The Japan Council for Implementation of the Maternal Emergency Life Support System (J-CIMELS) adopted the “Kyoto protocol”—which the Kyoto Society for Emergency Response in Obstetrics and Gynecology proposed in 2010—as the “evaluation and care protocol” intended to prevent the progression of pathologic conditions in expectant and nursing mothers by detecting maternal emergencies at an early stage and by taking appropriate and required measures. The protocol also incorporates maternal care including obstetric cardiopulmonary resuscitation (CPR) in the event that pathologic conditions deteriorate further despite the measures taken. The J-CIMELS aims to popularize the protocol among medical professionals involved in perinatal care. The protocol sets forth procedures that the first detector at any obstetric institution should follow. Specifically, the protocol describes monitoring the patient’s vital signs to assess breathing, circulation, and level of consciousness, recommends simple, appropriate approaches for oxygenation and transfusion that are indispensable in maternal emergencies, and provides steps to be taken for immediate measures and the use of an automated external defibrillator and adrenaline in obstetric CPR. The J-CIMELS developed a basic simulation-based practical training course, in which trainees carry out the required measures as per the protocol through simulated maternal emergencies, and has held the course throughout Japan since 2015. Popularization of the protocol is expected to reduce the number of maternal deaths in Japan.

Introduction

The Japan Council for Implementation of the Maternal Emergency Life Support System (J-CIMELS) was founded in 2015 by 7 academic organizations. Currently, 3 organizations of midwives and nurses are collaborating with the J-CIMELS (Figure 1). The objectives of the J-CIMELS are as follows: 1) to popularize standardized procedures for maternal life-saving among medical professionals of all specialties related to perinatal care in order to reduce the number of maternal deaths; and 2) to develop a system that provides expectant and nursing mothers with safe, high-quality medical care. One approach to achieving these objectives is to develop and popularize evaluation and care measures, as well as emergency life support, that comport with the physiology of expectant and nursing mothers in maternal emergencies. Life support protocols targeting expectant and nursing mothers are essentially identical to those for other adults. However, medical professionals must be mindful of the various considerations that apply more specifically to expectant and nursing mothers, such as supine hypotensive syndrome caused by the gravid uterus, as well as other conditions.

The number of maternal deaths from obstetric bleeding in Japan has decreased over the last 4 years as a result of continuous efforts to popularize the above-mentioned evaluation and care measures. The J-CIMELS considers promotion of simulation-based practical training that adopts the “evaluation and care protocol” in clinical
settings to have made great contributions toward these efforts.

The present article describes the evaluation and care protocol by outlining the simulation-based practical training course in which it is applied and presenting the achievements of the protocol and training course.

Shock and maternal emergencies

Various types of shock can develop in expectant and nursing mothers (Table 1). Shock frequently develops in women with uneventful pregnancies or deliveries, and their general condition deteriorates quickly. To prevent the progression of maternal emergencies to cardiac arrest, medical professionals must master life-saving and resuscitation procedures that comport with their pathophysiology apart from obstetric measures (e.g., hemostasis). The evaluation and care protocol is intended to prevent the progression of pathologic conditions of expectant and nursing mothers by detecting maternal emergencies at an early stage and taking appropriate and required measures. The protocol also incorporates maternal care including obstetric cardiopulmonary resuscitation (CPR) in the event that pathologic conditions further deteriorate despite the measures taken.

The protocol is a fundamental means for the need, and its contents should be simple to allow quick actions in the event of a maternal emergency. Medical professionals should master the protocol, implement it in clinical settings, and regularly take the simulation-based practical training course. This is true also for mastering life-saving procedures for individuals other than expectant and nursing mothers. The following 3 requirements should be met in order to achieve these objectives: 1) the protocol for expectant and nursing mothers; 2)
simulation scenarios; and 3) instructors of the practical training course. Among these requirements, the present article focuses on the contents of the evaluation and care protocol and briefly touches on methods to apply the protocol in simulations.

**Protocol for addressing maternal emergencies**

The J-CIMELS adopts the “Kyoto protocol”—which the Kyoto Society for Emergency Response in Obstetrics and Gynecology proposed in 2010 as the protocol to be used for maternal emergencies—as the basic J-CIMELS protocol whose primordial objectives were to provide obstetricians with how to take the initial actions for maternal emergencies and maternal life saving, as well as to implement obstetric CPR as needed. The Kyoto protocol, also known as the “care and evaluation protocol” (hereafter referred to as “the protocol”), was prepared with perinatal care settings in mind and has been in use even before the J-CIMELS was established.

