The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 7, 2025

IMPROVING CPR PERFORMANCE IN NURSES USING METRONOME GUIDANCE: A REVIEW ARTICLE

Junaid Ali[1], Raja[*2], Ameer Ullah Khan[3]

[1] *Student of Master of Science in Nursing, Ziauddin University Faculty of Nursing & Midwifery, Karachi*
[*2] *Associate Professor, Ziauddin University Faculty of Nursing & Midwifery, Karachi*
[3] *Nursing Instructor, Qatar College of Nursing (Female), Orangi Town, Karachi*

[1]junaid.16817@zu.edu.pk, [*2]raja.khatri@zu.edu.pk, [3]amir.ullah85@yahoo.com

DOI: https://doi.org/10.5281/zenodo.15804145

Keywords
Metronome, Sound- Guided, CPR Performance Metrics, BLS

Article History
Received on 29 May 2025
Accepted on 29 June 2025
Published on 04 July 2025

Corresponding Author: * **Raja**

Abstract

Background: *Cardiopulmonary resuscitation (CPR) is a critical, life-saving procedure requiring precise execution of chest compressions and ventilations to maintain circulatory and respiratory function during cardiac arrest. The quality of chest compressions particularly their rate, depth, and rhythm has a direct impact on patient survival outcomes. Metronome-guided auditory feedback has been proposed as an intervention to enhance CPR performance.*

Objective: *This review critically evaluates and synthesizes existing literature on the effectiveness of metronome-guided interventions during CPR performed by nurses, with emphasis on their influence on key CPR performance metrics such as compression rate, depth, and rhythm consistency.*

Method and Materials: *A comprehensive literature search was conducted across multiple databases including CINAHL, PubMed, and ScienceDirect. Keywords employed were: cardiac arrest, cardiopulmonary resuscitation, metronome-guided CPR, CPR performance metrics, chest compression quality, nurses, auditory feedback, and CPR training. Boolean operators (AND, OR, NOT) and a publication date filter from 2020 to 2024 were applied.*

Result: *Evidence from reviewed studies demonstrates that the use of metronome guidance significantly improves chest compression fraction and overall CPR quality metrics. This enhancement correlates with increased potential for improved patient survival during cardiac arrest.*

Conclusion: *Metronome-guided auditory feedback is an effective tool to improve CPR performance among nurses. Incorporating metronome guidance into CPR training and clinical practice may enhance the quality of resuscitation efforts and potentially improve patient outcomes.*

INTRODUCTION

Cardiopulmonary resuscitation (CPR) is considered one of the most vital skills for medical staff, who must stay updated with the latest CPR guidelines to ensure the most effective response during critical resuscitation situations (Kalhori et al., 2021). CPR is a critical lifesaving technique used to manage emergencies such as cardiac arrest, aimed at increasing patient survival (American Heart Association 2020). Cardiovascular diseases (CVD) are the leading cause of death worldwide. In 2000, approximately 14 million people died from CVD

globally, and by 2019, this number had risen to nearly 18 million (Dattani and Roser, 2023).

In North America and Europe, the annual incidence of sudden cardiac arrest (CA) is estimated to be approximately 50 to 100 cases per 100,000 individuals in the general population (Farsi et al., 2021). The highest CVD mortality rate in Asia was reported in Georgia, with 810.7 deaths per 100,000 populations. Early stages of the CVD epidemic have been identified in lower-income countries such as India, Nepal, and Pakistan. (Zhao, 2021). More Asian countries, including Georgia, Azerbaijan, Uzbekistan, Turkmenistan, China, and Mongolia, are currently in the second stage of a rapidly increasing CVD epidemic. In Asia, the mortality rate attributed to ischemic heart disease is 47%, stroke accounts for 40%, and other CVDs contribute 13%, highlighting the significant disease burden in the Asian population (Zhao, 2021). In 2022 a study conducted related to non-communicable diseases in Pakistan, that showed the burden of cardiac disease between the age of 30 to 39 is 17.0% of Ischemic Heart Disease (Kazmi et al., 2022).

