Massive air embolism during cardiopulmonary bypass. Causes, prevention, and management.

Massive air embolism (MAE) during cardiac surgery is a rare potentially catastrophic event. MAE may occur from intravascular lines, from the CPB circuit, or from the surgical field. Successful management of a MAE requires a rapid identification and coordinated response to remove the air, restore circulation, and protect/recover the brain from ischemic/reperfusion injury.

MAE case scenarios will be discussed specific preventative and recovery strategies will be discussed. Participants will learn how they should assess their program’s current ability to manage a MAE and how to improve their team’s readiness.

RESOURCES

TABLE 28.5 INTRAOPERATIVE AND POSTOPERATIVE MANAGEMENT OF AIR EMBOLISM

1. **Perfusionist**: Stop CPB immediately, clamp arterial and venous lines, and notify surgeon and anesthesiologist.
2. Locate and confirm source of air; if due to pressurized CPB component; isolate component from patient before relieving pressure.
3. **Perfusionist**: Purge air from CPB systemic flow line and refill with fluid.
4. **Surgeon**: Aspirate air (if present) from arterial cannula; if possible, initiate cardiac massage until CPB restarted.
5. **Anesthesiologists**: Place patient in steep head-down position; be prepared to temporarily occlude carotid arteries.
6. Confirm sufficient volume in CPB reservoir and resume CPB with active aortic root venting.
7. **Administer vasoppressors to raise perfusion pressure**
8. If suspected cerebral air embolism, cool patient on CPB and consider instituting retrograde cerebral perfusion; consider packing patients head in ice.
9. **Anesthesiologists**: Ventilate lungs vigorously with 100% oxygen; administer corticosteroids (2-4 g methylprednisone and/or 20 mg dexamethasone, and continue for 72-96 hr postoperatively).
10. **Administer 25 g mannitol and maintain for 48 hr postoperatively.**
11. **Aim for early patient arousal and assess for return of normal mentation.**
12. **Consult a neurologist if central nervous system damage is suspected.**
13. **Consider computed tomography or magnetic resonance imaging if patient fails to awaken or develops delayed mental deterioration.**
14. **Consider hyperbaric oxygen treatment (6 ATA using recommended U.S. Navy dive tables) and make necessary ground transportation arrangements; repeat hyperbaric therapy as necessary.**
15. **Do not give up resuscitative efforts unless patient expires or is diagnosed brain dead.**

CPB, Cardiopulmonary bypass; ATA, atmospheres of absolute pressure.
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From Gravlee, Davis, Kurusz, and Utley. Cardiopulmonary Bypass Principles and Practice Lipponcott Williams and Wilkins, Phila 2000 pp 595

Table 28.4 Steps to Perform Retrograde Cerebral Perfusion for Treatment of Massive Air Embolism

1. **Perfusionist**: Stop CPB.

2. **Anesthesiologist**: Place Patient in Steep Trendelenberg position.

3. **Surgeon**: remove Aortic Cannula from ascending Aorta

4. After purging air and refilling CPB systemic flow line, insert arterial cannula in the SVC above a point where a vascular clamp can be place; if bicaval cannulation has been used, the arterial cannula may be connected to the snared SVC cannula.

5. Begin retrograde perfusion with hypothermia 20° at a flow of 1-2 l/min for 1-3 min or until no more air or froth is seen existing the opened aorta.

6. **Anesthesiologists**: Temporarily compress the carotids during the later phase to purge air retrograde through the vertebral system.

CPB, Cardiopulmonary bypass; SVC, superior vena cava.

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Prevalence of MAE from Accident Survey


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