When confronted with a maternal emergency, obstetrics and gynecology specialists and midwives are prone to be less attentive to the patient’s airway, respiration, circulation, and level of consciousness given their main focus on examining the uterus and monitoring the fetus. Many maternal deaths resulting from obstetric critical bleeding can be attributed to the delay caused by obstetricians attempting to stop the bleeding and failure to promptly transfer the patient to a tertiary medical institution or call for in-hospital help.

To prevent such scenarios, the main objective of the protocol is to enable the first detector of maternal emergencies to transfer the patient to a tertiary medical institution (or to declare code blue in a general hospital) while conducting life-saving measures and obstetric CPR.

**Behavioral objectives of the protocol**

The protocol has the following 7 behavioral objectives: 1) to objectively detect maternal emergencies based on vital signs; 2) to appropriately conduct transfusion and oxygenation in the event of massive bleeding; 3) to precisely diagnose impaired consciousness; 4) to rapidly determine cardiopulmonary arrest; 5) to provide expectant and nursing mothers with adequate evaluation and care; 6) to quickly transfer expectant and nursing mothers to a tertiary medical institution (or call for in-hospital help); and 7) to prepare medical supplies/devices and drugs that are required for maternal emergencies.

The protocol is based on evaluation and care that consider the pathophysiologic characteristics of expectant and nursing mothers, and its contents are readily comprehensible not only by obstetrics and gynecology specialists, but also by all medical professionals involved in perinatal care. The J-CIMELS also offers an advanced simulation-based practical training course, which allows medical professionals to acquire the knowledge of advanced cardiovascular life support required for interdisciplinary care at tertiary medical institutions which accept severely ill patients (Figure 2).

**Contents of the protocol**

The protocol consists of the following 4 pillars: 1) detection of maternal emergencies (Figure 3); 2) initial actions at the time of maternal emergencies (Figure 4); 3) obstetric CPR of expectant and nursing mothers (Figure 5); and 4) medical supplies/devices and drugs that are required for maternal emergencies.

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**Figure 2. Outline of the evaluation and care protocol**

*The evaluation and care protocol is designed not only to save a woman suffering from serious maternal emergencies, but also to prevent the progression thereof by detecting signs and symptoms at an early stage. The protocol also addresses perinatal care up to CPR in the event the maternal emergency deteriorates further.

CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; ACLS, advanced cardiovascular life support.
Figure 3. Algorithms of basic and advanced cardiovascular support systems
SpO₂, arterial blood oxygen saturation; ICU, intensive care unit

Figure 4. Management of obstetric patients in the critical state
CPR, cardiopulmonary resuscitation; SI, shock index; OR, operation room; ICU, intensive care unit
Detection of maternal emergencies

Maternal emergencies must be detected without delay. The first pillar, “detection of maternal emergencies,” hence provides criteria for diagnosing the critical state of expectant and nursing mothers, as well as criteria for their transfer to a tertiary medical institution. Women before and after delivery exhibit aural symptoms (e.g., fatigue, perspiration, irregular respiration, and a feeling of collapse) even during the course of normal delivery, which can make it difficult to differentiate between normal and abnormal deliveries. Furthermore, circulatory blood volume is increased by 40% or more before delivery. Therefore, blood pressure is maintained in cases of modest bleeding due to compensatory mechanisms.1) Under such circumstances, the monitoring of not only bleeding volume, uterine contractions, and other changes during delivery, but also vital signs is mandatory for diagnosing maternal emergencies as quickly as possible.

The Maternal Death Exploratory Committee in Japan (JMDEC)2) reported that 80% of maternal deaths were initially considered low-risk pregnancies in women with no prior history or complications. Hence, the monitoring of vital signs is important for all pregnant women before and after delivery since even low-risk pregnant women are at risk of maternal emergencies. Specifically, an automated monitor and other medical devices should be used to continuously monitor blood pressure, pulse, and SpO2 every 15 minutes.3) Changes in level of consciousness should also be closely monitored because such changes are important signs of maternal emergencies.

