



REVIEW ARTICLE

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Teaching approach of ACLS in cardiac arrest with pregnancy

Adel Hamed Elbaih^{1,2}, Anas Yahia Alkhalaileh¹, Ossama Ashour Haikal¹

¹Suez Canal University, Faculty of Medicine, Department of Emergency Medicine, Ismailia, Egypt

²Emergency Medicine, Sulaiman Al-Rajhi University, Clinical Medical Science, College of Medicine, Saudi Arabia

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Abstract

Cardiac arrest is the abrupt loss of heart function in a person. Cardiac arrest can be lifesaving and it is important to understand the causes of maternal mortality to have an understanding of the unique pathogenic factors that may have precipitated the maternal cardiac arrest. Therefore, we aim to look into the common pitfalls that both medical students and new physicians face in the recognition, diagnosis, and management of these conditions. All Cardiac arrest pregnant patients who are requiring urgent management in the ED, with Emergency Physicians for teaching approach protocol. Appropriate for assessment and priorities for Cardiac arrest pregnant patients by training protocol to Emergency Physicians. Based on patients' causes of Cardiac arrest pregnant women. Collection of all possible available data about the Pregnancy with cardiac arrest in the Emergency department. By many research questions to achieve these aims so a midline literature search was performed with the keywords "critical care", "emergency medicine", "principals of resuscitation in Pregnancy", "ACLS with cardiac arrest in pregnancy". Literature search included an overview of recent definition, causes and recent therapeutic strategies. All studies introduced that the initial diagnosis of Pregnancy with cardiac arrest and their therapy is a serious condition that face patients of the emergency and critical care departments. Maternal cardiac arrest is a complex clinical scenario, and the resuscitation of the pregnant woman involves multi-specialties and complex care decisions. This review is hopefully enough to strengthen the knowledge of new physicians and, hopefully with the recommendations, reduce the rates of false diagnoses.

Keywords: Cardiac arrest, pregnant women, Emergency physicians, skill approach.

Introduction

The goal of Advanced Cardiovascular Life Support (ACLS) is to achieve the best possible outcome for individuals who are experiencing a life-threatening event. ACLS is a series of evidence-based responses simple enough to be committed to memory and recalled under moments of stress. These ACLS protocols have been developed through research, patient case studies, clinical studies, and opinions of experts in the field. The gold standard in the United States and other countries is the course curriculum published by the International Liaison Committee on Resuscitation (ILCOR) [1].

Incidences of the problem

Recent data from the US Nationwide Inpatient Sample suggest that cardiac arrest occurs in 1:12 000 admissions for delivery. Globally, 800 maternal deaths occur daily. Maternal mortality trends in the United States as reported by the Centers for Disease Control and Prevention from 1989 to 2009 have documented a steady increase from 7.2 deaths per 100 000 live births in 1987 to 17.8 deaths per 100 000 live births in 2009. However, maternal mortality rates are just a small representation of maternal critical events; maternal near-miss data should be considered. A maternal near miss is defined as "a woman who nearly died but survived a complication that occurred during pregnancy, childbirth, or within 42 days of termination of pregnancy." Data from the Netherlands show an incidence of maternal near miss of 1:141 in delivery wards. Among cases with severe maternal morbidity, there was an overall case fatality rate of 1:53. Knowledge deficits and poor resuscitation skills could be major contributors to poor outcomes once cardiac arrest has occurred. Despite these problems, recent data show that the rate of survival to hospital discharge after

*Corresponding Author: Adel Hamed Elbaih, Emergency Medicine Department, Faculty of Medicine, Suez Canal University and Clinical Medicine Science Department, Sulaiman Al Rajhi University, Al Bukayriah, Saudi Arabia. Mailing Address: Flat 3, Building 50, Heraa Street, Garden City Shark, Ismailia, Egypt E-mail: elbaihico@yahoo.com

maternal cardiac arrest may be as high as 58.9%, far higher than most arrest populations, further justifying appropriate training and preparation for such events despite their rarity [2].