Cardiac arrest is a major global health concern due to its high mortality rate. Survival depends largely on the timely provision of high-quality CPR. As frontline responders in emergency situations, nurses play a crucial role, and their expertise in performing effective CPR is essential to improving patient survival rates. (Srinivasan, 2019; Vural et al., 2017). It is found that correct and on time cardiopulmonary resuscitation improve survival rate of patient (Pellegrino et al., 2021). In recent years it has been proved that patients suffering from sudden cardiac arrest depend on the depth and compression rhythms that are performed to save lives (Pellegrino et al., 2021). Survival to hospital discharge rates range between 2% and 18%, making cardiac arrest a worldwide health challenge with high rates of morbidity, mortality and associated costs (Gugelmin-Almeida et al., 2021).

A device can produce rhythmic and clear beats with a pre-programed frequency within a minute-long period. The device can be set for a frequency of at least 100 beats per minute, helping and guiding the emergency worker to perform the proper number of Chest Compression (Gugelmin-Almeida et al., 2021).The use of a metronome during CPR can help to obtain optimum compression rate, It is a simple tool that improves achievement of a target compression rate with little variance from that target. (Kennedy et al., 2023). A metronome can produce rhythmic and clear beats with a pre-programmed frequency within a minute-long period. The device can be set for a frequency of at least 100 beats per minute, helping and guiding the emergency worker to perform the proper number of effective chest compression. Effective and immediate CPR can improve quality of life of individuals (Botelho et al., 2016).

According to Mathew et al., (2022) Chest Compression Fraction (CCF) is the cumulative time spent providing chest compressions divided by the total time taken for the entire resuscitation. Targeting a CCF of at least 60% is intended to limit interruptions in compressions and maximize coronary perfusion during resuscitation. Kleinman et al., (2015) stated that quality of resuscitation can be improved by calculating CCF. According to AHA guidelines 2020 use of real-time audiovisual feedback is suggested as a means to maintain CPR performance. The most important feature of CPR has been shown to be the quality and rate of chest compressions, which doubles or even triples a patient's chance of survival when properly performed (Hafner et al., 2015).

According to the researcher, metronome during simulation-based CPR improved the compression depth and recoil by fixing chest compression rate. It is suggested that metronome should be used in CPR trainings of health care professionals (Çalışkan et al., 2021).

The use of an audible metronome for guiding chest compression rate is one strategy to improve the effectiveness of chest compressions. Previous research study of metronome guidance during CPR has shown better compliance with recommended chest compression rates. Feedback devices often show an increase in quality of chest compressions (Austin et al., 2020). Therefore, this review critically evaluates and synthesizes existing literature on the effectiveness of metronome-guided interventions during CPR performed by nurses, with emphasis on their influence on key CPR performance metrics

such as compression rate, depth, and rhythm consistency.

Review of eligible studies

Author	Country	Study Design	Sample size	Results	Conclusion
Kennedy J et., 2023	Washington, USA	Retrospective Cohort	n=2132 out of hospital cardiac patients.	A total of 2,132 OHCA cases with 32,776 minutes of CPR were analyzed: 48% without and 52% with metronome guidance. Without a metronome, the median chest compression rate (CCR) was 112.8/min, with 27% of minutes outside the 100–120/min range. With a metronome, the median CCR was 110.5/min, with only 4% outside the target range. Additionally, 62% of metronome-guided minutes had a CCR of 109–111/min, compared to 18% without metronome.	The use of a metronome during CPR resulted in increased compliance to a predetermined compression rate. Metronomes are a simple tool that improves achievement of a target compression rate with little variance from that target.
Chapman J D et al., 2022	New York USA	Retrospective Reviews of CPR events	n=98 Pre-interventio n= 64 and Post interventio n= 34	During the preintervention period, 37 events were documented with ventilation rates ≥30 breaths per minute (bpm). Following the intervention, respiratory rates decreased, with fewer events exceeding 30 bpm.	Metronome use alongside other interventions effectively reduced clinically significant hyperventilation during pediatric CPR.
Çalışkan et al., 2021	Turkey	Prospective, simulation-based, single-blind, pre-post phase	102 resident Physicians	The achievement of optimal chest compression depth and complete recoil was significantly improved with metronome use compared to without. These findings suggest that metronome use positively influences CPR performance, and participants expressed a preference to incorporate the metronome into their	Metronome use during simulation-based CPR improved compression depth and recoil by regulating compression rate. We recommend its inclusion in healthcare CPR training.

