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IMPACT OF REAL TIME FEEDBACK ENABLED MONITOR ON QUALITY OF CARDIOPULMONARY RESUSCITATION IN MANIKIN.

Dr. Tejavenu Yedla	School of Experiential Learning and Simulation center, DMIHER(DU).
Dr. Gajanan Chavan	Head of Department, Anesthesia, AIIMS(Nagpur).
Dr. Shraddha Patel	Associate Professor, Dept. of OMR, SPDC, DMIHER(DU).
Dr. Apurva Giri	Faculty, School of Experiential Learning and Simulation center, DMIHER(DU).
Dr. Minakshi Urkude	Associate Professor, Dept. of Agadtantra, MGAC, DMIHER(DU).

KEYWORDS :

INTRODUCTION

Cardiopulmonary resuscitation (CPR) stands as a critical intervention in managing cardiac arrest (CA) and remains a cornerstone of life-saving measures. Despite its pivotal role, survival rates following CA events continue to be disconcertingly low. High-quality CPR, as defined by guidelines established by medical authorities, is recognized as a key factor in improving outcomes during these life-threatening situations. However, a significant gap exists between these well-established CPR protocols and the actual practices of healthcare professionals in real-world scenarios. Delivering consistent and high-quality CPR proves to be a formidable challenge, further compounded by the observation that CPR performance tends to degrade over the course of prolonged resuscitation efforts **[1,2]**.

To address these challenges, various feedback devices have been developed to offer real-time guidance on the quality of chest compressions in both training and clinical settings. One innovative approach involves the use of a sensor placed beneath the hands of the CPR provider, positioned directly over the sternum. This sensor provides immediate feedback on the rate and depth of chest compressions, enabling rescuers to make necessary adjustments to their CPR technique based on real-time information. Studies conducted with manikins in controlled environments provide a valuable means to evaluate these emerging technologies. By simulating real-world scenarios, this study aims to explore the impact of a real-time visual feedback device on the quality of chest compressions, aligning with international recommendations. The objective is to bridge the gap between established guidelines and the practical delivery of life-saving CPR **[3,4]**.

Immediate recognition and the early provision of Basic Life Support (BLS), with a focus on optimal cardiac compression, form the foundation for maximizing the chances of survival in individuals experiencing cardiac arrest. Regrettably, only a mere 10% of adults suffering non-traumatic cardiac arrest survive to be discharged. The American Heart Association's (AHA) BLS course plays a pivotal role in educating learners on the provision of high-quality CPR, with an emphasis on effective cardiac compressions, encompassing factors such as depth, rate, and recoil, all within a simulated environment. The ultimate aim of this training is to achieve Return of Spontaneous Circulation (ROSC) **[1,5,6]**.

Cardiac compression plays a central role in CPR, with guidelines recommending a compression rate of 100-120 compressions per minute, a compression depth of 5-6 centimeters, and the provision of adequate chest recoil. Additional critical components of high-quality CPR encompass the delivery of 6 ventilations per minute when a second rescuer is available, the avoidance of hyperventilation, and the minimization of interruptions, ideally lasting less than 10 seconds **[1,5,6]**.

The practice of CPR on basic manikins serves as a valuable means for acquiring essential skills, including proficiency in chest compressions and airway maneuvers. In this context, high-fidelity manikins equipped with real-time feedback devices not only enable learners to acquire fundamental skills but also empower them to measure and monitor their actual performance during CPR practice. This, in turn, allows for immediate corrective actions if needed **[7-14]**.

The development of various feedback devices for assessing and measuring the quality of CPR, including inbuilt audio and visual feedback systems, has revolutionized CPR training. These systems provide real-time feedback, enabling learners and instructors to take prompt corrective measures. Numerous studies have been conducted, demonstrating positive outcomes in skill acquisition both in controlled skill labs and real-life scenarios. In the quest to achieve ROSC, achieving a chest compression fraction of at least 70% for single rescuers and 80% for two rescuers has been identified as a critical benchmark **[1,7-14]**. Using a simulated scenario, this study aims to evaluate the impact of a real-time visual feedback device on the quality of chest compressions, aligned with international recommendations.