Cardiac arrest definition and causes in pregnancy [3]

Cardiac arrest is the abrupt loss of heart function in a person who may or may not have been diagnosed with heart disease. It can come on suddenly, or in the wake of other symptoms. Cardiac arrest is often fatal, if appropriate steps aren't taken immediately. Similar to the recommendations for adult (nonpregnant) ACLS, an understanding of the importance of diagnosing and treating the underlying cause or aggravating factors of the cardiac arrest is fundamental to the management of cardiac arrest in pregnancy. It is important to consider the cause of the cardiac arrest early in the management algorithm. Specific therapy directed at the cause of the cardiac arrest can be lifesaving. It is important to understand the causes of maternal mortality to have an understanding of the unique pathogenic factors that may have precipitated the maternal cardiac arrest. The most common causes of maternal cardiac arrest and mortality are listed in Table.

Table 1. Most common aetiologies of maternal arrest and mortality

Cause	Aetiology
Anaesthetic complications	High neuraxial block
	Hypotension
	Loss of airway
	Aspiration
	Respiratory depression
Accidents/Trauma	Local anaesthetic systemic toxicity
	Trauma
	Suicide
Bleeding	Coagulopathy
	Uterine atony
	Placenta accrete
	Placental abruption
	Placenta previa
	Retained products of conception
	Uterine rupture
	Surgical
Cardiovascular causes	Transfusion reaction
	Myocardial infarction
	Aortic dissection
	Cardiomyopathy
	Arrhythmias
	Vale disease
	Congenital heart disease

Indications and contraindications

Although management of cardiac arrest begins with BLS and progresses sequentially through the links of the chain of survival, there is some overlap as each stage of care progresses to the next. Generally, in the three guidelines, ACLS comprises the level of care between BLS and post-cardiac arrest care. Therefore, the Indications and contraindications are the same for BLS [4].

Indications

CPR should be performed immediately on any person who has become unconscious and is found to be pulseless. Assessment of cardiac electrical activity via rapid "rhythm strip" recording can provide a more detailed analysis of the type of cardiac arrest, as well as indicate additional treatment options [5].

Loss of effective cardiac activity is generally due to the spontaneous initiation of a nonperfusing arrhythmia, sometimes referred to as a malignant arrhythmia. The most common nonperfusing arrhythmias include the following: Ventricular fibrillation (VF), Pulseless ventricular tachycardia (VT), Pulseless electrical activity (PEA), Asystole and Pulseless bradycardia [6].

CPR should be started before the rhythm is identified and should be continued while the defibrillator is being applied and charged. Additionally, CPR should be resumed immediately after a defibrillator shock until a pulsatile state is established.

Contraindications

The only absolute contraindication to CPR is a do-not-resuscitate (DNR) order or other advanced directive indicating a person's desire to not be resuscitated in the event of cardiac arrest. A relative contraindication to performing CPR is if a clinician justifiably feels that the intervention would be medically futile [7].

Description of a problem, a lack of knowledge on a certain topic or a segment on WHY this is a problem

Cardiac arrest in pregnancy is one of the most challenging clinical scenarios. Although most features of resuscitating a pregnant woman are similar to standard adult resuscitation, several aspects and considerations are uniquely different. The most obvious difference is that there are 2 patients, the mother and the fetus. Caregivers must have a thorough understanding of maternal mortality to best prevent and treat cardiac arrest in pregnancy. Maternal mortality is defined as the death of a woman during pregnancy and up to 42 days after delivery or termination of pregnancy, if the cause of death is related to or aggravated by the pregnancy or its management.

Important Physiological Changes in Pregnancy

Fetal development and maternal maintenance of pregnancy require multiorgan physiological adaptations that are pertinent to the team responding to cardiopulmonary arrest during pregnancy.

Cardiac output rises 30% to 50% as a result of increased stroke volume and, to a lesser extent, increased maternal heart rate (15–20 bpm). Systemic vascular resistance decreases as a result of an increase in several endogenous vasodilators, including progesterone, estrogen, and nitric oxide, leading to a decrease in mean arterial pressure, reaching a nadir in the second trimester. The enlarging uterus can produce increased afterload through compression of the aorta and decreased cardiac return through compression of the inferior vena cava, starting at $\approx$ 12 to 14 weeks of gestational age. As a result, the supine position, which is most favorable for resuscitation, can lead to hypotension. Uteroplacental blood flow increases from 50 to close to 1000 mL/min during pregnancy, receiving up to a maximum of 20% of maternal cardiac output at term. Expanded intravascular volume and a decrease in uterine vascular resistance facilitate sufficient uterine placental blood. Overall, uterine vascular reactivity is altered, characterized by reduced tone, enhanced vasodilation, and blunted vasoconstriction. Systemic hypotension can overwhelm the compensatory mechanisms, which attempt to maintain uterine blood flow [8].