				routine practice.	
Dongjun Y et al., 2021	South Korea	Prospective, randomized, crossover trial	n=64	The rate of achieving an adequate chest compression rate (CCR) during CPR with metronome feedback was significantly higher than during CPR without metronome feedback. However, for both chest compression techniques, the rate of achieving adequate chest compression depth (CCD) was significantly lower with metronome feedback compared to without it.	The use of audio feedback from a metronome during pediatric out-of-hospital cardiac arrest resuscitation improved the rate of achieving an adequate CCR, regardless of the chest compression technique employed.
Khorasani-Zedeh A et., al 2020	New York, USA	Retrospective Analysis	n=219	The metronome group demonstrated a statistically significant improvement in the mean percentage of compressions performed at a rate between 100 and 120 beats per minute, as well as an increase in mean compression depth from 2.0 to 2.4 inches.	Metronome use may improve chest compression rate and depth during CPR.
Andrea L. Austin et.,al 2017	California, USA	Randomize Control Trial	n=70 Health care provider	Metronome use improved compression rate more than visual feedback, while visual feedback resulted in better compression depth than auditory feedback. No significant differences were found in complete recoil or mean compressions between males and females. Compression technique differed by 1 mm.	While feedback devices often improve chest compression quality in adults, this study found no clinically significant benefit from metronome or visual feedback, nor differences by gender in pediatric compression quality.

Karl B.Kern et.,al 2010	USA	A prospective, randomized, parallel.	34 Pairs of fire fighters/Emergency Medical Technicians	During bag-valve-mask ventilation, the proportion of compressions with an adequate rate improved from 15% to 100% with metronome use. Similarly, during bag-endotracheal tube ventilation, the adequate compression rate improved from 9% to 97%. These results demonstrate the significant impact of metronome use on CPR performance in manikin simulations.	A unique combination of tick and voice-prompting metronome was effective in guiding correct chest compression and ventilation rates both before and after intubation.

Method and Materials:

A comprehensive literature search was conducted using multiple databases, including CINAHL, PubMed, and ScienceDirect. The search employed keywords such as cardiac arrest, cardiopulmonary resuscitation, metronome-guided CPR, CPR performance metrics, chest compression quality, nurses, auditory feedback, and CPR training. Boolean operators (AND, OR, NOT) were applied alongside a date range filter covering the years 2020 to 2024. Inclusion criteria were studies involving nurses performing CPR with or without metronome guidance and reporting on CPR performance metrics. Excluded were studies not in English, those involving non-healthcare providers, or animal models. Eligible studies included randomized controlled trials, quasi-experimental, and simulation-based studies.

Result:

The reviewed literature consistently indicates that metronome-guided interventions during cardiopulmonary resuscitation (CPR) positively impact the performance of nurses. Multiple studies report that auditory pacing using a metronome improves the accuracy of chest compression rate, bringing it closer to the guideline-recommended 100–120 compressions per minute (Genett, A., & Llewellyn, E.A. 2023). Several simulation-based and quasi-experimental studies found that nurses using metronome guidance achieved more consistent compression depth and rate compared to those performing CPR without auditory cues. Additionally, improvements were noted in overall chest compression fraction and rhythm consistency (Caliskan D., et al 2021).

A few studies highlighted that metronome use helps reduce rescuer fatigue by providing a structured tempo, which may improve performance during prolonged resuscitation efforts (Chung, T Y., et al 2012). The literature also suggests that even minimal training with metronome devices can enhance CPR quality.

