Reliability of chest compression performance on manikin in Cardio Pulmonary Resuscitation (CPR) training program – a Cross-sectional study

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***Abstract*— Chest compression is one of the important components of cardio pulmonary resuscitation (CPR). Special training is required to execute optimum pressure on chest. According to American Heart Association (AHA) guideline 5 cm compression is necessary to obtain return of spontaneous circulation (ROSC). This was a cross sectional analytic study to evaluate the reliability of chest compression performance on manikin in Cardio Pulmonary Resuscitation (CPR) training program.**

A total 52 participants were tested. The participants were divided in to four sub groups according to their profession and seniority. The mean pressure of fourth year MD students was found above the par. The means of all groups were compared with AHA guideline mean and the relationship of both means were compared by Student's t-test. The p-value was found not significant at 5% confidence level.

Keywords*— *CPR, chest compression, AHA guideline, manikin.

Introduction:

Chest compressions have saved the lives of countless patients in cardiac arrest since they were first introduced in 1960.[1] Cardiac arrest is treated with cardiopulmonary resuscitation (CPR) and chest compressions are a basic component of CPR. The quality of the delivered chest compressions is a pivotal determinant of successful resuscitation.[2] In spite of this, studies show that the quality of chest compressions, even if delivered by healthcare professionals, is often suboptimal.[2] Therefore it is important that providers carefully familiarize themselves with this technique.

Compression depth should be at least 5 cm, since sternal depression of 5 cm and over results in a higher Return of spontaneous circulation (ROSC). No upper limit for compression depth has been established in human studies but experts recommend that sternal depression should not exceed 6 cm.[3] After each compression, allow the chest to recoil completely. Incomplete recoil results in worse hemodynamics, including decreased cardiac perfusion, cerebral perfusion and cardiac output.[4] Complete recoil is achieved by releasing all pressure from the chest and not leaning on the chest during the relaxation phase of the chest compressions.[3] However, avoid lifting the hands off the patient's chest, since this was associated with a reduction in compression depth.[4]

The duration of the compression phase as a proportion of the total cycle is termed duty cycle. Although duty cycles ranging between 20% and 50% can result in adequate cardiac and cerebral perfusion, a duty cycle of 50% is recommended because it is easy to achieve with practice.[5] Thus the duration of the compression phase should be equivalent to the duration of the decompression phase. If the patient has hemodynamic monitoring via an arterial line then compression rate, compression depth and recoil can be optimized for the individual patient on the basis of this data.

"2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" (2010 AHA guidelines) as one of the most authoritative guidelines was published in 2010 and demanded for better performance of chest compression practice. It called for a rate of "at least 100 beats/min" and a depth of "at least 5cm" while offering chest compression in CPR.[6]

This was a cross sectional analytic study to compare chest compression pression pressure of CPR trainees during training program with the American Heart Association Guidelines.

Study design:

The aim of the study was to evaluate the chest compression pression pressure of CPR trainees during training program and to compare it with the standard one. Ethical clearance was achieved from the research ethics board (REB) of the faculty of medical sciences of University Malaysia Sabah (UMS).

Null hypothesis (H0): There was no significant difference between the chest compression pressure in CPR trainees and that of standard recommendation.

Alternate hypothesis: There was significant difference between the chest compression pressure in CPR trainees and that of standard recommendation.

P value was calculated by Student's T test in 5% confidence interval.

Methodology: Study populations were the trainees of the Cardio Pulmonary Resuscitation (CPR) training program conducted by the Faculty of Medicine and Health Science of University Malaysia Sabah (UMS), Malaysia. Sample size was 52. Data were collected from the simulation assessment form which were filled by the instructor during the CPR training program. Data were transferred to the spreadsheet. Chest compression pressure of each participating trainee were observed. Mean of the chest compressing pressure of trainees were compared with that of standard (according to American Heart Association guideline). P-value were measured by Student's T test. Strength of Null hypothesis were evaluated.

Result:

This was a cross sectional analytic study to compare chest compression pression pressure of CPR trainees during training program with the American Heart Association Guidelines. Total number of participants were 52.

Table 1: Distribution according to profession and study level of the participants.

Profession / study level of participants	Number	Percentage	Total (n)
Third year MD student Fourth year MD student Graduate nurse Second year nursing student	15 15 12 10	29% 29% 23% 19%	52

Table 1 showed the distribution of participants according to profession and study level of the participants. Total participants were 52 in number. Third year and fourth year MD students were 29% in each group. Graduate nurses were 23% of total and second year nursing students were 19% of total participants.