Methodology

Study Design

This single-center observational study was conducted at Acharya Vinoba Bhave Rural Hospital in the Maharashtra state in India, **between November and December 2021**. The study was approved by the institutional review board and ethics committee with IEC Certificate Number : DMIMS(DU)/IEC/2020-21/9309

Study Participants:

The study included interns who were assigned to a skill lab following their Basic Life Support (BLS) CPR skill training and assessment. A total of 50 interns were selected and randomized into two groups for the simulated scenario of Cardiopulmonary arrest using the SIMMAN 3G simulator, which provided real-time visual feedback on the depth and rate of cardiac compressions, along with the duration of each compression cycle.

Participants were divided into two groups as follows:

- Control Group: This group consisted of 25 interns who underwent assessment and simulation without any visual feedback device.
- Study Group: This group also comprised 25 interns, but they were equipped with a visual feedback device during the assessment and simulation.

CPR Performance Parameters:

The assessment was conducted in a simulated scenario of Cardiopulmonary arrest using the SIMMAN 3G simulator. High-quality chest compressions were defined as those with a depth between 50-60mm and a frequency of 100-120 compressions per minute. The duration of each simulated scenario was set at 2 minutes, encompassing a total of 5 cycles of chest compressions, interspersed with adequate chest recoil.

Outcome Measures:

The study aimed to evaluate the impact of the feedback device on the quality of CPR skills among participants. The primary objectives were as follows:

- To estimate the impact of the feedback device on the quality of CPR, specifically focusing on the depth and rate of chest compressions, and the duration of each compression cycle.
- To compare the overall CPR score between the Control Group and the Study Group.

Statistical Analysis:
Data analysis involved comparing the performance of the two groups using appropriate statistical tests. The statistical significance of the results was determined through p-values. The primary outcomes assessed included the overall CPR score, compression depth, compression rate, and the duration of each cycle. The study also evaluated the achievement of advanced CPR performance status.

The statistical analysis aimed to provide insights into the effectiveness of the feedback device in improving CPR performance among the study group in comparison to the control group.

RESULTS

The study included a total of 50 interns who were selected and randomized into two groups: the Control group without a visual feedback device (n=25) and the Study group with a visual feedback device (n=25). The baseline characteristics of the participants, including age, gender, CPR knowledge, and skills, were similar between the two groups.

The 'overall CPR score,' which serves as a comprehensive measure of CPR performance, was found to be significantly higher in the study group when compared to the control group group ($p < 0.001$). In the study group, the median 'overall CPR score' was 69.5, with an interquartile range (IQR) of 56-86, while in the control group group, the median score was 56, with an IQR of 19-77.

A notable finding was the achievement of advanced CPR performance status in a higher proportion of participants in the study group (46.2%) as compared to the control group group (26.9%), demonstrating the efficacy of the visual feedback device ($p = 0.001$).

Regarding chest compression (CC) depth, the study revealed that the mean depth of CCs was significantly lower in the study group (52mm, IQR: 43-60) when compared to the control group group (59.5mm, IQR: 49-91) ($p = 0.005$). The depth in the study group was both lower and appropriate for high-quality CPR.

Analysis of the percentage of time during which adequate CC depth was achieved showed that the study group consistently outperformed the control group group. In the study group, 66% of the time (IQR: 48-91) saw the achievement of adequate CC depth, whereas the control group group achieved this 50% of the time (IQR: 41-79).

The study also examined the adequacy of CC rate and found that the study group achieved a significantly higher percentage of adequate CC rate compared to the control group group. In the study group, 40.5% of the time (IQR: 10-62) had an adequate CC rate, while the control group group reached this level of adequacy only 19% of the time (IQR: 2-54).