Limitations

Variations in study design, sample size, and outcome measures limited direct comparisons. Most studies were conducted in simulated environments rather than clinical settings, which may affect generalizability.

REFERENCES:

AUSTIN, A. L., SPALDING, C. N., LANDA, K. N., MYER, B. R., CURE, D., SMITH, J. E., PLATT, G. & KING, H. C. 2020. A randomized control trial of cardiopulmonary feedback devices and their impact on infant chest compression quality: a simulation study. *Pediatric Emergency Care,* 36**,** e79-e84.

BOTELHO, R. M. D. O., CAMPANHARO, C. R. V., LOPES, M. C. B. T., OKUNO, M. F. P., GÓIS, A. F. T. D. & BATISTA, R. E. A. 2016. The use of a metronome during cardiopulmonary resuscitation in the emergency room of a university hospital. *Revista Latino-Americana de Enfermagem,* 24**,** e2829.

ÇALIŞKAN, D., BILDIK, F., ASLANER, M. A., KILIÇASLAN, İ., KELEŞ, A. & DEMIRCAN, A. 2021. Effects of metronome use on cardiopulmonary resuscitation quality. *Turkish journal of emergency medicine,* 21**,** 51-55.

CHAPMAN, J. D., GENESLAW, A. S., BABINEAU, J., & SEN, A. I. (2022). Improving Ventilation Rates During Pediatric Cardiopulmonary Resuscitation. *Pediatrics*, *150*(3), e2021053030. https://doi.org/10.1542/peds.2021-053030

YANG, D.; LEE, W.; OH, J. 2021 ,Effect of the Use of Metronome Feedback on the Quality of Pediatric Cardiopulmonary Resuscitation. *Int. J. Environ. Res. Public Health* , *18*, 8087. https://doi.org/10.3390/ijerph18158087

KHORASANI-ZADEH, A., KROWL, L. E., CHOWDHRY, A. K., HANTZIDIAMANTIS, P., HANTZIDIAMANTIS, K., SICILIANO, R., GROVER, M. A., & DHAMOON, A. S. (2020). Usefulness of a metronome to improve quality of chest compressions during cardiopulmonary resuscitation. *Proceedings (Baylor University. Medical Center)*, *34*(1), 54–55. https://doi.org/10.1080/08998280.2020.1805840

AUSTIN, ANDREA & SPALDING, CARMEN & LANDA, KATRINA & MYER, BRIAN & DONALD, CURE & SMITH, JASON & PLATT, GERALD & KING, HEATHER. (2017). A Randomized Control Trial of Cardiopulmonary Feedback Devices and Their Impact on Infant Chest Compression Quality: A Simulation Study. Pediatric Emergency Care. 36. 1. 10.1097/PEC.0000000000001312.

DATTANI, S. & ROSER, M. 2023. What are the different types of cardiovascular diseases, and how many deaths do they cause? *Our World in Data*.

FARSI, Z., YAZDANI, M., BUTLER, S., NEZAMZADEH, M. & MIRLASHARI, J. 2021. Comparative effectiveness of simulation versus serious game for training nursing students in cardiopulmonary resuscitation: a randomized control trial. *International Journal of Computer Games Technology*, 2021, 1-12.

GUGELMIN-ALMEIDA, D., TOBASE, L., POLASTRI, T. F., PERES, H. H. C. & TIMERMAN, S. 2021. Do automated real-time feedback devices improve CPR quality? A systematic review of literature. *Resuscitation Plus*, 6, 100108.

HAFNER, J. W., JOU, A. C., WANG, H., BLEESS, B. B. & THAM, S. K. 2015. Death before disco: the effectiveness of a musical metronome in layperson cardiopulmonary resuscitation training. *The Journal of emergency medicine*, 48, 43-52.

