Evaluation of Skills in Cardiopulmonary Resuscitation—What is the Initial Behavior of 1st Grade Senior High School Students?

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Abstract

Since it is recommended that only effective cardiopulmonary resuscitation (CPR) improves survival rates, many countries have promoted public CPR for several years, especially from school education. In 2006, our Department of Education will also initiate new CPR curriculum in high school. The quality assurance of training outcomes is essential and comparisons between different training methods are enviable. The aim of this study was to describe the initial behavior before the new curriculum, and test a model of quality assurance, consisting of a Video Recording Combined with the Recording Resusci Anne Printout(VIDRAP)combined with the ILCOR checklist, for evaluation of CPR performance. A group of 1st grade senior high school students (n =157) was used in this study. The result points out several points of concern: 1. The combination of a complete checklist and a VIDRAP program facilitate data gathering for the instructor and enables quality controls as a routine procedure. Moreover, quality controls at different levels, both individual and collective, of students' skill-retention are possible, as well as comparisons of various training methods at national and international levels.2. The results expose major points of concern regarding CPR training and skill-retention, although about half of all participants prior to CPR training experience, the performance is still poor. It shows we should strain CPR training courses in senior high school. 3. When new guidelines are discussed, it would be beneficial to test them on the possibility of practical application. *(Ann Disaster Med. 2006;4:37-43)*

Key words: Cardiopulmonary Resuscitation (CPR); Education; Skill Retention

Introduction

Since cardiopulmonary resuscitation (CPR) was introduced by Kouwenhoven in 1960,[1] many studies have shown the effectiveness of this technique.[2-3] However, the inherent inefficiency of this approach and the challenges related to teaching and retaining the skills needed to perform the technique correctly have limited its overall effectiveness.[4] Effective CPR was defined as performance of both adequate ventilation (with visible expansion of the chest wall during mouth-to-mouth ventilation) and compressions (with palpable pulse during chest compressions).[5] Now, millions of people

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around the world are currently trained in basic CPR. And our Department of Education will also initiate new CPR curriculum in senior high school in 2006. It seems therefore important to secure and facilitate the possibility of learning good CPR. Quality assurance of the education is therefore of great importance and ought to be included as a routine procedure,[5] including quality assurance as a routine procedure necessitates easily conducted performance tests. In order to optimize CPR education it is of great value to compare various training methods, in terms of quality of performance. However, comparable data of initial CPR performance has been difficult to obtain. Brennan et al. emphasize the importance of objective comparable assessment of training outcomes.[6] These authors provide a valid instrument for this purpose, containing a checklist revised by ILCOR in 2003, to be used in combination with an instrumented manikin. In the present study, a specially designed computer software which calculates new parameters from those measured by the instrumented manikin, was used in combination with the revised Brennan et al. checklist, in an attempt to make the assessments even more precise. The aim of this study was to describe the initial behavior before the new curriculum, and test a model of quality assurance, consisting of a Video Recording combined with the Recording Resusci Anne Printout(VIDRAP), combined with the ILCOR checklist, for evaluation of CPR performance.

Methods

Participants

In this study we examined 157 students studying at The Affiliated Senior High School of National Taiwan Normal University. The participants included 4 classes in 26 classes. The sampling rate is 15.4%. The age of the participants ranged from 15 to 16 years old(mean 15.4 ; SD = ± 0.49).Boy students enclose 50.3%. 79 participants(50.3%)had attended a CPR training course in last 2 years before this evaluation. All participants have not CPR experience in their earlier period life.

