Society for Maternal-Fetal Medicine
High-risk pregnancy experts

SMFM Statement

smfm.org

Society for Maternal-Fetal Medicine Special Statement: Checklist for initial management of amniotic fluid embolism

Patient Safety and Quality Committee, Society for Maternal-Fetal Medicine; C. Andrew Combs, MD, PhD; Douglas M. Montgomery, MD; Lorraine E. Toner, MD; Gary A. Dildy, MD

Amniotic fluid embolism is a rare syndrome characterized by sudden cardiorespiratory collapse during labor or soon after delivery. Because of its rarity, many obstetrical providers have no experience in managing amniotic fluid embolism and may therefore benefit from a cognitive aid such as a checklist. We present a sample checklist for the initial management of amniotic fluid embolism based on standard management guidelines. We also suggest steps that each facility can take to implement the checklist effectively.

Key words: cardiac arrest, cardiopulmonary resuscitation, critical care, implementation, perimortem cesarean delivery, pulmonary hypertension, resuscitative hysterotomy, right heart failure

Introduction

Amniotic fluid embolism (AFE) is a rare syndrome characterized by sudden cardiorespiratory collapse during labor or within 30 minutes after delivery of the placenta.[1] The syndrome is believed to be triggered by the abnormal release of trophoblasts or other material into the maternal circulation.[2] Despite its name, AFE likely has no direct relation to either amniotic fluid or an embolism.[2,3] The reported incidence is 1.9 to 6.1 per 100,000 births, and the case fatality rate has been reported to exceed 50% in "classic" cases characterized by cardiovascular collapse and coagulopathy.[2]

Because of its rarity, many obstetrical providers have no experience in managing AFE, and many facilities will encounter only 1 or 2 cases per decade. When faced with a catastrophic, unfamiliar emergency in a highly emotionally charged environment, providers often find it difficult to think clearly or to recall the steps for the appropriate management. The result may be panic, confusion, chaos, poor communication and coordination among providers, and a suboptimal patient outcome.

The management of AFE can benefit greatly from a cognitive aid such as a checklist. We present a sample checklist for the initial management of an AFE based on the management guidelines proposed by the Society of Maternal-Fetal Medicine,[4] a recent expert review,[5] and a hospital system management flowchart.[6] We suggest steps that each facility can take to implement the checklist effectively.

Corresponding author: The Society for Maternal-Fetal Medicine, Patient Safety and Quality Committee. smfm@smfm.org

Checklist

A sample checklist is presented in the Box. We sought specifically to cover the immediate management of AFE in the labor and delivery (L&D) unit when a rapid response is critical. Once the patient is stabilized and transferred to the intensive care unit, there is usually more time for reflection, reading, and discussion. Therefore, management during the later stages is not covered in this presentation.

One of the driving principles was to keep the checklist concise and uncluttered. We excluded items that we felt were unlikely to be overlooked (eg, summoning help, calling a "code," initial use of 100% O_2, securing intravenous access, and use of a bag and mask or intubation for ventilation). We followed common checklist design principles, such as the use of a sans-serif font, minimizing the use of color, and inclusion of a version date. The checklist is designed to be a single-page document, printable on an 8.5×11-inch paper.

We focused on providing guidance for the personnel likely to be present in the patient's room (eg, obstetrician, anesthesiologist, and L&D nurses) rather than attempting to guide the responses of diverse personnel throughout the hospital (such as the blood bank, pharmacy, rapid-response team, and intensive care team). A broader, hospital-wide response algorithm is available elsewhere.[6]

The differential diagnosis of AFE includes pulmonary embolism, myocardial infarction, air embolism, high spinal block, and sepsis. The initial management of all these conditions focuses on the same "ABC" principle: support of airway, breathing, and circulation. The clinical finding that will ultimately confirm the diagnosis of an AFE is the rapid appearance of disseminated intravascular coagulation (DIC).[2]

BOX

Amniotic fluid embolism checklist for initial management

This checklist is a sample only. Each facility should modify it to fit the facility-specific circumstances

Manage circulatory collapse

- ☐ ABCs: manage airway, breathing, and circulation
- ☐ Designate a timekeeper to call out times at 1-min intervals
- ☐ If no pulse, start CPR
  - ○ Manually displace uterus or lateral tilt
  - ○ Use backboard
- ☐ Consider move to operating room only if this can be accomplished in 2 min or less
- ☐ If no pulse at 4 min, START perimortem cesarean delivery (resuscitative hysterotomy)
  - ○ Splash prep only, do not wait for antibiotics
  - ○ Goal is to improve chances of resuscitation