Diagnostic criteria for a critical state are met when any of the following apply: i) a reduction in level of consciousness; ii) shock index (SI) >1.5 and persisting bleeding; iii) SI >1.5; and iv) SpO2 <95% in room air.4) “A reduction in level of consciousness” represents a state in which a pregnant woman does not open her eyes in response to pain stimuli such as compressing the fist onto the sternum or pressing a pen or another object on a nail. The reduction corresponds to the 3-digit score in the Japan coma scale. The SI is an indicator of systemic circulation that is calculated by heart rate divided by systolic blood pressure.5)

To simplify behavioral criteria, the protocol uses a 1-stage numerical criterion alone so that medical professionals can make an immediate decision in the event of a maternal emergency. This can be considered the “final criterion.” Therefore, action in maternal emergencies should be taken no later than the moment at which maternal conditions meet this criterion. Once this criterion is surpassed, action must be taken immediately. This criterion also serves as an absolute indication that the patient should be transferred to a tertiary medical institution.
institution; preparations for maternal transfer should be initiated shortly after surpassing this criterion. However, the decision for maternal transfer can be made even before reaching this criterion. When maternal emergencies occur at a tertiary medical institution, the same criteria should be used to declare “code blue” to call for in-hospital help and initiate interdisciplinary treatment.

Urine volume, respiratory rate, fever, and other changes are also aural symptoms of maternal emergencies. However, the protocol sets forth only minimal requirements to allow the first detector to detect changes immediately and make a diagnosis succinctly during the several minutes before in-hospital support is available or maternal transfer to a tertiary medical institution is initiated. Respiratory rate and fever are factors that contribute to the judgement of severity in sepsis. The protocol uses “quick SOFA” to allow for a quick diagnosis.

**Initial actions for maternal emergencies**

Respiratory status should be checked the moment when a maternal emergency is considered to have occurred according to the criterion for “detection of maternal emergencies” discussed in the previous section. Elevation of the chest should be monitored carefully. Obstetric CPR should be initiated without hesitation when the presence or absence of spontaneous respiration is unclear. The latest CPR guideline (the 2015 Japanese guideline) suggests that cardiopulmonary arrest should be judged when spontaneous respiration cannot be verified.

Simultaneously, the presence or absence of a pulse should be verified by palpation. When a definite diagnosis cannot be made with confidence, obstetric CPR should be initiated based on the absence of a pulse. However, determining the presence or absence of a pulse or respiration may be difficult when the patient is in shock. In such cases, the worst state should be assumed and lifesaving measures should be taken promptly without delay. Repeated examinations to obtain a definite diagnosis will consume time and result in delayed life-saving measures.

When spontaneous respiration can be verified, a mask with a reservoir should be used to administer 100% oxygen at a flow rate of 10–15 L/min. Oxygenation is required not only to address decreased SpO₂, but also for normal SpO₂ under shock conditions when cellular hypoxia is caused by a decrease in blood perfusion into peripheral tissues.

Oxygenation is also required when the patient has impaired consciousness, which in most cases is caused by a decrease in cerebral blood flow. Oxygenation is mandatory in maternal emergencies and should be initiated at as high a concentration as possible. Oxygenation near 100% can be administered at an oxygen flow rate of 10–15 L/min through a mask with a reservoir. The duration of hypoxemia is likely to be extended when oxygenation occurs via a cannula starting at a low oxygen concentration, followed by a gradual increase in oxygen flow rate. Instead, oxygenation should be initiated at a high oxygen concentration and followed by a gradual reduction in oxygen flow rate when the patient’s condition improves.

The fact that the patient’s airway is open should be reverified when SpO₂ does not reach 95% even after administrating high-concentration oxygen. If the patient is able to vocalize, then the patient’s airway can be considered open. Predominant causes of airway obstruction in maternal emergencies are asphyxia secondary to aspiration caused by vomit and others, as well as glossopisis caused by impaired consciousness.

Simple, noninvasive procedures should be followed when attempting to keep the patient’s airway open by tilting the head and lifting the chin, and the open airway must be maintained. When the airway is difficult to secure, a transnasal airway should be established. The transnasal airway does not induce vomiting when inserted into a patient with sustained consciousness.