Checklist

In order to be able to evaluate the examination skills and to ensure the correct sequence up to initiation of CPR, a checklist was used. The version of the Brennan et al. checklist, published in 1996, revised by ILCOR in 2003,[6] which contains the comprehensive set of data, was used. It includes 2 components. One is Five-point subjective overall rating. The other is CPR skill checklist. The Five-point subjective overall rating has 5 levels with understandable definitions described as table 1 .（1）Not competent （2）Questionably competent （3）Competent （4）Very good （5）Outstanding. CPR skill checklist describes the steps which are not reported or incompletely reported by the instrumented manikin （as table 2）. The sequence and performance of each item are carefully described by ILCOR. The items were coded (0 = not performed, or performed incorrectly; 1 = performed as described) and summarized to make a checklist performance scale, with a possible range from 0 to 23 points. Both of the checklists were translated to the traditional Chinese, and corrected by 8 experts. The correlation of two checklists is high （Pearson Correlation = 0.96）.All scorers were given the same information before evaluation. The intra-scorer reliability and inter-scorer reliability are no difference in twice

Table 1. Five-point subjective overall rating definitions

Levels	Rating Definitions
Outstanding（5）	All skills were performed very well with no errors and almost exactly as described in the standards. CPR performed in this way is likely to be effective and the victim would not be endangered.
Very good（4）	All skills were performed competently, although improvement is possible. Errors may be minor; most were corrected. No serious errors in technique or sequence were made. CPR performed in this way is likely to be effective and the victim would not be endangered.
Competent（3）	Skills were crude and sometimes failed to meet standards; several steps may have been out of sequence or were skipped, and/or some errors went uncorrected, although any serious errors were corrected. CPR performed in this way would probably be effective and the victim would not be endangered.
Questionably competent（2）	Skills were crude and often failed to meet the standard and/or serious errors were left uncorrected. There may have been serious errors in sequence or delays. The chest was compressed and some ventilations resulted in chest rise. CPR performed this way might be effective. Errors might endanger the victim.
Not competent（1）	Skills were performed poorly or not at all; errors might seriously endanger a victim. CPR may not have been performed. Efforts, if any, did not result in BOTH chest rise and compression of chest. CPR performed in this way would probably not be effective and/or the safety of the victim would be endangered.

Source：Chamberlain, D. A., & Hazinski, M. F.(2003). Education in Resuscitation: An ILCOR Symposium. *Circulation, 108*(20), 2575-2594.

trials($p > .05$).

Video recording combined with the recording Resusci-Anne printout

Video Recording was progressing when evaluation and a Leardal Skillmeter Resusci Anne was connected to a computer with a specially designed software. The software contains the usual parameters measured by a Laerdal Skillmeter Resusci Anne: session duration for the CPR event (measured in seconds), number of inflations and compressions done, and percentage of correct inflations and compressions according to AHA standards. Inflation volume and flow rate for each inflation, and mean compression rate per minute are measured.

Results

Assessment of skills according to checklist

1.The Five-point subjective overall rating：
149 of the participants(94.9%)are rated “Not competent”. 5 of the participants(3.18%)are rated “Questionably competent”. 2 of the participants(1.27%)are rated “ competent”. And only 1 of the participants(0.64%)are rated “Outstanding”.

2. CPR skill checklist：
27.4% participants checked for unresponsiveness. 42.7% participants calling for help or indicating that help is needed, after check of unresponsiveness and before chest compressions. 6.4% participants opening of the airway prior to checking for breathing. 1.3% participants checked the breathing for a minimum of five seconds before any breaths were given. 1.9% participants given adequate ventilation (with visible expansion of the chest wall