Anticipate uterine atony, DIC, hemorrhage

- ☐ Oxytocin prophylaxis plus other uterotonics as needed
- ☐ Consider intraosseous line if needed for large-bore IV access
- ☐ Initiate massive transfusion protocol
  - ○ Cryoprecipitate preferred over FFP to reduce volume overload
- ☐ Consider thromboelastometry if available
- ☐ Tranexamic acid (1 g IV over 10 min) if DIC or hemorrhage occurs

Manage pulmonary hypertension and right ventricular failure

(Anesthesiology, Critical Care, or Cardiology)

- ☐ Consider echocardiography (thoracic or esophageal)
- ☐ Avoid fluid overload (eg, 500 mL boluses and reassess)
- ☐ Vasopressor if needed: norepinephrine 0.05–3.3 μg/kg/min
- ☐ Inotropes if needed:
  - ○ Dobutamine 2.5–5.0 μg/kg/min or
  - ○ Milrinone 0.25–0.75 μg/kg/min
- ☐ Pulmonary vasodilator if needed to unload right ventricle
  - ○ Inhaled nitric oxide 5–40 ppm or
  - ○ Inhaled epoprostanol 10–50 ng/kg/min) or
  - ○ IV epoprostanol 1–2 ng/kg/min (via central line) or
  - ○ Sildenafil 20 mg orally (if awake/alert)
- ☐ Consider ECMO if prolonged CPR or refractory right heart failure
- ☐ Wean FiO_2 to maintain O_2 saturation 94% to 98%

Postevent debrief (entire team)

- ☐ Identify opportunities for improvement including any need for revisions to checklist
- ☐ Discuss family and staff support needs
- ☐ Report case to Amniotic Fluid Embolism Registry

Version February 17, 2021

CPR, cardiopulmonary resuscitation; *DIC*, disseminated intravascular coagulation, *ECMO*, extracorporeal membrane oxygenation; *FFP*, fresh or frozen plasma; FiO_2, inhaled fraction of O_2; *IV*, intravenous.

SMFM. SMFM Special Statement: Checklist for initial management of amniotic fluid embolism. Am J Obstet Gynecol 2021.

Cardiac arrest accompanies many cases of AFE, but not all.[4] After running several maternal cardiac arrest drills at our hospitals, we concluded that it is too complex to combine a detailed cardiac arrest checklist and an AFE checklist. Therefore, the focus of our checklist is on the management of AFE after the patient has been resuscitated following cardiac arrest, and we only include rudimentary guidance regarding resuscitation, primarily to remind the care team that a cesarean delivery should be started within 4 minutes of maternal cardiac arrest if the maternal circulation has not been restored.

We assume that a nurse or other provider will initiate basic life support with a subsequent transition to advanced cardiac life support once skilled providers and resources are available. However, general management of cardiac arrest is a broader topic with additional considerations (eg, timing and frequency of defibrillation or dosage and route of medications). Thus, we believe that facilities should have a separate flowsheet or checklist for cardiac arrest during pregnancy. Excellent examples can be found in the American Heart Association Scientific Statement on cardiac arrest in pregnancy.[7]

Cesarean delivery will improve maternal hemodynamics and should be started within 4 minutes in a patient undergoing cardiopulmonary resuscitation to increase the probability of successful resuscitation.[5,7] Indeed, the term "resuscitative hysterotomy" has been proposed as a

replacement for the term "perimortem cesarean delivery" to more accurately reflect the potential maternal benefits of the procedure.[8] The procedure is most often performed at the patient's immediate location to save time. Moving the patient to an operating room can be considered if it can be accomplished within 1 to 2 minutes. Once the infant is delivered, the obstetrical care provider's attention should be directed toward preventing and managing hemorrhage and DIC.

In the section "Anticipate uterine atony, DIC, hemorrhage," we remind clinicians to be prepared for these complications and suggest steps that may reduce morbidity, including the use of uterotonic agents, administration of tranexamic acid,[9] and initiation of the hospital's protocol for massive transfusion. DIC accompanies over 80% of AFE cases.[4] Typical massive transfusion protocols call for the replacement of red cells, platelets, and fresh or frozen plasma in approximately a 1:1:1 ratio. However, cryoprecipitate is preferred over fresh or frozen plasma in the setting of an AFE to minimize the risk of volume overload.[5]

In the section "Manage pulmonary hypertension and right ventricular failure (Anesthesiology, Critical Care, or Cardiology)," we focus on pulmonary hypertension and right heart failure, which are characteristic of AFE,[4,5] and provide guidance regarding the administration of inotropic medications and afterload-reducing agents. In addition, the anesthesia provider will assume a key role in the management of the airway, ventilation, fluids, and administration of other medications. However, these roles are not specifically delineated in the checklist because they are not likely to be overlooked by a skilled anesthetist.

