Original Article

A Randomized Trial Assessing the Effectiveness of High-fidelity Simulation Training in Managing Maternal Cardiac Arrest among Emergency Medical Professionals in India

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Abstract

Introduction: Maternal cardiac arrest is a rare but critical event that poses significant risks to both the mother and the fetus. As majority of population in India lives in the rural areas, Emergency Medical Professionals assist in childbirth in transit in ambulances. This timely assistance ensures the safe transportation of both mother and new born baby to the hospital. The aim of this study was to assess the effectiveness of high-fidelity simulation training in the management of maternal cardiac arrest among emergency medical professionals. **Methods:** The randomized simulation study aimed to assess the effectiveness of high-fidelity simulation in managing maternal cardiac arrest. Two hundred and fifty emergency medical professionals were randomly assigned to 50 groups. Participants underwent a prebriefing session before engaging in simulation scenarios. After the initial scenarios, participants received a debriefing session emphasizing the standardized algorithm for maternal cardiac arrest management. A week later, participants engaged in a second simulation scenario, and their adherence to the algorithm was assessed. The data were analyzed using statistical tests, and the entire simulation session was video recorded for reliability. **Results:** The results showed that participants demonstrated an improvement in managing both maternal and obstetric interventions in the posttraining scenario compared to the pretraining scenario. The successful implementation of the advanced cardiac life support algorithm and the debriefing session were key factors in improving participants' performance. However, continuous exposure and practice are necessary to maintain and enhance these skills. **Conclusion:** Health-care professionals should actively seek opportunities for ongoing training and education to stay updated with the latest guidelines and advancements in managing maternal cardiac arrest.

Keywords: Advanced cardiac life support maternal cardiac arrest algorithm, EMS professionals, high-fidelity simulation, maternal cardiac arrest

Introduction

The World Health Organization (WHO) defines maternal health as the health of women during the pregnancy, childbirth, and postnatal period. As per a survey conducted by the WHO, it was found that about 287,000 women died during and following pregnancy and childbirth in 2020. The WHO has set a Sustainable Development Goal target to reduce the global maternal mortality ratio to <70/100,000 live births by 2030.[1] Major causes of maternal death can be attributed to severe bleeding, high blood pressure, trauma, sepsis, or any other complications during or after delivery. Maternal cardiac arrest is a rare but critical event that poses significant risks to both the mother and the fetus.[2-4] However, the rarity of maternal cardiac arrest leads to limited opportunities for the health-care professionals to master proficiency in managing the emergency.[5]

EMS professionals in ambulances play a vital role in managing obstetric emergencies, especially in countries like India where a significant number of deliveries occur in ambulances.[6,7] In cases where a woman goes into labor while being transported in

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an ambulance, EMS professionals need to be equipped with the knowledge and skills to provide immediate and appropriate care. Their knowledge and skills in obstetric emergency management are crucial for ensuring the safety and well-being of both the mother and the baby during transport and until they reach a health-care facility.[8] Continuous training and education are essential to keep EMS professionals prepared and competent in managing these emergencies effectively.[8,9] Effective management requires a multidisciplinary approach, including early recognition, high-quality cardiopulmonary resuscitation (CPR), and timely interventions for saving both mother and child.[9,10]

Providing comprehensive training to EMS professionals on the recognition and management of maternal arrest is essential. This includes knowledge of basic life support (BLS) and advanced cardiac life support (ACLS) protocols specific to pregnant women.[10] The American Heart Association (AHA), USA, has come up with a standardized algorithm for the management of maternal cardiac arrest.[10] The key recommendations, as highlighted in AHA 2020 guidelines for the management of maternal cardiac arrest, include the provision of high-quality CPR and relief of aortocaval compression with manual lateral uterine displacement and performing perimortem cesarean delivery in 5 min, depending on provider resources and skill sets.[10,11]

Maternal arrest is a rare event in clinical practice, making it difficult for health-care professionals to gain hands-on experience in managing such situations.[12] Simulation-based learning has emerged as an effective educational tool and has been found to be useful in improving the learner knowledge, competence in emergency decision-making, leadership, and individual and team performance by allowing learners to practice skills in a safe and controlled environment.[13] High-fidelity simulations can help recreate realistic scenarios of maternal arrest, including the physiological changes and challenges that emergency medical professionals may face. This allows learners to experience the complexity and urgency of managing such situations, enhancing their ability to respond effectively in real-life emergencies.[13,14]