Furthermore, the study assessed the adequacy of chest recoil, an essential aspect of high-quality CPR. The results indicated that the study group consistently outperformed the control group group in achieving adequate chest recoil. In the study group, 97% of the time (IQR: 63-100) demonstrated adequate chest recoil, whereas the control group achieved this 83% of the time (IQR: 43-100).

In contrast, the mean compression rate was statistically similar in both the study and control group groups, indicating that the visual feedback device primarily affected other aspects of CPR quality, such as depth, rate, and recoil.

These findings provide very strong evidence supporting the study group in delivering high-quality CPR in a simulated environment compared to the control group. Notably, the study group displayed significantly better depth and rate of chest compressions, achieved advanced CPR performance status more frequently, and consistently maintained adequate CC depth, rate, and chest recoil during the simulated scenarios.

DISCUSSION

The simulated CPR scenario in this study illustrates the significant enhancement in the quality of chest compressions delivered by healthcare professionals when using a real-time visual feedback device. This positive outcome aligns with previous research findings. While some studies, like the one by Gruber et al., did not find significant differences in effective compression rates among BLS providers using various feedback devices, it's important to consider the context. Their study primarily involved recently trained providers, and all groups underwent several hours of CPR training without feedback. This suggests that feedback devices may be particularly beneficial for providers with insufficient or outdated training **[11]**. In contrast, our study found no differences in performance between healthcare professionals with recent BLS/ALS training and those with outdated training, highlighting that even experienced or recently trained CPR providers can benefit from real-time feedback.

Efforts to standardize the quality of CPR are continually evolving, with the European Resuscitation Council and the American Heart Association emphasizing fundamental aspects of high-quality CPR. These include minimizing compression interruptions, achieving the appropriate compression rate and depth, avoiding leaning between compressions, and reducing excessive ventilation. Our study revealed that without the aid of a feedback device, chest compressions during the simulated scenario were often too shallow and too fast, underscoring the need for CPR quality improvement. Notably, healthcare providers frequently overestimate the proportion of optimal CPR delivered. This finding echoes the results of Chang et al., who demonstrated that real-time feedback enhances the accuracy of CPR depth perception in providers compared to team leaders. A systematic review by Yeung et al. further supported the use of real-time feedback devices during training for skill acquisition. Both manikin and human studies have consistently shown that real-time feedback devices help healthcare professionals adhere more closely to resuscitation guidelines **[13,14]**.

Various methods and technologies have been developed to support healthcare professionals during training, including audio-feedback systems, video-recording systems, automated external defibrillator interaction systems, mobile applications, metronomes, and motion-sensing devices. These tools aim to facilitate the acquisition and maintenance of high-quality CPR skills. The positive outcomes of this study highlight the effectiveness of incorporating real-time visual feedback into CPR training, which has the potential to significantly improve the quality of CPR delivery by healthcare professionals. As these technologies continue to advance, they may play a crucial role in enhancing the performance of CPR providers and ultimately improving survival rates in cardiac arrest cases **[1-5]**.

CONCLUSION

Incorporating a visual feedback system significantly improves the quality of chest compressions provided by healthcare professionals in a simulated cardiac arrest scenario using a manikin. The proportion of chest compressions meeting optimal depth and rate criteria significantly increases, even among recently trained CPR providers. The implementation of feedback systems in clinical practice can provide critical information and enhance the monitoring of CPR provider performance. Further clinical trials are needed to evaluate the impact of these strategies in clinical practice and assess their potential impact on morbidity and mortality.

Limitations

While the positive results of this study are noteworthy, several limitations should be considered. The study population was relatively small, and there was no control group for comparison. The constant visual focus required when using the feedback device may not fully simulate the distractions and challenges of a real-world scenario. Furthermore, parameters related to chest recoil were not evaluated. Finally, a manikin trial cannot fully replicate a real-life CPR situation, as it lacks important environmental factors, including higher stress levels and longer durations of CPR. In a clinical setting, healthcare providers must manage various distractions and communicate with the CPR team, which was not replicated in this study.