Avoidance of fluid overload is an important management principle of pulmonary hypertension and right heart failure. We recommend using blood products for volume resuscitation rather than crystalloid or colloid fluids. Inotropes and pulmonary vasodilators are the mainstays of management. Transthoracic or transesophageal echocardiography can be used to guide therapy. Extracorporeal membrane oxygenation can be considered if there is severe right ventricular dysfunction that remains refractory to medical management.[5]

A debriefing is recommended soon after the patient is moved to the intensive care unit or, if the patient expires, to the morgue. The purposes of the debriefing are to discuss which aspects of the care were managed well and to identify the areas in which systems or processes need to be improved. In addition, there should be a brief discussion about the need for psychological and emotional support for the patient, family members, and clinical staff. Resources for patient and family support are included in a patient safety bundle entitled "Support After a Severe Maternal Event by the Council on Patient Safety in Women's Health Care."[10] Other support resources are offered by the AFE Foundation.[11] Healthcare providers can also be "second victims" who feel traumatized by adverse medical events; therefore, it is important to address their needs as well.[12] Finally, we recommend that all cases of suspected AFE be submitted to the international registry maintained by the AFE Foundation.[11] Reports based on the registry have yielded valuable insights regarding the risk factors, clinical correlates,[13] and outcomes of AFE.[14] Future analyses of the registry data may reveal management strategies associated with improved outcomes. The registry will be most valuable if all cases are reported, even if the outcome is not favorable.

Suggestions for Implementation

The sample checklist is presented as general guidance and shows a practical approach approach for the initial stabilization and management of a patient with an AFE. Different facilities should modify and adapt it to fit their unique attributes. These attributes may include whether the facility has trainees (eg, residents, medical students, nursing students), 24-hour in-house anesthesia coverage, a hospital-wide rapid-response team, an in-house blood bank, anesthesia carts, "crash carts" stocked with the medications listed, and several other facility-specific considerations.

The optimal implementation of the checklist requires several steps, which we encourage each facility to follow. Additional guidance on these steps is covered in two recent overviews[15,16] regarding the development and implementation of checklists. Suggested steps include:

- Assemble a multidisciplinary team to review the checklist and make modifications to fit facility-specific requirements. A relevant stakeholder group will most likely include obstetrical providers (eg, generalists, hospitalists, and maternal-fetal medicine subspecialists), obstetrical anesthesia providers (eg, anesthesiologists and nurse anesthetists), L&D nursing (leadership and staff), medicine subspecialists (eg, cardiology, pulmonary, or critical care), blood bank, pharmacy, rapid-response team, and emergency department. Each stakeholder group should have at least one member on the team.
- Decide where the checklist should be kept. Almost all AFE cases occur in a labor room, delivery room, or operating room. It is likely impractical to post the checklist on a wall in every relevant room. A likely place to keep it would be in a pocket on the side of the "crash cart" or "hemorrhage cart" in the L&D unit. Units with a readily accessible computerized system for storing and accessing such material may consider keeping the checklist there.
- Conduct a pilot test of the checklist by having the development team run through some simulated scenarios. Identify problem items and make modifications as needed to address them. This should be followed by a subsequent pilot test.
- Make announcements. Once the finalized checklist is in place, communicate to all the relevant clinical staff

(obstetrical providers, obstetrical anesthesiologists, and L&D nurses) where it is kept. Review the contents of the checklist during nursing in-service training, grand rounds, and obstetrics and anesthesia departmental meetings. Discuss it at board reports and during change-of-shift huddles.

- Run simulations and drills of AFE scenarios to familiarize all the relevant staff with the location of the checklist and to give them practice in using it to guide the execution of the interventions.
- Conduct a sentinel event analysis after each AFE case. Identify systems or processes that can be improved, such as delays involving medications, blood products, or personnel. Discuss any changes needed to improve the checklist contents or location.

Use of a readily available checklist by providers who have practiced using it should result in a coordinated, controlled response to an AFE and improve the outcomes by ensuring that patients who experience this rare, catastrophic event receive timely and optimal care.

REFERENCES

1. Clark SL, Romero R, Dildy GA, et al. Proposed diagnostic criteria for the case definition of amniotic fluid embolism in research studies. Am J Obstet Gynecol 2016;215:408–12.