To achieve positive patient outcomes, it is crucial for health-care professionals to effectively collaborate and communicate as a team;[15,16] this is especially important when dealing with maternal arrest, as it requires seamless coordination and care from multiple disciplines. During emergency situations, simulation-based learning provides an opportunity for interdisciplinary teams to enhance their skills in coordination, communication, and collaboration. This type of learning ultimately leads to improved outcomes for both the mother and the baby.[16,17] By improving their preparedness and competence, health-care professionals are better equipped to handle emergencies and provide the necessary care, resulting in better patient outcomes.[17,18]

The effectiveness of high-fidelity simulation training in managing maternal cardiac arrest among emergency medical professionals is the focus of this study.

Methods

Objective

The aim is to study the effectiveness of high-fidelity simulation training in the management of maternal cardiac arrest among emergency medical professionals.

Procedure

The simulation study aimed to evaluate the effectiveness of high-fidelity simulation in the management of maternal cardiac arrest. The study included 250 emergency medical professionals, including AYUSH doctors, working in ambulances from various regions across India. These participants had undergone training in the Post Graduate Diploma in Emergency Medical Services program, the curriculum of which was recognized by the Los Angeles Paramedical Institute and Department of Transportation, USA. The program encompassed a wide range of topics including BLS techniques, airway management strategies, handling various cardiac scenarios, recognizing and responding to different arrhythmias, administering emergency drugs in critical situations, utilizing defibrillators effectively, ensuring proper spinal immobilization, conducting triage assessments, and mastering other lifesaving skills necessary for both medical and trauma management. Furthermore, the training program specifically addressed the needs of special populations, such as pregnant women, pediatric patients, and the elderly, by focusing on customized approaches and techniques to ensure effective medical care and emergency response in diverse health-care settings.

To enhance exposure to high-fidelity simulation, all participants were randomly assigned to 50 groups of 5 individuals each. The simulation sessions were conducted in two phases, with a 1-week interval between them. The same group of participants participated in both scenarios. Each session comprised a 15-min prebriefing, a 10-min simulation, and a 20-min debriefing. Thus, the entire simulation session lasted for 45 min. These sessions were conducted by experienced facilitators who were AHA Basic and ACLS instructors and simulation educators.

An internationally standardized protocol for managing maternal cardiac arrest was utilized for the study Please see Appendix 1 for the Cardiac Arrest in Pregnancy Algorithm @ 2020 American Heart Association (AHA), USA. The critical actions of maternal interventions such as recognizing cardiac arrest, initiating CPR, airway management, intravenous administration, continuous BLS/ACLS management, and obstetric interventions such as uterine displacement during compressions and need for consideration of perimortem cesarean section were evaluated.

During the prebriefing, participants familiarized themselves with the simulation equipment and manikin to ensure readiness for the scenarios. Throughout the simulation scenarios, participants were evaluated on their management of maternal cardiac arrest, emphasizing adherence to best practices, including high-quality CPR, airway management,

ACLS management including arrhythmia recognition and defibrillation, medication administration, and administration of left lateral uterine displacement during administration of CPR. The scenarios encompassed various medical and trauma-related cases to provide comprehensive exposure.

After the initial simulation scenarios, all groups engaged in detailed debriefing sessions led by facilitators. These sessions allowed participants to reflect on their actions, decision-making, and the application of the standardized algorithm for maternal cardiac arrest management recommended by the AHA. A second simulation scenario involving maternal arrest was conducted a week later to assess participants' adherence to the algorithm and compare their performance with the initial scenario.

Statistical analysis, including *t*-tests for equality of means with independent samples, was used to evaluate the improvement in postsimulation scenario performance. To ensure assessment reliability, the entire simulation session was recorded on video with participants' consent. The videos were reviewed by two facilitators to ensure inter-rater reliability, reduce bias, and maintain consistency. Data analysis using IBM software Statistical Product and Service Solutions (SPSS), version 23 included calculating means, standard deviations, and *P* values. The study did not calculate the inter-rater reliability for kappa because the assessment of participant performance during the simulation sessions was conducted by two facilitators who jointly reviewed the recorded videos. These facilitators did not assess the participants independently or simultaneously but rather collaborated to ensure consistency in evaluating participant performance.

The results were presented using tables and figures to provide a comprehensive overview of participants' performance and the effectiveness of high-fidelity simulation in managing maternal cardiac arrest.