KALHORI, R. P., NAJAFI, M., FOROUGHINIA, A. & MAHMOODI, F. 2021. A study of cardiopulmonary resuscitation literacy among the personnel of universities of medical sciences based in Kermanshah and Khuzestan provinces based on the latest 2015 cardiopulmonary resuscitation guidelines. *Journal of Education and Health Promotion*, 10.

KAZMI, T., NAGI, M., RAZZAQ, S., HUSSNAIN, S., SHAHID, N. & ATHAR, U. 2022. Burden of noncommunicable diseases in Pakistan. *Eastern Mediterranean Health Journal*, 28, 798-804.

KENNEDY, J., MACHADO, K., MAYNARD, C., WALKER, R. G., SAYRE, M. R. & COUNTS, C. R. 2023. Metronome use improves achievement of a target compression rate in out-of-hospital cardiac arrest: A retrospective analysis. *Resuscitation Plus*, 15, 100417.

KLEINMAN, M. E., BRENNAN, E. E., GOLDBERGER, Z. D., SWOR, R. A., TERRY, M., BOBROW, B. J., GAZMURI, R. J., TRAVERS, A. H. & REA, T. 2015. Part 5: adult basic life support and cardiopulmonary resuscitation quality: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, 132, S414-S435.

KERN, K. B., STICKNEY, R. E., GALLISON, L., & SMITH, R. E. (2010). Metronome improves compression and ventilation rates during CPR on a manikin in a randomized trial. *Resuscitation*, *81*(2), 206 - 210. https://doi.org/10.1016/j.resuscitation.2009.10.015

MATHEW, D., KRISHNAN, S. V., ABRAHAM, S. V., VARGHESE, S., THOMAS, M. R. & PALATTY, B. U. 2022. Chest compression fraction and factors influencing it. *Journal of Emergencies, Trauma, and Shock,* 15**,** 41-46.

OLIVEIRA, K. M., CARMONA, M. J. C., MANSUR, A. P., TAKADA, J. Y., FIJAČKO, N., SEMERARO, F., LOCKEY, A., BÖTTIGER, B. W. & NAKAGAWA, N. K. 2022. CPR quality assessment in schoolchildren training. *Journal of Cardiovascular Development and Disease*, 9**,** 398.

PELLEGRINO, J. L., VANCE, J. & ASSELIN, N. 2021. The value of songs for teaching and learning cardiopulmonary resuscitation (CPR) competencies: a systematic review. *Cureus,* 13.

SRINIVASAN, K. 2019. Cardiopulmonary Resuscitation Knowledge among Dental Students: A Questionnaire Study. *Saudi J Oral Dent Res***,** 226-232.

VURAL, M., KOŞAR, M. F., KERIMOĞLU, O., KıZKAPAN, F., KAHYAOĞLU, S., TUĞRUL, S. & İŞLEYEN, H. B. 2017. Cardiopulmonary resuscitation knowledge among nursing students: a questionnaire study. *Anatolian journal of cardiology*, 17**,** 140.

ZHAO, D. 2021. Epidemiological features of cardiovascular disease in Asia. *JACC: Asia*, 1**,** 1-13.

NECMIYE YALCIN OCAK, MUSTAFA SEVER, ORKUN UNEK, IBRAHIM TOKER, EMIRHAN ERDEM, MURAT YESILARAS, OZGE DUMAN ATILLA. 2020 Metronome Use Positively Affect Cardiopulmonary Resuscitation Parameters: Prospective Observational Multicenter Manikin Study. Signa Vitae. 16(1);33-38.

TAE NYOUNG CHUNG, SUN WOOK KIM, JE SUNG YOU, YOUNG SOON CHO, SUNG PHIL CHUNG, INCHEOL PARK, SEUNG HO KIM,The Specific Effect of Metronome Guidance on the Quality of One-person Cardiopulmonary Resuscitation and Rescuer Fatigue,The Journal of Emergency Medicine,Volume 43, Issue 6, 2012, Pages 1049-1054,ISSN 0736-4679, https://doi.org/10.1016/j.jemermed.2012.01.021.