Functional residual capacity decreases by 10% to 25% during pregnancy as the uterus enlarges and elevates the diaphragm. Increased ventilation (ie, an increase in tidal volume and minute ventilation) occurs, beginning in the first trimester, reaching a level 20% to 40% above baseline by term, mediated by the elevated serum progesterone levels. This produces a mild respiratory alkalosis with compensatory renal excretion of bicarbonate, resulting in an arterial carbon dioxide pressure of $\approx$ 28 to 32 mm Hg (3.7–4.3 kPa) and a plasma bicarbonate level of 18 to 21 mEq/L. Oxygen consumption increases because of the demands of the fetus and maternal metabolic processes, reaching a level 20% to 33% above baseline by the third trimester. The reduced functional residual capacity reservoir and increased consumption of oxygen are responsible for the rapid development of hypoxemia in response to hypoventilation or apnea in the pregnant woman. Upper airway edema and friability occur as a result of hormonal effects and may reduce visualization during laryngoscopy and increase the risk of bleeding [9].

Pregnancy is characterized by glomerular hyper filtration and increased renal blood flow by 40% to accommodate the maternal role of fetal detoxification of metabolic byproducts and maintenance of maternal osmoregulation in the face of increased circulatory intravascular volume. Altered tubular function prevents wasting of glucose, amino acids, and proteins required by both maternal and fetal metabolisms. On balance, Starling forces favor a narrowing of the oncotic pressure–wedge pressure gradient, increasing the tendency for pulmonary edema to develop [10].

Drug metabolism is altered by several different mechanisms in pregnancy. In addition to changes in renal physiology, gastrointestinal absorption and gastrointestinal transit affect bioavailability. Protein binding changes also alter the free fraction of the drug available. Steroid-induced acceleration of the hepatic P450 metabolism and increased renal clearance will also lower circulating drug levels [11].

Methodology used in this research with research hypothesis and aims

Relevant literature considered for inclusion in this research was identified through an up-to-date search strategy of the process used for the 2010 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations and the 2010 International Liaison Committee on Resuscitation worksheets, PubMed, Embase, and an AHA master resuscitation reference library. The search also included a review of bibliographies and manual searches of key articles.

The epidemiology was obtained from World Health Organization, UNICEF, UNFPA, The World Bank, United Nations Population Division; Trends in Maternal Mortality and Centers for Disease Control and Prevention; Pregnancy mortality surveillance system.

-Research hypothesis and aims: the research questions

Are/ How to apply ACLS protocol or algorithm in a pregnant patient presents of symptoms suggestive of cardiac arrest?

What is the right technique and sequence should be followed?

WHY this study is necessary

The goal in studying cardiac arrest is to improve health outcome by understanding why and how people get care during cardiac arrest event where basically time is life; the longer it takes to get care, the less patient survives, and more disability ensues. Although most features of resuscitating a pregnant woman are similar to standard adult resuscitation, several aspects and considerations are uniquely different. The most obvious difference is that there are 2 patients, the mother and the fetus. It is important also because ACLS aims to impart both cognitive knowledge and psychomotor skills of CPR and to provide a standardized care to cardiac arrest victims in accordance with the specific guidelines so it is important to apply the right technique of ACLS when dealing with patient who present with cardiac arrest especially if the patient is pregnant.

Segment that underlines the research question that should be answered (based on the problem describe earlier)

A fast and well-coordinated response to maternal cardiac arrest is important, and the cardiac arrest in pregnancy in-hospital ACLS algorithm should be used as a guide to management (Figure (1)). The ACLS maternal cardiac arrest team will continue BLS tasks and perform advanced airway management, insert an intravenous access above the diaphragm, and administer the usual ACLS drugs and doses when indicated. With the arrival of the obstetric and neonatal teams, preparation for PMCD can begin. The ACLS algorithm includes PMCD as a treatment option for the mother who has not achieved ROSC by 4 minutes after the onset of cardiac arrest and in whom the uterus extends to or above the umbilicus. The cause of the arrest needs to be considered and addressed as necessary.