Expectant and nursing mothers are prone to develop pharyngeal edema as compared with nonpregnant women, which can make tracheal intubation difficult. Failure of intubation increases the risk of causing complete airway obstruction due to the deteriorating pharyngeal edema. Tracheal intubation should not be repeated persistently when mask ventilation can be used as an alternative to secure the airway. General obstetrics and gynecology specialists do not routinely conduct tracheal intubation, and thus the risk of failure is high. In addition, airway intubation requires both time for preparation and staff for assistance. Therefore, lingering over airway intubation in the event of a maternal emergency when medical staff is scarce will cause further delays in other life-saving actions that should be taken, potentially leading to a worsening of maternal condition.

When seizures occur, the first action should be to stop them in order to allow respiration. The bag-valve-mask should be used to continue artificial ventilation because the patient cannot ventilate during convulsions. Mask ventilation should be continued during convulsions even when the patient’s movements make it difficult to do so. Previously, bite blocks were used during seizures; they are no longer used given the risk of squeezing the tongue root. When appropriate, a transnasal airway should be inserted.

If airway intubation is considered necessary in a patient with complete airway occlusion, the physician at the scene who is most accustomed to airway intubation should use a tracheal tube with as small a bore as possible, with the intention of succeeding intubation on
the first attempt. Preparations for tracheotomy should also be made for cases of complete airway obstruction.

When 95% SpO₂ cannot be achieved during airway management, the bag-valve-mask should be used for artificial ventilation with 100% oxygen. The bag should be attached to a reservoir and kneaded at a rate of once per 6 seconds to administer oxygen at a rate of ≥ 10 L/min. Caution should be exercised to avoid hyperventilation. Elevation of the patient’s chest caused by mask ventilation indicates successful airway securement. The patient should be transferred without delay to a tertiary medical institution where an emergency physician or anesthesiologist who is accustomed to airway intubation is present. In a non-high-level medical institution, further actions on the airway and respiration may be difficult. Accordingly, actions should be shifted to controlling circulation at this stage.

Intravenous access should be established with 2 large-bore cannulas at the time of shock. However, intravenous access is frequently difficult to establish under shock status because the venous lumen has collapsed. The establishment of 1 intravenous access in advance of all deliveries is important for maternal safety. The quick establishment of intravenous access is critically important in maternal emergencies, and using the median cubital vein is convenient in such cases.

Rapid transfusion should be initiated with an extracorporeal fluid replenisher. Artificial colloid solutions should be avoided for rapid transfusion under shock conditions given reports that they increase the incidence of acute renal failure and mortality. Transfusion should be initiated at the full rate. Subsequently, vital responses including vital signs should be monitored, and the transfusion rate reduced when SI becomes 1 or lower. Initiating transfusion at the maximal rate is important because initiating at a slow rate (e.g., 100 ml/h) and increasing it gradually when no improvement is achieved will prolong the state of shock. However, massive, rapid transfusion in a patient with declined cardiac function could lead to pulmonary edema. Cardiac shock should be ruled out by monitoring myocardial movements using ultrasound tomography if there is sufficient manpower. Preparations for blood transfusion should be made when weaning from a shock state cannot be achieved by the time acute transfusion of 1 to 2 liters is completed. At the latest, blood transfusion should be commenced the moment when transfusion of 3 liters is completed; the patient should be transferred to a tertiary medical institution no later than this stage.

At 22 weeks of gestation, left uterine displacement alleviates compression of the inferior vena cava caused by the gravid uterus and is expected to improve systemic circulation. Furthermore, patients easily lapse into hypothermia at the time of shock. Therefore, the transfusion fluid should be warmed to 39°C. When possible, maternal body temperature should be maintained by elevating room temperature, using a blanket, or by any other means. Hypothermia, one component of the trauma triad of death in addition to acidosis and abnormal coagulation, augments the reduction in coagulation function and makes hemostasis difficult. The prevention of hypothermia is a very important factor that affects the prognosis of hemorrhagic shock.

Transfer to a tertiary medical institution should be initiated while making efforts to improve the patient’s shock status via the above-mentioned first-aid measures. Alternatively, in-hospital support should be awaited.

**Obstetric CPR of pregnant women**

Cardiopulmonary arrest should be diagnosed when an expectant or nursing mother with an emergency does not respond to a stimulus or is no longer breathing (including agonal respiration that is seen immediately after cardiac arrest). Misjudging agonal respiration as normal respiration leads to the overlooking of cardiopulmonary arrest, resulting in deterioration of the patient’s prognosis. The diagnosis of agonal respiration is difficult to make for obstetrics and gynecology specialists who have limited experience examining patients with agonal respiration. Therefore, obstetric CPR should be initiated once agonal respiration is assumed to have occurred based on abnormal respiration (Figure 5). Obstetric CPR should never be delayed by taking time to verify cardiac arrest. Indeed, sternal compression conducted on a patient who has no cardiopulmonary arrest has a low risk of causing serious impairment. Hence, sternal compressions should be initiated when dithered and can be discontinued when the patient’s condition improves (e.g., corporal movements and spontaneous respiration).