2. Clark SL. Amniotic fluid embolism. Obstet Gynecol 2014;123:337–48.

3. Funk M, Damron A, Bandi V, Aagaard K, Szigeti R, Clark S. Pulmonary vascular obstruction by squamous cells is not involved in amniotic fluid embolism. Am J Obstet Gynecol 2018;218:460–1.

4. Society for Maternal-Fetal Medicine (SMFM), Pacheco LD, Saade G, Hankins GD, Clark SL. Amniotic fluid embolism: diagnosis and management. Am J Obstet Gynecol 2016;215:B16–24.

5. Pacheco LD, Clark SL, Klassen M, Hankins GDV. Amniotic fluid embolism: principles of early clinical management. Am J Obstet Gynecol 2020;222:48–52.

6. Hession PM, Millward CJ, Gottesfeld JE, et al. Amniotic fluid embolism: using the medical staff process to facilitate streamlined care. Perm J 2016;20:15–248.

7. Jeejeebhoy FM, Zelop CM, Lipman S, et al. Cardiac arrest in pregnancy: a scientific statement from the American Heart Association. Circulation 2015;132:1747–73.

8. Rose CH, Faksh A, Traynor KD, Cabrera D, Arendt KW, Brost BC. Challenging the 4- to 5-minute rule: from perimortem cesarean to resuscitative hysterotomy. Am J Obstet Gynecol 2015;213:653–6, 653.e1.

9. Fitzpatrick KE, van den Akker T, Bloemenkamp KWM, et al. Risk factors, management, and outcomes of amniotic fluid embolism: a multicountry, population-based cohort and nested case-control study. PLoS Med 2019;16:e1002962.

10. Alliance for Innovation on Maternal Health. Support after a severe maternal event patient safety bundle (+AIM). Council on Patient Safety in Women Health Care. 2020. Available at: https://safehealthcareforeverywoman.org/aim/patient-safety-bundles/support-after-a-severe-maternal-event-patient-safety-bundle-aim/. Accessed February 17, 2021.

11. Amniotic Fluid Embolism Foundation. The AFE Foundation helps families and clinicians impacted by amniotic fluid embolism (AFE). 2018. Available at: https://www.afesupport.org/. Accessed February 1, 2021.

12. Seys D, Wu AW, Van Gerven E, et al. Health care professionals as second victims after adverse events: a systematic review. Eval Health Prof 2013;36:135–62.

13. Stafford IA, Moaddab A, Dildy GA, et al. Amniotic fluid embolism syndrome: analysis of the Unites States international registry. Am J Obstet Gynecol MFM 2020;2:100083.

14. Clark SL, Hankins GD, Dudley DA, Dildy GA, Porter TF. Amniotic fluid embolism: analysis of the national registry. Am J Obstet Gynecol 1995;172:1158–67; discussion 1167–9.

15. Committee on Patient Safety and Quality Improvement. Committee Opinion No. 680: The Use and Development of Checklists in Obstetrics and Gynecology. Obstet Gynecol 2016;128:e237–9.

16. Society for Maternal-Fetal Medicine (SMFM) Patient Safety and Quality Committee, Bernstein PS, Combs CA, Shields LE, Clark SL, Eppes CS. The development and implementation of checklists in obstetrics. Am J Obstet Gynecol 2017;217:B2–5.

All authors and committee members have filed a conflict of interest disclosure delineating personal, professional, and/or business interests that might be perceived as a real or potential conflict of interest in relation to this publication. All conflicts have been resolved through a process approved by the Executive Board. The Society for Maternal-Fetal Medicine (SMFM) has neither solicited nor accepted any commercial involvement in the development of the content of this publication.

This document has undergone an internal peer review through a multilevel committee process within SMFM. This review involves critique and feedback from the SMFM Patient Safety and Quality and Document Review Committees and final approval by the SMFM Executive Committee. SMFM accepts sole responsibility for document content. SMFM publications do not undergo editorial and peer review by the *American Journal of Obstetrics & Gynecology*. Publications are reviewed every 36 to 48 months and updates are issued as needed. Further details regarding SMFM publications can be found at www.smfm.org/publications.

SMFM has adopted the use of the word "woman" (and the pronouns "she" and "her") to apply to individuals who are assigned female sex at birth, including individuals who identify as men as well as nonbinary individuals who identify as both genders or neither gender. As gender-neutral language continues to evolve in the scientific and medical communities, SMFM will reassess this usage and make appropriate adjustments as necessary.

All questions or comments regarding the document should be referred to the SMFM Patient Safety and Quality Committee at smfm@smfm.org.

  https://doi.org/10.1016/j.ajog.2021.01.001