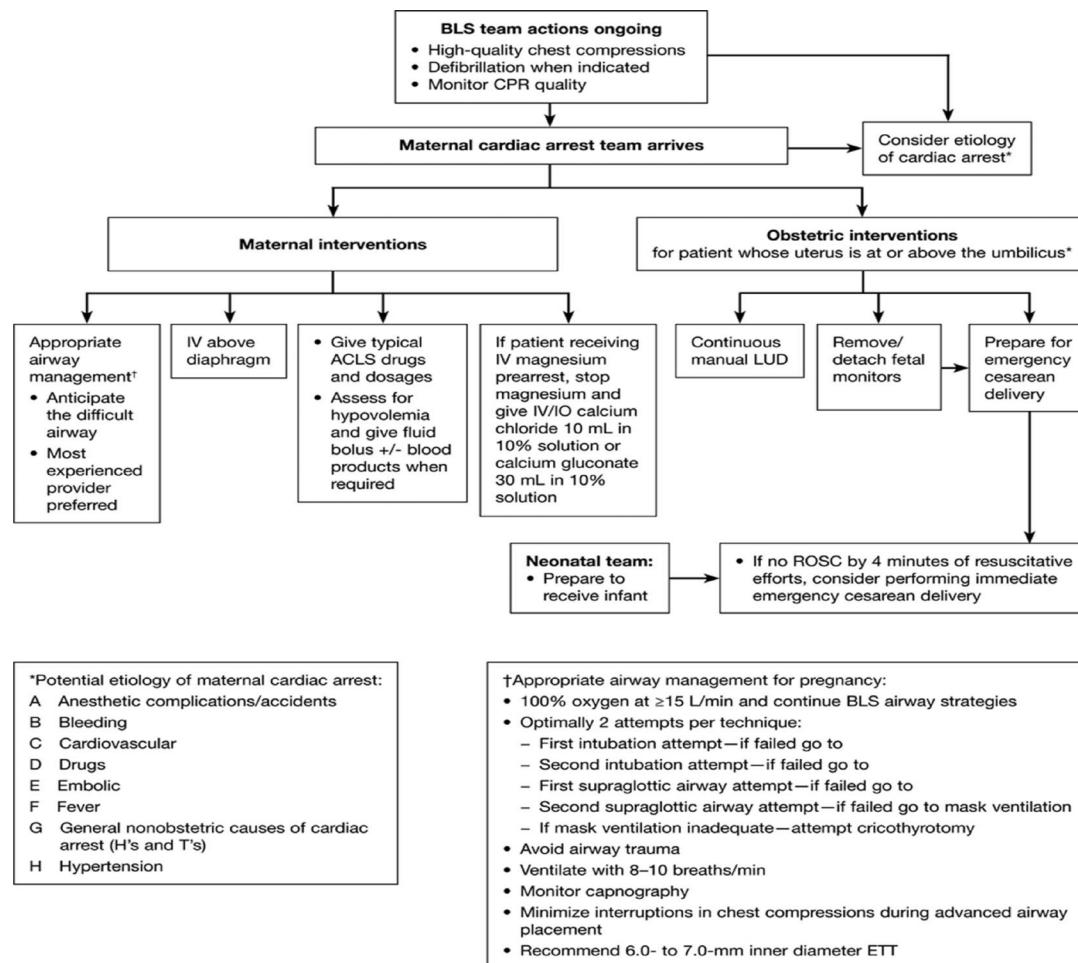


Figure 1. Cardiac arrest in pregnancy in-hospital ACLS algorithm

Describe steps of the right technique of this method point by point

Basic Life Support

The unique physiology of pregnancy renders the patient vulnerable to hypoxemia and hemodynamic disadvantage, given the rapid development of desaturation with apnea and the presence of aortocaval compression when the patient is unconscious and supine. Therefore, all BLS interventions are essential and should be initiated rapidly and simultaneously once the rescuers arrive. As with all adult resuscitations,