Results

As shown in Figure 1, all groups successfully managed the initial steps of identifying maternal cardiac arrest, assembling the cardiac arrest team, and considering the cause of the arrest in both simulation scenarios.

As shown in Figure 2, improvement was observed among the groups in the management of both maternal and obstetric interventions in the posttraining scenario compared to the pretraining scenario. Specifically, there was a significant increase in the effectiveness of obstetric intervention, with a rate of 75.60% in Scenario 2 compared to only 21.16% in Scenario 1.

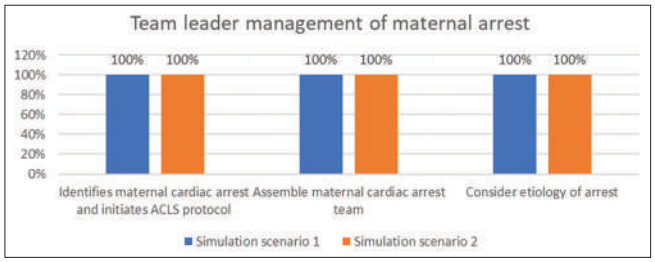


Figure 1: Team leader management of maternal arrest. ACLS: Advanced cardiac life support

Discussion

In the first scenario, the participants were initially confused about how to manage maternal and obstetric interventions in maternal cardiac arrest. This confusion is common, as maternal cardiac arrest presents unique challenges that require specific interventions;[19,20] however, the participants were able to rely on their prior knowledge of the ACLS cardiac arrest algorithm to guide their actions. The ACLS algorithm provides a step-by-step approach to managing cardiac arrest, including the administration of CPR, defibrillation, and medication administration. While the ACLS algorithm does not specifically address maternal and obstetric interventions, it provides a framework for managing the immediate life-threatening situation [Table 1].[20,21]

In the second scenario, following a comprehensive debriefing session, the participants demonstrated a high level of proficiency in implementing maternal and obstetric interventions based on the AHA maternal cardiac arrest algorithm.[21] One notable aspect of their performance was the successful utilization of manual left lateral uterine displacement technique consistently during the administration of CPR. This technique is crucial in optimizing maternal and fetal outcomes during cardiac arrest situations. Moreover, the participants displayed a keen understanding of the timing and considerations for advanced airway management in the mother. After two cycles of CPR, they were able to assess the need for an advanced airway to ensure effective ventilation and oxygenation, recognizing the importance of timely intervention in improving patient outcomes. Furthermore, the participants exhibited advanced clinical judgment by emphasizing the critical decision-making process regarding the potential requirement for a perimortem cesarean section. Recognizing the time-sensitive nature of

Table 1: Pre and post mean scores and *T* test value

Simulation scenario (pre)	Simulation scenario (post)	*t*-test
Mean: 13.57	Mean: 15.57	*P*=0.036379792

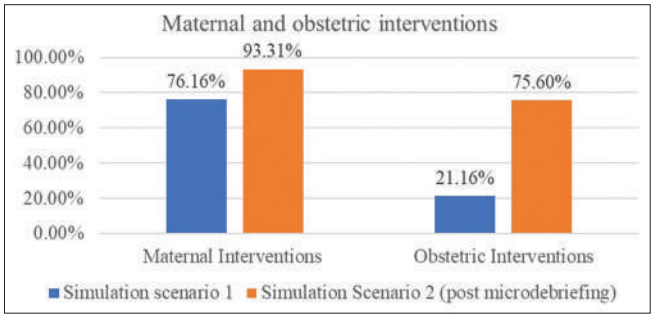


Figure 2: Maternal and obstetric interventions

maternal cardiac arrest, they highlighted the necessity of considering this intervention after 4 min of unsuccessful resuscitation efforts. This decision reflects their ability to prioritize lifesaving measures and intervene promptly to optimize maternal and fetal survival rates in such challenging circumstances. Overall, the participants' successful implementation of these specialized interventions underscores their proficiency in managing complex obstetric emergencies and highlights their dedication to providing optimal care for both the mother and the fetus in critical situations.

