simulated "bystander" CPR at all.

The first study compared three groups of swine in VF cardiac arrest for 30 seconds prior to any treatment followed by BLS CPR consisting of either standard BLS, chest compressions only, or no CPR until 12 minutes to simulate the arrival of the ACLS paramedics. No difference in acute resuscitation results were seen, but by 24 hours those receiving no BLS support had a higher mortality rate then either those treated with standard or chest compression-only BLS CPR. No difference was found between either form of BLS (9). Additional confirmatory studies were done lengthening the time before treatment was started (10-11) or adding a period of myocardial ischemia to better simulate the typical clinical scenario of out-of-hospital cardiac arrest (12). Table 2 presents the individual study parameters and results.

Table 2. University of Arizona Resuscitation Research Group Experimental Studies of Chest Compression-only CPR

*30 seconds of untreated VF			(Circulation 1993;88:1907)	
*12 minutes of BLS CPR				
	n	ROSC	24Hr Surv	
"A"	16	16/16	16/16	
"B"	16	16/16	16/16	
"C"	8	8/8	1/8*	(* = p<.001)
*2 minutes of untreated VF			(Ann Emerg Med 1995;26:342)	
*10 minutes of BLS CPR				
	n	ROSC	24 Hr	48Hr
"A"	8	8/8	7/8	7/8
"B"	10	10/10	9/10	8/10
*5 minutes of untreated VF			(Circulation 1997;95:1635)	
*8 minutes of BLS CPR				
	n	ROSC	24 Hr	
"A"	10	9/10	6/10	
"B"	10	10/10	5/10	
"C"	6	4/6	0/6*	(* = p<.03)
VF associated with Acute MI			(Circulation 1997;96:4364)	
*2 minutes of untreated VF				
*10 minutes of BLS CPR				
	n	ROSC	24 Hr	
"A"	15	8/15	3/15	
"B"	14	8/14	5/14	
"C"	14	9/14	1/14**	(**=p<.07)

Legend: "A" = standard BLS CPR (including ventilation)
"B" = chest compressions-only BLS
"C" = no BLS

Two additional studies were done to resolve concerns. The first looked at the importance of ventilation during BLS for asphyxial cardiac arrest. In this study the airway was occluded until loss of aortic pulsations occurred (13). Subjects were then randomized to chest compression plus ventilation, chest compression alone, ventilation alone, or nothing for an additional 8 minutes to simulate the time prior to arrival of the EMS system. The importance of ventilation for asphyxial cardiac arrest was documented, though doing anything, including just chest compressions alone was better than doing nothing until professional help arrived. The final study was performed to evaluate the importance of a patent airway during BLS for VF cardiac arrest (14). Again comparing standard BLS CPR (including ventilation and a patent airway) against chest compression-only BLS (with an intentionally occluded airway) no difference in initial or 24 hour outcome was found. The experimental data is both consistent and powerful suggesting that chest compression-only BLS CPR for initial lay public responders is equally as effective for 24-48 hour survival as is standard BLS CPR with rescue breathing of expired air. Table 3 summaries the five studies done with ventricular fibrillation cardiac arrest.

Table 3.
Summary of the University of Arizona Studies in VF Cardiac Arrest

	n	ROSC	24-48 Hours
CC &V	59	51/59 (86%)	42/59 (71%)
CC-Only	60	53/60 (88%)	44/60 (73%)
NO CPR	28	21/28 (75%)	2/28 (7%)

Two important clinical trials support and collaborate these experimental data. In a prospective

evaluation by the Belgium Cerebral Resuscitation Group where arriving EMS personnel were asked to report on the ongoing BLS effort by lay persons at the scene (15-16). In the 15% of the population where "good" quality chest compressions and ventilations were being done upon their arrival 16% survived, in the 4% of the cardiac arrest victims where "good" quality chest compressions alone were being done 15% survived, and in the majority (67%) where no BLS CPR was being attempted only 6% survived. Both forms of BLS were significantly better than no bystander effort, but not different from each other (Table 4).

Table 4.

3,053 Human Arrests

	n	long-term survival
"good" CC&V	443	71/443 (16%)
"good" CC-Only	116	17/116 (15%)
No CPR	2,055	123/2,055 (6%)*
		(* = p<.001)

(Resuscitation 1989;17(suppl):S99)
(Resuscitation 1993;26:47)

Similar results have been reported with telephone dispatcher-assisted BLS CPR in Seattle (Hallstrom AP. Personal communication at Wolf Creek V conference -reported in this issue). After randomly instructing nearly 500 callers in either standard BLS CPR versus chest compression-only BLS no difference in outcome was found, with the trend in favor of chest compressions-only (survival: 10% vs 14.5%; p=0.09).

Given the support that chest compressions-only BLS is equal to standard BLS, at least for the 10 or so minutes most bystanders are involved a novel and bold step towards simplifying BLS CPR was proposed. Assar and colleagues devised a new strategy of BLS training entitled "staged teaching" of CPR (17). Three stages of CPR instruction were proposed and labeled "Bronze", "Silver", and "Gold". The Bronze stage taught opening the airway and providing chest compressions without active ventilation. Ventilation by mouth-to-mouth means was introduced at the Silver stage using a ratio of 50:5 compressions to ventilations, with emphasis on ventilation's importance in resuscitation of children. The Gold stage then taught full standard conventional BLS CPR as per the European Resuscitation Council guidelines. A pilot study (n=50) was performed showing that chest compression-only BLS (with attention to the airway) could be taught effectively within a 2 hour course. Compared to an historical control group taught standard BLS CPR, those taught "Bronze" level were better at achieving effective chest compressions as measured on a practice manikin (75% vs <50% controls). The hope is that lay people will be willing to be adequately trained in all three levels, but realistically it is conceded that some will stop after being trained in only one or two levels. Believing that chest compressions alone in the early minutes of cardiac arrest is still far superior to doing nothing a randomized trial of skill acquisition and retention comparing standard BLS training versus "Bronze" CPR was undertaken.