The automated external defibrillator (AED) not only determines the indication for defibrillation through an automated analysis of electrocardiography, but also allows for standard CPR (i.e., basic life support) by individuals who are not medical professionals when following its instructions. The AED is a very useful tool for obstetrics and gynecology specialists, as well as midwives who are not accustomed to obstetric CPR, when encountering a pregnant patient with an emergency. The protocol strongly recommends that AEDs are always equipped for use during deliveries.

CPR should be initiated with sternal compressions. Every 1-minute delay in CPR reportedly causes 7–10% decreases in survival rate after cardiac arrest. Therefore, practitioners of CPR must initiate sternal compressions as quickly as possible without hesitancy. A marked delay in initiating sternal compressions due to overlooking cardiopulmonary arrest will severely affect the patient’s
prognosis.

High-quality (strong, rapid, and constant) sternal compressions are critically important in CPR. The target site of sternal compressions should be the lower half of the sternum. Compressions should be applied to the center of the chest, not the left side. The diaphragm of a pregnant woman before delivery is raised by the gravid uterus. Therefore, compressions should be applied to the sternal side that is slightly nearer to the head than usual. Practitioners of obstetric CPR should be mindful to never compress the patient’s stomach or gravid uterus.

Compressions should be of an intensity that lowers the chest by at least 5 cm, and at a rate of 100–120 compressions/min. They should be stopped in order to allow the chest wall to completely return to the original position after every compression. The duration of CPR interruption required to replace practitioners should be ≤ 10 seconds.

The gravid uterus should be displaced to the left because it presses the inferior vena cava. The left lateral position may render sternal compressions insufficient and airway establishment difficult. Therefore, manual displacement of the gravid uterus to the left while maintaining the supine position is desirable.

Thirty sternal compressions should be conducted, followed by 2 sessions of artificial respiration. CPR should be repeated at this ratio. As mentioned previously, the patient’s airway should be kept open by tilting the head and lifting the chin, and aspiration should be performed by means of the transnasal airway. Tracheal intubation is not mandatory, and precious time should not be wasted by persisting on it. However, if tracheal intubation is absolutely necessary to secure the airway, a small-bore tracheal tube (about 6.5 mm in inner diameter) should be used because the upper airway of expectant and nursing mothers is narrower than usual due to edema or other changes.

The duration of sternal compression interruption should be kept to a minimum when performing tracheal intubation. If present, an anesthesiologist or an emergency physician should perform the intubation. There is no need to interrupt sternal compressions at the time of artificial respiration when ventilation is conducted with the tracheal tube. Ventilation should be conducted at a rate of 1 ventilation per 6 seconds (10 ventilations per minute) during sternal compressions. A higher ventilation rate is risky because hyperventilation lowers the survival rate. The successful verification of chest elevation is enough for 1 ventilation.

AEDs should be powered on when needed, with the pads connected to the device as per the accompanying instructions. Practitioners of CPR may follow the AED instructions, should interrupt sternal compressions once the automated analysis of electrocardiography begins, and should then move away from the patient.

Defibrillation should be conducted when instructions are received from the AED. Electrocardiography, pulse, and other variables should not be verified immediately after defibrillation, and sternal compressions should be resumed as per the AED’s instructions. Practitioners of CPR should follow the AED’s instructions because the subsequent analysis of electrocardiography starts after continuation of the 2-minute CPR. When the electrocardiographic analysis indicates no need for further defibrillation, the heart beat has presumably resumed. The presence or absence of electrocardiographic waveforms should be verified when the electrocardiographic monitor is connected to the patient, and the presence of a pulse should be confirmed within 10 seconds when the waveforms are present. When the presence or absence of a pulse is unclear, sternal compressions should be reinitiated immediately.

When the presence of a pulse is verified, artificial respiration should be conducted at a rate of 10 breaths/min until spontaneous respiration resumes. However, since cardiac arrest is highly likely to occur again, the patient’s pulse should be checked frequently, and sternal compressions should be resumed without delay when the pulse cannot be clearly verified.