This suggests that the debriefing session provided the participants with the necessary information and guidance to apply the algorithm to the specific context of maternal cardiac arrest. The significant $P = 0.03$ also supports the fact. The debriefing session included a discussion of the unique challenges and considerations in managing maternal cardiac arrest, such as administering high-quality CPR, relief of aortocaval compressions with lateral uterine displacement, and consideration of a perimortem cesarean section for viable fetuses.[10] The management of maternal cardiac arrest is a rare event, and emergency medical professionals may not encounter it frequently in their practice.[10] Therefore, it is crucial for these professionals to receive regular training and updates on the latest guidelines and algorithms for managing maternal cardiac arrest.[22,23]

In this study, participants' success in implementing the necessary interventions can be attributed to their knowledge of the algorithm and their ability to apply it in a simulated setting. This highlights the importance of training and familiarizing emergency medical professionals with the specific protocols and algorithms for managing maternal cardiac arrest.[23,24]

High-fidelity simulation provides a valuable learning experience, but it should be supplemented with repeated simulation sessions and ongoing training.[22] Regular training sessions and updates on the latest guidelines and algorithms can help emergency medical professionals stay up to date with the best practices for managing maternal cardiac arrest.[25] These training sessions should include hands-on practice and simulation exercises to reinforce the knowledge and skills required in real-life situations.[26,27]

It is also important for the stakeholders and authorities to provide resources and support to these health-care professionals to pursue ongoing training and education in the management of maternal cardiac arrest. This can include access to training materials, workshops, and opportunities for professionals to participate in real-life emergency scenarios under supervision.[28]

Allocating specific time for training from their regular working hours can greatly benefit the ability of EMS professionals to effectively manage such emergencies.[29] Having designated training hours separate from their regular working hours ensures that EMS professionals can fully concentrate on their learning without any distractions or time constraints. This dedicated time allows them to engage in hands-on training, participate in simulations, and receive feedback from experienced instructors. They can also collaborate with their peers, share experiences, and learn from each other's insights.

Repeated simulation sessions allow health-care professionals to reinforce their knowledge and skills, as well as identify areas for improvement.[30,31] Thus, by prioritizing regular training and ongoing education, EMS professionals can enhance their preparedness and improve outcomes for pregnant women experiencing cardiac arrest.

Conclusion

This study provided evidence that participants experienced enhanced skills and approaches in managing maternal cardiac arrest following high-fidelity simulation training. Notably, there was a significant improvement in the effectiveness of obstetric interventions in the posttraining scenario compared to the pretraining scenario.

Engaging in repeated simulation sessions and attending conferences and workshops can further reinforce knowledge and skills while also identifying areas for improvement. In summary, high-fidelity simulation training is a valuable tool for enhancing the management of maternal cardiac arrest among emergency medical professionals.

In addition, conducting research and collecting data on the management and outcomes of maternal arrest in ambulances can help identify areas for improvement and inform future training programs and protocols. It is crucial for health-care authorities and organizations to prioritize the development and implementation of training programs and protocols specifically tailored to the management of maternal arrest in ambulances, ultimately improving outcomes for pregnant women in emergency situations.

Research quality and ethics statement

This study was approved by the Independent Ethics Committee of Symbiosis International (Deemed University). The authors followed applicable EQUATOR Network (https://www.equator-network.org/) guidelines during the conduct of this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