Preliminary analysis of some 500 lay people randomized to either standard BLS CPR training (per ERC guidelines) or "Bronze" level BLS CPR has been completed and was presented at the Wolf Creek V meeting (September 9, 1999). Training was for two hours in each group with class size limited to maximum of 40 participants. Experienced ERC-certified instructors were utilized with a strict ratio of one for every six participants. Some skills were taught to both groups (Table 5). The major difference was the standard BLS group was taught chest compressions at 80-120/min, mouth-to-mouth breathing, and instructed to use a 15:2 compression to ventilation ratio. The "Bronze" BLS group was taught chest compressions at 80-120/min for 50 compressions, then pause long enough to reopen the airway, and take two breaths themselves before starting the 50 compressions again. Upon completion of the training each participant was asked to demonstrate what they had just learned using a recording Resusci-AnneÔ mannequin as if she was a real victim of cardiac arrest. All were video taped silently.

Table 5.
Similar Items and Skills Taught to Both Groups

Recognition of heart attack symptoms
Appropriate warnings about the physical demands of CPR
The “safe” approach to a cardiac arrest victim
Assessment of consciousness
Shouting for help
Opening the airway
Check for breathing
Phone for an ambulance
Count compressions out loud

No differences in baseline demographics were seen between the two groups. No differences were likewise seen in several aspects of BLS performance including hand positioning, depth of chest compression, and chest compression rate (average = 109/min). Those taught the simplified technique ("Bronze") did substantially better in some aspects of BLS CPR. They were better at shouting for help, opening the airway, checking for breathing, and phoning for an ambulance.

Some important differences were that Bronze trained rescuers had a substantially shorter time period to beginning the resuscitation effort than did the standard BLS group. In fact they started doing something for the victim in half the time it took the standard BLS trained individuals to begin (approximately 30 sec versus 60 seconds). This 30 seconds in the beginning of a resuscitation effort may potentially be very important in preserving both vascular tone and gasping for a longer period during the cardiac arrest resuscitation effort. Additionally, the length of time during which chest compressions were interrupted, either for ventilating the cardiac arrest victim or for the rescuer to stop and take their two breaths was much shorter for the "Bronze" group compared to the standard group (approximately 10 seconds versus 15 seconds per each interruption).

Due to the more frequent interruptions of chest compressions in the standard group (using the 15:2 ratio of compressions to ventilations) and the increased time without chest compressions per interruption, the actual number of chest compressions delivered was markedly different between the two groups. The "bronze" trained group delivered twice as many chest compressions per minute as did the standard BLS group, though as noted previously the rate of compressions did not differ. The simplified chest compression-only trained group averaged about 80 delivered chest compressions per minute, while the standard BLS trained individuals averaged only 40 per minute. Theoretically, over a typical 8 minute period of bystander provided BLS CPR such differences could translate into a striking difference in total number of chest compressions provided. Using the approximate averages per group suggests about 320 compressions delivered with standard BLS versus twice that at about 640 compressions delivered with "Bronze" stage BLS CPR. If circulation is the key to long-term success in the early treatment period of adult cardiac arrest, then this doubling of delivered compressions should be a significant advantage of the simplified Bronze BLS approach.

CONCLUSIONS

Evidence continues to mount from many sources including experimental work, clinical observations, and BLS training studies supporting chest compression-only BLS CPR as a viable alternative for bystander-lay person cardiopulmonary resuscitation. The need to simplify and thereby improve and expand basic life support efforts by the lay public is further reason to strongly consider the potential of chest compression-only CPR.

ABSTRACT

Current resuscitation methods, though occasionally effective, rarely perform as well as initially anticipated. Some of the disappointment can be attributed to the difficulty of the task for many, including both professional and lay first responders. Significant attention has recently been paid to the need to simplify both the technique and the

teaching of resuscitation. In considering simplification of the current resuscitation scheme a logical start is an honest reappraisal of the importance and priorities of each of the once sacrosanct ABCs, specifically establishment of an Airway, artificial Breathing (specifically mouth to mouth breathing), and chest compressions for temporary Circulation.

Experimental data continues to accumulate indicating that most important within this triad is Circulation. Adequate oxygen exists within the blood during at least the first 10 minutes of cardiac arrest. If circulation is provided to distribute such oxygen no survival disadvantage results with chest compression-only basic life support efforts. Even a totally occluded airway during the first 6 minutes of cardiac arrest does not compromise survival if reasonable circulation is provided with chest compressions.

Clinical studies support the same conclusion that what most influences survival in any basic life support effort is circulation not ventilation. Belgium investigators have shown equal survival rates among those treated with chest compressions plus ventilation and those receiving chest compressions alone. Telephone dispatcher-guided BLS CPR has likewise shown no survival disadvantage to chest compression-only CPR when compared to phone-guided standard BLS CPR.

Based on this reasoning, a new simplified basic life support method has been proposed "Staged" cardiopulmonary resuscitation consists of a strategy to initially teach lay persons a simplified approach to basic life support, that requires only chest compressions and not mouth-to-mouth breathing. "Bronze" CPR where chest compression-only BLS is taught was compared to the standard ERC BLS course for lay persons. Mannequin "exit testing" upon course completion has revealed significant advantages of the simplified approach when compared to standard CPR courses for lay public.

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