In clinical settings, practitioners of CPR should never overlook cardiac arrest, as it may delay the resumption of sternal compressions. When electrocardiographic waveforms are absent, but the AED considers defibrillation to be unnecessary or the electrocardiographic monitor is not connected to the patient, sternal compressions should be resumed as per the AED’s instructions.

Pharmacotherapy should be conducted in parallel with CPR as per the AED’s instructions, since while the AED is useful for evaluation and care, it is not useful for dosing. In order to simplify life-saving measures, the protocol only mentions adrenaline as a pharmacotherapeutic agent. Adrenaline 1 mg (1 ml of liquid concentrate) should be administered intravenously every 3 to 5 minutes, followed by flushing with 20 ml of infusion solution or physiological saline. Adrenaline can be administered immediately after the onset of CPR, and adrenaline administration should be repeated and CPR continued up until heart beats resume.

The tertiary medical institution, in which emergency cesarean section (perimortem cesarean section) is conducted in an attempt to save the transferred patient, should have simulated the procedure by assuming in advance that the patient will arrive in cardiac arrest.

**Medical supplies/devices and drugs required in maternal emergencies**

The protocol provides only a minimal description...
of medical supplies/devices and drugs required in maternal emergencies. Adrenaline alone is listed as an indispensable drug for treating anaphylactic shock and cardiac arrest (Figure 6), with the presumption that nicardipine, magnesium sulfate, diazepam, ephedrine, and other drugs are constantly equipped in the “crash cart” at labor and delivery facilities. While some primary care facilities have steroid and noradrenaline preparations, the protocol does not include them in the list as drugs of first choice for addressing maternal emergencies. The supplies/devices in the list are those which can be prepared even by a medical institution with limited resources.

Applying the protocol in simulated scenarios

To immediately address maternal emergencies in clinical practice as per the protocol, the clinical settings in which the emergencies are expected to occur should be simulated, and simulation-based practical training should be carried out to address the emergencies. Skills required to address these emergencies will never be applied in clinical settings unless practitioners of obstetric CPR are able to address the emergencies in a simulated setting, regardless of whether they understand the protocol on an intellectual level.

The J-CIMELS uses the selected actual maternal deaths of greater incidences in simulation scenarios. Table 1 summarizes major disorders. JMDEC tallies maternal deaths that occur in Japan every 3 months and yearly.

JMDEC, which is made up of medical professionals of different specialties (e.g., obstetrics and gynecology specialists, emergency physicians, anesthesiologists, pathologists, cardiologists, and radiologists), investigates these cases in detail and presents measures to prevent their recurrence.

By incorporating the above-mentioned points into simulation scenarios, the J-CIMELS encourages trainees in the simulation-based practical training course to take measures to prevent recurrence. These efforts have translated into reductions in the number of cases of postpartum bleeding—the most predominant cause of maternal death in 2015—over the last 4 years (Figure 7). Moving forward, the J-CIMELS will incorporate into simulation scenarios sepsis and puerperal cardiomyopathy, the number of cases of which are increasing in Japan. The textbook, “Initial actions to take at the time of maternal emergencies,” explains these disorders in detail, allowing trainees to further study on their own after participating in the training course.

The present article summarizes the J-CIMELS-prepared evaluation and care protocol for expectant and nursing mothers. The main points set forth in the protocol include the quick detection of maternal emergencies, taking appropriate life-saving actions based on the pathophysiology of expectant and nursing mothers, and requesting in-hospital support when necessary. The number of maternal emergencies a medical professional experiences is decreasing in clinical settings due to the decrease in number of overall deliveries. Under such circumstances, medical professionals must gain

**Preparations for and actions in vaginal delivery**
- Instruct the patient to obtain and possess the blood type certificate during early pregnancy.
- Obtain the consent form for blood transfusion in advance of delivery.
- Establish intravenous access with a 18-20 G cannula in the upper arm to administer an extracellular fluid replenisher.
- Record vital signs by means of the automated measuring device up to 2 hours after delivery.