Table 2. Checklist Definitions

Subject action	Definitions
1. checks unresponsiveness	Subject is close to manikin. Subject shouts; Are you all right? (or a similar phrase). Subject taps or gently shakes manikin during this step.
2. Sequence : The unresponsiveness check must precede any intervention, including opening the airway.	
3. calls or phones for help	Subject calls or phones for help or sends someone to call or phone for help; Subject either simulates a phone call or tells bystander to phone 911 (or other emergency response number), phone for an ambulance, or another clear instruction (getting an AED is not required nor is it acceptable to get an AED without calling or phoning for help).
4. Sequence : This must occur after a check of unresponsiveness and before starting ventilations. If there is no check for unresponsiveness, the call for help must precede all other steps.	
5. opens airway using head tilt; chin lift	Subject kneels beside the manikin near shoulders and uses the palm of one hand to apply firm backward pressure on forehead and uses the other hand to lift the bony part of the lower jaw near the chin. There is obvious movement of the head from the neutral position. The nose may or may not be pinched.
6. Sequence : This must precede checking for breathing.	
7. checks breathing	Subject places his or her ear near mouth and nose of the manikin and looks at manikin chest. The breathing check should take no more than 10 " Do not count breathing check if the subject has not opened the airway.
8. Sequence : This must occur before any breaths are given.	
9. Attempts 2 breaths	so that the chest rises at least once and no more than twice Subject maintains an open airway (as above), pinches the nose shut, places his/her mouth over mouth of manikin, and exhales into manikin. The manikin chest rises visibly at least once and no more than twice. Do not count breaths if subject has not opened airway.
10. Sequence : Must precede any chest compressions.	
11. checks for signs of circulation.	Subject pauses after first 2 breaths and looks, listens, and feels for breathing AND scans the manikin for signs of movement. The check for signs of circulation should take no more than 10 seconds (verify this with a clock or watch). To get a check, the subject must perform the look, listen, and feel component and the scan the manikin component
12. Sequence : Must follow initial 2 breaths and precede any chest compressions.	
13. locates compression position	on lower half of the sternum aligns the long axis of the palm of one hand directly on the lower half of the sternum. If palm is located primarily in the upper half of the sternum or a significant part of the palm is below the end of the sternum, do not give a check for this skill. If the palm is rotated incorrectly, do not count it. (No single method need be used for this step, but use the separate line on the right to record a 1; if the subject traces the outline of the ribs and finds a place 1 finger above where the ribs come together; record a 2; if the subject finds a place 2 fingers above the xiphoid; record a 3; if the subject bares the chest and visually finds a point on the sternum between the nipples.)
14. Sequence : Must precede any compressions.	
15. gives at least 13 and no more than 17 compressions.	Subject Compressions must result in visible depression and release of the sternum.
16. attempts to give 2 breaths.	Subject Chest must rise at least once and no more than twice (as above).
17. repeats cycles at least 2 more times.	Subject Performs at least 2 more cycles of a minimum of 13 and a maximum of 17 compressions interspersed with breathing attempts after each cycle.
18. Subject opens airway between every set of compressions	using head tilt ;chin lift; As above, but check only if done for all additional sets of compressions and ventilations.
19. attempts at least 2 breaths	so that chest rises at least once and no more than twice between every set of compressions; As above, but check only if done for all additional sets of compressions and ventilations.
20. locates compression position	between every set of compressions.As above, but check only if done for all additional sets of compressions and ventilations. It is not necessary to record the method used beyond the first cycle.
21. checks for signs of circulation.	As above but after the 3rd, 4th, or 5th cycle of compressions and ventilations. Must have both the look, listen, and feel component and the scan the manikin component to get a check. Subject should stop and reassess the victim for no more than 10 seconds.
22. Sequence : Must follow at least 3 and no more than 5 cycles of compressions and ventilations	
23. resumes CPR	After reassessment, subject resumes CPR, including both compression and ventilations.

Source : Chamberlain, D. A., & Hazinski, M. F.(2003). Education in Resuscitation: An ILCOR Symposium. *Circulation, 108* (20), 2575-2594.

during mouth- to- mouth ventilation). Only 0.6% participants checked the circulation signs last for at least 5 seconds according to guidelines used in this study. 8.9% participants find

Table 3. The Five-point subjective overall

Rating	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	149	94.9	149	94.9
2	5	3.18	154	98.09
3	2	1.27	156	99.36
5	1	0.64	157	100