High-quality chest compressions are essential to maximize the patient's chance of survival. For high-quality chest compressions, the patient must be supine on a hard surface, the rescuer's hands must be placed correctly, the correct rate and depth of compressions must be performed, and interruptions must be minimized. In the pregnant patient, supine positioning will result in aortocaval compression. Relief of aortocaval compression must be maintained continuously during resuscitative efforts and continued throughout post-arrest care. Manual LUD should be used to relieve aortocaval compression during resuscitation. Positioning of Hands During Chest Compressions (no scientific evidence to support changing

the recommendation for hand placement for chest compressions). Defibrillation Issues During Pregnancy, Prompt application of defibrillation in the setting of ventricular fibrillation or pulseless ventricular tachycardia is critical to maximize the likelihood of survival. This is no different in the pregnant patient. Defibrillation would be unlikely to cause electric arcing to fetal monitors, and the presence of fetal monitors should not deter providers from the use of rapid defibrillation when indicated. Airway and Breathing, Hypoxemia develops more rapidly in the pregnant patient compared with the nonpregnant patient; therefore, rapid, high-quality, and effective airway and breathing interventions are essential. Higher partial pressure of oxygen is required to achieve the same maternal oxygen saturation, thus highlighting the importance of ensuring maternal oxygenation and ventilation concurrent with effective chest compressions in the pregnant patient [12].

The Maternal Cardiac Arrest Team

Activating and achieving prompt code team response is one of the most fundamental tasks to be completed during maternal cardiac arrest. Each hospital must have a specific method to activate the maternal cardiac arrest team; for example, "maternal code blue" or "code blue maternal" could serve as a universal call to action. Creating 1 "bundled" emergency code call (eg, maternal code blue)

to all necessary responders simultaneously may save time, help prevent confusion, and reduce the risk of team members not being notified. The composition of the code team must reflect the fact that 2 critically ill patients (mother and fetus) must be resuscitated [13].

Fetal Assessment During Cardiac Arrest

During active CPR, the focus should remain on maternal resuscitation and restoration of maternal pulse and blood pressure with adequate oxygenation. During this time, evaluation of the fetal heart will not be helpful and carries the risk of inhibiting or delaying maternal resuscitation and monitoring. Should the mother achieve ROSC and her condition be stabilized, then fetal heart surveillance may be instituted when deemed appropriate. There may be situations during advanced pregnancy in which noninvasive relief of inferior vena cava compression with manual LUD is not enough to provide a hemodynamic advantage to result in successful resuscitation. This is when PMCD needs to be considered as the definitive means to achieve complete relief of inferior vena cava compression and as a treatment option during ACLS measures for maternal cardiac arrest. Resuscitation team leaders should activate the protocol for a PMCD as soon as cardiac arrest is identified in a pregnant woman whose uterus extends to or above the umbilicus. By the time the physician is ready to deliver the baby, standard ACLS should be underway, and immediately reversible causes of cardiac arrest should have been ruled out. When the gravid uterus is large enough to cause maternal hemodynamic changes as a result of aortocaval compression, PMCD should be considered regardless of fetal viability [14].

Neonatal Resuscitation Team

It is expected that each maternity hospital will have a designated team for managing unexpected neonatal resuscitations. Because of the high likelihood of delivering a depressed neonate after maternal arrest, the team attending delivery must anticipate and be prepared for an advanced resuscitation. This includes designating a team leader, checking equipment, and pre assigning specific roles to team members. Team composition optimally should include a neonatologist/pediatrician, neonatal nurses, and respiratory therapists who should be familiar with the local neonatal resuscitation algorithms. At least 1 member of the team must be skilled in emergency neonatal endotracheal intubation. In some settings, this may require accepting the urgent assistance of other subspecialty professionals, for example, an anesthesiologist, an otolaryngologist, or emergency physicians [15, 16].