**Articles required in maternal emergencies**
- Oxygen mask with the reservoir
- Bag-valve-mask with the reservoir
- Nasal airway/oral airway
- Suction system for sputum (max. vacuum pressure: 80 kPa)
- Oxygen cylinder (at least 500 L)
- Patient monitor (desirable) level 3
- AED (automated external defibrillator) or defibrillator (desirable) level 3
- Adrenaline (1 mg/A)
- 18-20 G cannulas
- An extracellular fluid replenisher (warmed to 39°C if possible)

**Monitoring of vital signs**
- Level of consciousness
- Blood pressure
- Pulsebeat
- \( \text{SpO}_2 \) (levels 1-3)

**Monitoring and evaluation of postpartum blood loss**
- Amount of vaginal bleeding (g/h)
- Uterine contraction
- Verification of fundal height
- Presence or absence of vulvar hematoma

**Figure 6. Procedures for normal vaginal delivery and medical supplies/devices required for maternal emergencies**

| SpO\(_2\), arterial blood oxygen saturation; AED, automated external defibrillator | SpO\(_2\), arterial blood oxygen saturation; AED, automated external defibrillator |
|---|---|
| | |
experience performing these protocol-based actions through simulations in order to be prepared for the emergencies. The protocol will not fully function unless mastered by medical professionals of all specialties involved in perinatal care. The J-CIMELS will improve the simulation-based practical training course to further elevate the quality and safety of perinatal care, and plans to continue efforts to spread the protocol’s influence throughout Japan.

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Conflict of interest

The author declares no conflicts of interest.

References

1. Karamermer Y, Roos-Hesselink JW. Pregnancy and adult congenital heart disease. Expert Rev Cardiovasc Ther. 2007; 5: 859–869.
2. Takeda S. Education and training approaches for reducing maternal deaths in Japan. Hypertens Res Pregnancy. 2018; 6: 15–19.
3. American College of Surgeons Committee on Trauma. Trauma Evaluation and Management (TEAM): Program for Medical Students; Instructor Guide. American College of Surgeons, Chicago, 1999.
4. Nagaya K, Fetters MD, Ishikawa M, et al. Causes of maternal mortality in Japan. JAMA. 2000; 283: 2661–2667.
5. Hasegawa J, Ikeda T, Sekizawa A, et al. Recommendations for saving mothers’ lives in Japan: Report from the Maternal Death Exploratory Committee (2010-2014). J Obstet Gynaecol Res. 2016; 42: 1637–1643.
6. Tom Clutton-Brock. Critical Care. In: Lewis G. Eds. Saving Mothers’ Lives: Reviewing maternal deaths to make motherhood safer—2003–2005. Confidential Enquiry into Maternal and Child Health. London: CEMACH, 2007; 238–247.
7. Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA. 2016; 315: 801–810.
8. American Heart Association. BLS Provider Manual eBook. 201. Available from URL: https://ebooks.heart.org/product/bls-provider-manual-ebook50025959. Accessed September 24, 2019.
9. Perkins GD, Travers AH, Berg RA, et al. Part 3: Adult basic life support and automated external defibrillation: 2015 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2015; 95: e43–e69.
10. Soar J, Callaway CW, Aibiki M, et al. Part 4: Advanced life support: 2015 International Consensus on Cardiopulmonary
Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Resuscitation. 2015; 95: e71–e120.

11. Soar J, Nolan JP, Böttiger BW, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 3. Adult advanced life support. Resuscitation. 2015; 95: 100–147.

12. Kodali BS, Chandrasekhar S, Bulich LN, Topulos GP, Datta S. Airway changes during labor and delivery. Anesthesiology. 2008; 108: 357–362.

13. Stackhous RA, Bainton CR. Difficult airway management. In: Hughes SC, Levinson G, Rosen MA. eds. Shnider and Levinson’s Anesthesia for Obstetrics. 4th edn. Philadelphia: Lippincott Williams & Wilkins, 2001; 375–389.

14. Hosono S, Tamura M, Isayama T, et al. Neonatal Resuscitation Committee Japan Society of Perinatal Medicine. Neonatal cardiopulmonary resuscitation project in Japan. Pediatr Int. 2019; 61: 634–640.

15. Rossaint R, Bouillon B, Cerny V, et al. The European guideline on management of major bleeding and coagulopathy following trauma: fourth edition. Crit Care. 2016; 20: 100.

16. Hasegawa J, Sekizawa A, Tanaka H, et al. Current status of pregnancy-related maternal mortality in Japan: a report from the Maternal Death Exploratory Committee in Japan. BMJ Open. 2016; 6: e010304.