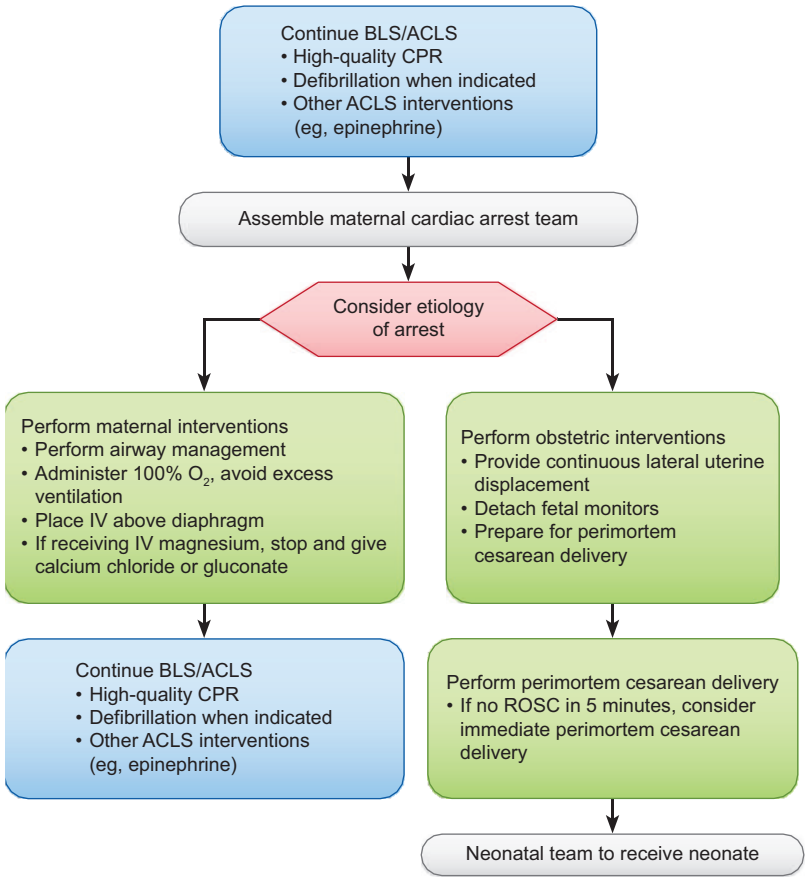
References

1. WHO. Available from: https://www.who.int/initiatives/endingpreventable-maternal-mortality. [Last accessed on 2023 Dec 23].
2. Campbell TA, Sanson TG. Cardiac arrest and pregnancy. J Emerg Trauma Shock 2009;2:34-42.
3. King SE, Gabbott DA. Maternal cardiac arrest – Rarely occurs, rarely researched. Resuscitation 2011;82:795-6.
4. Mhyre JM, Tsen LC, Einav S, Kuklina EV, Leffert LR, Bateman BT. Cardiac arrest during hospitalization for delivery in the United States,