EMS Considerations

Maternal cardiac arrest that occurs out of hospital will likely have worse outcomes than cardiac arrest that occurs in hospital. Therefore, a coordinated EMS response to maternal cardiac arrest is of critical importance. If possible, additional prehospital providers should respond to the location of the maternal arrest to ensure that a sufficient number of providers is available to provide BLS and ACLS care, including LUD. Prehospital providers should not be expected to perform a PMCD; however, transporting the mother in cardiac arrest to a location where PMCD can be performed in a

timely manner is essential. Fetal cardiac activity may be slow but present after many minutes of maternal pulselessness. As a result, fetal survival can occur in cases when maternal vital signs are lost before arrival in the emergency department and when CPR fails to restore maternal pulses [17].

Recommendations

- Chest compressions should be performed at a rate of at least 100 per minute at a depth of at least 2 in (5 cm), allowing full recoil before the next compression, with minimal interruptions.
- Interruptions should be minimized and limited to 10 seconds except for specific interventions such as insertion of an advanced airway or use of a defibrillator.
- The patient should be placed supine for chest compressions.
- Continuous manual LUD should be performed on all pregnant women who are in cardiac arrest in which the uterus is palpated at or above the umbilicus to relieve aortocaval compression during resuscitation.
- Because an immediate cesarean delivery may be the best way to optimize the condition of the mother and fetus (see section on “PMCD”), this operation should optimally occur at the site of the arrest. A pregnant patient with in-hospital cardiac arrest should not be transported for cesarean delivery. Management should occur at the site of the arrest. Transport to a facility that can perform a cesarean delivery may be required when indicated (e.g., for out-of-hospital cardiac arrest or cardiac arrest that occurs in a hospital not capable of cesarean delivery).
- The same currently recommended defibrillation protocol should be used in the pregnant patient as in the nonpregnant patient. There is no modification of the recommended application of electric shock during pregnancy.
- Fetal assessment should not be performed during resuscitation.
- Fetal monitors should be removed or detached as soon as possible to facilitate PMCD without delay.

Conclusion

Maternal cardiac arrest is a complex clinical scenario. Resuscitation of the pregnant woman involves multi-specialties and complex care decisions. Although maternal cardiac arrest is rare, it appears to be increasing in frequency. The number of high-risk women undergoing pregnancy is on the rise, as is the rate of severe complications related to pregnancy (including cardiac arrest). The newly developed in-hospital and out-of-hospital BLS and ACLS algorithms should be the backbone of the response plan to a maternal cardiac arrest. Special attention should be paid to manual LUD, the difficult airway, and appropriate use of PMCD. Lifesaving interventions such as defibrillation and medications should not be withheld in the setting of pregnancy so we summarized in table (2) for Teaching Clinical Assessment Checklist

Table 2. Checklist for Teaching Clinical Assessment

Call for help Start CPR	D Call maternal code blue (Time: _____)
	D Backboard (Time: _____)
	D IMMEDIATE BLS
	D AED/defibrillator
	D Maternal airway equipment
	D Scalpel/cesarean pack
	D Assign timer/documenter
A Airway	D Document time of cardiac arrest (Time: _____)
	D Assign cognitive aid reader/recorder
	D Left uterine displacement (manual) (Time: _____)
	D Hands midsternum
	D 100 compressions/min (Time: _____)
	D PUSH HARD, PUSH FAST
	D Change compressors every 2 minutes
	D Obtain IV access above diaphragm (Time: _____)
	D Minimize interruptions in chest compressions
	D Chin lift/jaw thrust if not trauma victim
B Breathing	D 100% O ₂ at :2:15 Umin (Time: _____)
	D Use self-inflating bag-mask
	D Oral airway or
	D Experienced personnel: intubation with 6.0- to 7.0-mm inner diameter ETT or (Time: _____)
	D Supraglottic airway (eg, laryngeal mask airway with gastric port) (Time: _____)
D Defibrillate	D If not intubated: 30 compressions to 2 breaths
	D If intubated: 8-10 breaths/min
	D Administer each breath over 1 second
	D Pads front and side
E Extract Fetus	D AED: analyze/defibrillate every 2 minutes (Time: _____)
	D Immediately resume CPR for 2 minutes
	D Prepare for delivery
E Extract Fetus	D PMCD started (Time: _____) and
	D Fetus delivered (Time: _____)

Conflict of interests

The authors declare that they have no competing interests.

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