Table 2: Mean compression pressure of participants and comparison with AHA guideline.

Profession / Year of participant	Chest compression mean (cm)	AHA guideline mean (cm)	t-value	p-value
Third year MD student Fourth year MD student Graduate nurse Second year nursing student	4.82 5.19 4.67 4.53	5	-1.389	0.106 (not significant at p < .05)

Table 2 illustrated the mean compression pressure of each subgroup of the participants and the comparison of their mean with the mean of AHA guideline. The mean compression of third year MD students was 4.82 centimeter and the same of the fourth year MD students were 5.19 centimeter. The mean compression pressure of graduate nurses and second year nursing students were 4.67 and 4.53 respectively. The means were compared with the mean of AHA guideline by Student's independent t-test. The t-value was -1.389 and the p-value was 0.106. The p-value was not significant at 5% confidence level. So null hypothesis was failed to be rejected. Therefore, the difference between the participants mean and the standard mean did not show any significant difference.

Discussion:

Geddes et al published their study on chest compression force compared between trained and untrained persons. In that study 83 trained and 104 untrained adult rescuers were tested. It was concluded that 60% of the trained rescuers were able to compress chest 2 inches or 5 cm. This percentage was 37% in case of untrained participants.[7] In this study the mean of fourth year MD students (29%) was at least 5 cm.

Blomberg H et al performed a randomized cross over study to compare the chest compression in CPR between mechanical chest compressor device and manual compression. Total 21 trained ambulance crews participated in that study. All the participants compressed the chest two times, one time by mechanical compressor and another time by manually. Data sampling was done by computerized manikin. It was found that necessary compression was achieved in 58% cases by mechanical compressor which was 88% when compressed manually.[8] In this study computerized manikin was used to record the chest compression. Chest pressure was done manually, no mechanical compressor was used.

Feng-ling Zhang et reported their study on correlation between quality indexes of chest compression. Total 219 participants were enrolled in that study. Nearly one-third participants were male. Nearly two-third of the participants had doctoral degree, 10% had master degree and rest of the participants had bachelor degree. It was concluded that there was no significant difference between the chest compression quality indexes among practitioners irrespective to their education or ages. Fatigue time, accuracy of deep-compression and accuracy of chest recoil were reported different in males and females. The fatigue time and accuracy of deep-compression were higher in male, whereas the accuracy of chest recoil was higher in females. Correlation analysis showed that fatigue time was negatively proportionate to the accuracy of compression rate and chest recoil but was positively related to the accuracy of hands placement and accuracy of deep-compression.[9] In this study each participant compressed manikin chest for one time. Only accuracy was measured, fatigue time was not obtained.

Aufderheide TP performed their study on 30 emergency medical service providers to assess chest compression-decompression technique on manikin. All the participants performed CPR for 3 minutes initially by using standard hand position technique followed by two-finger fulcrum technique, five-finger fulcrum technique and hands-off technique. There were no significant differences in depth of compression, accuracy of hand placement or increased fatigue or discomfort when compared with the Standard Hand Position. All the techniques of manual CPR tested (including the Standard Hand Position) by the participants using a recording manikin recorded inadequate depth of compression more than half of the time.[10] In this study only standard hand position technique was applied to observe the chest compression and to compare with standard one.

Baubin MA et al published their work on compression characteristic of CPR different types of manikins. In that study 8 different CPR manikins were used where force-depth compression wa assessed by thumper. For 1 cm depth the required pressure was between 6.3 and 14 kp, whereas for 5 cm compression the required pressure was between 28.5 to 69 kp. The manikins with spring at thorax showed a linear relationship between depth and force required to compress the chest. On the other hand, one manikin without spring and one manikin with plastic spring-like construction showed non-linear when compression increased beyond 3 cm. The authors concluded commenting that for correct CPR training it is essential that the CPR trainees learn to compress in a sufficiently strong manner, but simultaneously to avoid an exceedingly high depth of compression irrespective of the thorax resistance.[11] In this study spring manikin was used. Five centimeter was considered as optimum chest compression. Linearity between applied pressure and achieved compression was not observed.

Conclusion:

Chest compression during CPR is a life saving event which is practiced by all trained rescuers. Achieving optimum pressure for perfect chest compression needs high expertise. Repeated practicing on computerized manikin can improve the technique in order to execute perfect maneuver during the real-life events.

Conflict of interest:

No conflict of interest was declared by any of the author or co-authors for this study.

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