Table 4. Checklist scale. Summarized number of points

Variable	N	Mean	Std Dev	Minimum	Maximum
score	157	2.96	2.94	1	22

Table 5. Checklist scale. Correct Percentage of very Variable

Variable	Frequency	Percent	Variable	Frequency	Percent	Variable	Frequency	Percent
1	43	27.39	9	3	1.91	17	46	29.3
2	19	12.1	10	2	1.27	18	9	5.73
3	67	42.68	11	1	0.64	19	2	1.27
4	8	5.1	12	2	1.27	20	2	1.27
5	10	6.37	13	14	8.92	21	17	10.83
6	14	8.92	14	125	79.62	22	1	0.64
7	2	1.27	15	63	40.13	23	5	3.18
8	5	3.18	16	5	3.18			

Table 6. Rescue breathing and compression performance measured by the computer software

Variable	N	Mean	Std Dev	Minimum	Maximum
correct percentage of breathing	157	0.014268	0.092509	0	1
correct percentage of compression	155	0.105419	0.231686	0	1
correct percentage of compression rate	157	0.127389	0.334475	0	1

the right position on lower half of the sternum. 10.8% participants correctly followed at least 3 and no more than 5 cycles of compressions and ventilations. Average score is 2.96 (SD = ±2.94), varied between 1 and 22, as shown in Table 4 and 5.

CPR-performance measured by the computer program

All participants performed CPR for approximately 1- 4 minutes. And we were mainly interested in the averages. (the correct percentage of breathing, the correct percentage of compression, the correct percentage of compression rate).

Average correct rate of breathing varied between 0% and 100%, with an average of 1.43%. Most of the errors are inflations that "too much" "too little" and "too fast". Average correct rate of compression varied between 0% and 100%, with an average of 10.54%. Most of the errors are compression that "too deep" "too shallow" and "Incorrect hand position". Average compression rate (compressions per minute during the compression cycle) varied between 42 and 164, with an average of 78. But the correct rate of compression rate is only 12.74%.

Discussion

Understanding the initial behaviors in CPR is beneficial to educational design, comparing educational outcomes, and research analysis. The initial behavior of 1st grade senior high school students in CPR skills has been shown as Table 3 to 6. Most of participants are "Not competent", the score of checklist is low, and rescue breathing and compression performance measured by the computer software is still poor, although about half of all participants prior to CPR training experience. It approved that resuscitations skills deteriorate quickly and theoretical knowledge may be retained longer than practical skills.[8] Therefore, we must concern that a course enough to learn and retain this skill or not. Are retraining courses effective? And

after how long should retraining courses be offered? To increase the quality of CPR performance is of great importance for the outcome of the cardiac arrest victim. [9] It is suggested that only effective CPR improves survival rates.[10] NRCT as well as AHA have presented guidelines stating how CPR should be performed. Existing guidelines are supposed to reflect effective CPR. and we should strain CPR training courses in senior high school.

Otherwise, in order to enable comparisons of various methods of CPR training, the importance of making objective assessments of training outcomes is stressed by Brennan et al.[7] Using a computerized manikin in combination with a complete checklist，and video recording minimizes the possibility of subjective judgements.[11] As the instrumented manikin and the computer perform assessments of the quality of chest compressions and ventilations, subjective judgements are eliminated. However filling in the checklist must be done by a person and therefore entails a risk for mis-judgement. The computer software provides the instructor with valuable information concerning CPR performance skills for each student without the need for further analyses. [12] In the future, the instructors can use this instrument in order to make their own quality control. The prerequisite for making quality controls, as a routine procedure, is that it is easy to accomplish.[13] Moreover, data gathering via the computer enables data collection from many students, enabling the finding of weaknesses in the education system.[14] This also enables comparisons of various training methods at national and international levels.

Conclusions

From the results of this study we conclude that:

1. The combination of a complete checklist and a VIDRAP program facilitate data gathering for the instructor and enables quality controls as a routine procedure. Moreover, quality controls at different levels, both individual and collective, of students' skill-retention are possible, as well as comparisons of various training methods at national and international levels.
2. The results expose major points of concern regarding CPR training and skill-retention, although about half of all participants prior to CPR training experience, the performance is still poor. It shows we should strain CPR training courses in senior high school.
3. When new guidelines are discussed, it would be beneficial to test them on the possibility of practical application.

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