REFERENCES

1. Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2015;132(18 Suppl 2):S414-35, 10.1161/CIR.0000000000000259
2. Edelson DP, Abella BS, KramerJohansen J, Wik L, Myklebust H, Barry AM, et al. Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Resuscitation. 2006;71(2):137-45, 10.1016/j.resuscitation.2006.04.008

3. Beckers SK, Skorning MH, Fries M, Bickenbach J, Beuerlein S, Derwall M, et al. CPREzy improves performance of external chest compressions in simulated cardiac arrest. Resuscitation. 2007;72(1):100-7, 10.1016/j.resuscitation.2006.05.020
4. Elding C, Baskett P, Hughes A. The study of the effectiveness of chest compressions using the CPR-plus. Resuscitation. 1998;36(3):169-73, 10.1016/s0300-9572(98)00016-1
5. Berdowski J, Berg RA, Tijssen JG, Koster RW. Global incidences of out-of-hospital cardiac arrest and survival rates: Systematic review of 67 prospective studies. Resuscitation. 2010;81(11):1479-87, 10.1016/j.resuscitation.2010.08.006
6. Lyon RM, Clarke S, Milligan D, Clegg GR. Resuscitation feedback and targeted education improves quality of pre-hospital resuscitation in Scotland. Resuscitation. 2012;83(1):70-5, 10.1016/j.resuscitation.2011.07.016
7. Mathys J. Labuschagne, Azmia Arbee, Carla de Klerk, Elizabeth de Vries, Timon de Waal, Taskeen Jhetam, Brittany Piest, Judah Prins, Somey Uys, Riaan van Wyk, Cornel van Rooyen. A comparison of the effectiveness of QCPR and conventional CPR training in final-year medical students at a South African university, African Journal of Emergency Medicine,Volume 12, Issue 2, 2022, Pages 106-111, https://doi.org/10.1016/j.afjem.2022.02.001.
8. Boyle AJ, Wilson AM, Connelly K, McGuigan L, Wilson J, Whitbourn R. Improvement in timing and effectiveness of external cardiac compressions with a new non-invasive device: the CPR-Ezy. Resuscitation. 2002;54(1):63-7, 10.1016/s0300-9572(02)00049-7
9. Skorning M, Derwall M, Brokmann JC, Rörtgen D, Bergrath S, Pflipsen J, et al. External chest compressions using a mechanical feedback device : cross-over simulation study. Anaesthesist. 2011;60(8):717-22. 11, 10.1007/s00101-011-1871-6
10. Noordergraaf GJ, Drinkwaard BW, van Berkom PF, van Hemert HP, Venema A, Scheffer GJ, et al. The quality of chest compressions by trained personnel: the effect of feedback, via the CPREzy, in a randomized controlled trial using a manikin model. Resuscitation. 2006;69(2):241-52, 10.1016/j.resuscitation.2005.08.008
11. Gruber J, Stumpf D, Zapletal B, Neuhold S, Fischer H. Real-time feedback systems in CPR. Trends Anaesth Crit Care 2012;2(6):287–94, 10.1016/j.tacc.2012.09.004
12. Perkins GD, Handley AJ, Koster RW, Castrén M, Smyth MA, Olasveengen T, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation. Resuscitation. 2015;95:81-99, 10.1016/j.resuscitation.2015.07.015
13. Kirkbright S, Finn J, Tohira H, Bremner A, Jacobs I, Celenza A. Audiovisual feedback device use by health care professionals during CPR: a systematic review and metaanalysis of randomised and nonrandomised trials. Resuscitation. 2014;85(4):460-71, 10.1016/j.resuscitation.2013.12.012
14. Yeung J, Meeks R, Edelson D, Gao F, Soar J, Perkins GD. The use of CPR feedback/prompt devices during training and CPR performance: a systematic review. Resuscitation. 2009;80(7):743-51, 10.1016/j.resuscitation.2009.04.012