1998-2011. Anesthesiology 2014;120:810-8.
5. Hardeland C, Svendsen EJ, Heitmann GB, Leonardsen AL. Healthcare personnel self-assessed competence and knowledge following implementation of a new guideline on maternal resuscitation in Norway. A repeated measure study. Health Sci Rep 2023;6:e1035.
6. Singh S, Doyle P, Campbell OM, Rao GV, Murthy GV. Transport of pregnant women and obstetric emergencies in India: An analysis of the '108' ambulance service system data. BMC Pregnancy Childbirth 2016;16:318.
7. Beaird DT, Ladd M, Jenkins SM. Ems prehospital deliveries. In: Statpearls. Treasure Island (Fl): Statpearls Publishing; 2023. Available from: https://www.Ncbi.Nlm.Nih.Gov/Books/Nbk525996/. [Last updated on 2023 Oct 26].
8. Afshari A, Khodaveisi M, Sadeghian E. Exploring the educational challenges in emergency medical students: A qualitative study. J Adv Med Educ Prof 2021;9:79-84.
9. Vijayaraghavan S, Rishipathak P, Hinduja A. High-fidelity simulation versus case-based discussion for teaching Bradyarrhythmia to emergency medical services students. J Emerg Trauma Shock 2019;12:176-8.
10. Jeejeebhoy FM, Zelop CM, Lipman S, Carvalho B, Joglar J, Mhyre JM, *et al.* Cardiac arrest in pregnancy: A scientific statement from the American Heart Association. Circulation 2015;132:1747-73.
11. Morley PT, Atkins DL, Finn JC, Maconochie I, Nolan JP, Rabi Y, *et al.* Evidence evaluation process and management of potential conflicts of interest: 2020 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Circulation 2020;142:S28-40.
12. Madden AM, Meng ML. Cardiopulmonary resuscitation in the pregnant patient. BJA Educ 2020;20:252-8.
13. Kulkarni S, Futane SS. Cardiopulmonary resuscitation in obstetric patient: Special considerations. J Obstet Gynaecol India 2022;72:192-200.
14. Lee A, Sheen JJ, Richards S. Intrapartum maternal cardiac arrest: A simulation case for multidisciplinary providers. MedEdPORTAL 2018;14:10768.
15. Babiker A, El Husseini M, Al Nemri A, Al Frayh A, Al Juryyan N, Faki MO, *et al.* Health care professional development: Working as a team to improve patient care. Sudan J Paediatr 2014;14:9-16.
16. McMains JC, Larkins MC, Doherty AM, Horiates J, Alachraf K, Gordon JA, *et al.* Knowledge retention from emergency medicine simulation-based learning curriculum for pre-clinical medical students. Cureus 2023;15:e41216.
17. Institute of Medicine (US) Committee on The Health Professions Education Summit; Greiner Ac, Knebel E, editors. The core competencies needed for health care professionals. In: Health Professions Education: A Bridge to Quality. Ch. 3. Washington (Dc): National Academies Press (Us); 2003.
18. Fisher N, Eisen LA, Bayya JV, Dulu A, Bernstein PS, Merkatz IR, *et al.* Improved performance of maternal-fetal medicine staff after maternal cardiac arrest simulation-based training. Am J Obstet Gynecol 2011;205:5.e1-5.
19. Chow KM, Ahmat R, Leung AW, Chan CW. Is high-fidelity simulation-based training in emergency nursing effective in enhancing clinical decision-making skills? A mixed methods study. Nurse Educ Pract 2023;69:103610.
20. Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, *et al.* Part 3: Adult basic and advanced life support: 2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation 2020;142:S366-468.
21. Rosen MA, DiazGranados D, Dietz AS, Benishek LE, Thompson D, Pronovost PJ, *et al.* Teamwork in healthcare: Key discoveries enabling safer, high-quality care. Am Psychol 2018;73:433-50.
22. Carey JM, Rossler K. The how when why of high fidelity simulation. In: Statpearls Treasure Island (Fl): Statpearls Publishing; 2023. Available from: https://www.Ncbi.Nlm.Nih.Gov/Books/Nbk559313/. [Last updated on 2023 May 01].
23. Robertson B, Schumacher L, Gosman G, Kanfer R, Kelley M, DeVita M. Simulation-based crisis team training for multidisciplinary obstetric providers. Simul Healthc 2009;4:77-83.
24. Cardoso SA, Suyambu J, Iqbal J, Cortes Jaimes DC, Amin A, Sikto JT, *et al.* Exploring the role of simulation training in improving surgical skills among residents: A narrative review. Cureus 2023;15:e44654.
25. Kikuchi J, Deering S. Cardiac arrest in pregnancy. Semin Perinatol 2018;42:33-8.
26. Mlambo M, Silén C, McGrath C. Lifelong learning and nurses' continuing professional development, a metasynthesis of the literature. BMC Nurs 2021;20:62.
27. King R, Taylor B, Talpur A, Jackson C, Manley K, Ashby N, *et al.* Factors that optimise the impact of continuing professional development in nursing: A rapid evidence review. Nurse Educ Today 2021;98:104652.
28. Flaubert Jl, Le Menestrel S, Williams DR, *et al*., Editors. The Future of Nursing 2020-2030: Charting A Path To Achieve Health Equity. Washington (Dc): National Academies Press (Us); 2021 May 11. 4, The Role Of Nurses In Improving Health Care Access And Quality. Available From: Https://Www.Ncbi.Nlm.Nih.Gov/Books/Nbk573910/. [Last accessed on 2023 Dec 23].
29. Oostlander SA, Bournival V, O'Sullivan TL. The roles of emergency managers and emergency social services directors to support disaster risk reduction in Canada. Int J Disaster Risk Reduct 2020;51:101925.
30. Al Gharibi KA, Arulappan J. Repeated simulation experience on self-confidence, critical thinking, and competence of nurses and nursing students-an integrative review. Sage Open Nurs 2020;1. Available from: http://www.Dx.Doi.Org/10.1177/2377960820927377. [Last accessed on 2023 Dec 28].
31. Shields AD, Battistelli JD, Kavanagh LB, Thomson BA, Nielsen PE. A modified Delphi approach to determine current treatment advances for the development of a resuscitation program for maternal cardiac arrest. BMC Emerg Med 2022;22:149.

Appendix 1

Appendix 1: Maternal cardiac algorithm of the American Heart Association, USA



Maternal Cardiac Arrest

- Team planning should be done in collaboration with the obstetric, neonatal, emergency, anesthesiology, intensive care, and cardiac arrest services.
- Priorities for pregnant women in cardiac arrest should include provision of high-quality CPR and relief of aortocaval compression with lateral uterine displacement.
- The goal of perimortem cesarean delivery is to improve maternal and fetal outcomes.
- Ideally, perform perimortem cesarean delivery in 5 minutes, depending on provider resources and skill sets

Advanced Airway

- In pregnancy, a difficult airway is common. Use the most experienced provider.
- Provide endotracheal intubation or supraglottic advanced airway.
- Perform waveform capnography or capnometry to confirm and monitor ET tube placement.
- Once advanced airway is in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Potential Etiology of Maternal Cardiac Arrest

A Anesthetic complications
B Bleeding
C Cardiovascular
D Drugs
E Embolic
F Fever
G General nonobstetric causes of cardiac arrest (H's and T's)
H Hypertension