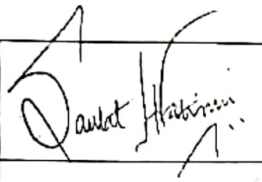
Aga Khan University Hospital

Title:	Air Embolism: Prevention and Treatment		
Department / Division:	Anaesthesiology / Operating Room		
Approved By:		**Document No.:**	OR-PP-016
Section Head, Cardio-thoracic Surgery		**Issuance Date:**	October 01, 1996
Chief Perfusionist, Operating Room		**Revision Date:**	July 24, 2023
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1. Purpose(s):

1.1. To facilitate communication between Perfusionist, Anesthetist and surgical staff in the event of an air embolism.

1.2. To provide a quick reference for Perfusionist/technicians.

1.3. To reduce patient risks and hazards during emergency situations involving the extracorporeal circuit.

1.4. To document requirements for equipment and disposable supplies.

2. Scope:

2.1. Perfusionist inattention

2.2. Reversal of left ventricular vent tubing in roller head

2.3. Unexpected contraction of left ventricle

2.4. Defective Oxygenator

2.5. Interruption of arterial line

2.6. Pressurized cardiotomy reservoir

2.7. Inadequate de-bubbling of bypass system

2.8. Runaway pump head

2.9. Perforation in tubing on negative side of pump

3. Responsibility:

Cardiac Surgeons. Anesthesiologist and Cardiac Perfusionist.

4. Terms & Definition:-

Retrograde cerebral perfusion: To remove air from the brain by pumping blood up the superior vena cava

5. Process/ Process:-

Steps	Rationale
5.1 **Prevention:**	
5.1.1 Team perfusion	
5.1.2 Level sensor and bubble detector with shut off potential	
5.1.3 Bypass circuit should be carefully inspected.	
5.1.4 Tubing direction should be verified.	5.1.4 To avoid any reverse flow.
5.1.5 All holders should be fastened tightly.	5.1.5 To avoid any accidental breakdown of circuit.
5.1.6 All vent ports should be open	
5.1.7 All alarms are on and functioning.	
5.1.8 Circuit completely de-bubbled.	
5.1.9 Scrub nurse should check direction of suckers and vent at field using a basin of normal saline before using on patient.	
5.1.10 Surgical team should have a means of initiating immediate fibrillation at all times.	
5.1.11 Maintain suckers to as low flow as possible to handle return.	
5.1.12 Limit or prohibit personnel around pump during Cardiopulmonary Bypass (CPB).	
5.2 **Treatment Protocol:**	
5.2.1 Role of Perfusionist:	
5.2.1.1 Shut off pump immediately and clamp venous line	5.2.1.1 To avoid further damage.
5.2.1.2 Alert surgical and anesthesia team	5.2.1.2 To ensure quick response from team.
5.2.1.3 Search for and correct the cause.	
5.2.2 Role of Anesthetist:	

Steps	Rationale
5.2.2.1 Manually compress the carotid arteries	5.2.2.1 To avoid air entering the brain.
5.2.2.2 Place patient into deep Trendelenburg position	5.2.2.2 To help to prevent cerebral embolus.
5.2.2.3 Ventilate lungs with 100% O_2 for at least 6 hours.	5.2.2.3 To maximize blood alveolar gradients for elimination of N_2.
5.2.3 Role of Surgeon:	
5.2.3.1 Fill the pericardia with cold irrigation solution until aortic cannulation site is submerged	
5.2.3.2 Decannulate and purge the arterial line of all gaseous emboli	
5.2.3.3 Wedge aortic cannula into superior vena cava (SVC) through SVC cannula or through a small cavo atrial junction puncture	5.2.3.3 To remove air from upper part of the body.
5.2.3.4 Remove all air through submerged aortic cannulation site, right atrial apex and large bore needle stabs into the pulmonary artery (PA) and right ventricle (RV)	5.2.3.4 To remove air from heart and aorta.
5.2.3.5 In addition small bore needle stabs can be used	5.2.3.5 To remove air from distal sites of coronary vessels.
5.2.3.6 After purging air from right heart, with permission of surgeon, the Perfusionist can initiate hypothermic retrograde perfusion of the head via the SVC at low flow (1-2 1/min) as the anesthetist releases the carotid arteries. This should be continued for approximately 3-4 minutes. If needed, air can be removed from lower part of the body by inferior vena cava (IVC)	5.2.3.6 To remove air from upper body carotid compression, allow retrograde purging of air from vertebral arteries.
5.2.3.7 Recannulate the aorta.	
5.3 **Perfusion:**	

Steps	Rationale
5.3.1 Resume bypass and cool to 20°C.	
5.3.2 Administer 1 gm Dexamethasone.	5.3.2 To aid in cell membrane stabilization.
5.3.3 Induce deep barbiturate anesthesia with Sodium Phenobarbital in 10mg/kg and maintain with a 1-3mg/kg infusion.	5.3.3 This state should be maintained until intracranial pressure has been normal (<33 mmHg) for 24-48 hours.
5.3.4 Give Mannitol, Steroid and Barbiturate.	5.3.4 To reduce cerebral damage.
5.3.5 Complete surgical procedure.	
5.3.6 Re-warm patient slowly (6°-8°C gradient) to 35°C, when at 35°C stop re-warming and discontinue CPB.	3.3.6 Lowering patient temperature, increasing gas solubility helps to reabsorb bubbles because decreased metabolic demands may limit ischemic damage prior to bubble resorption.
5.4 **If Hyperbaric Chamber is available:**	
5.4.1 Transport patient to hyperbaric chamber while maintaining barbiturate anesthesia, moderate hypothermia (34°C) and Trendelenburg position.	5.4.1 Hyperbaric chamber can accelerate resorption of residual bubbles.
5.4.2 Compress to 6 atmospheres while ventilating with room air (if possible).	
5.4.3 Quickly decompress chamber to 3 atmospheres and ventilate with 100% O_2.	5.4.3 To avoid cerebral O_2 toxicity.
5.4.4 Allow intermittent ventilation with room air.	

6. References:

Gravlee, G.P., Davis R.F., Kurusz, M., & Utley, J.R (2000). Cardiopulmonary Bypass: Principles and Practice. (2ndedition). New York: Lippincott Williams & Wilkins.

Cardiopulmonary Bypass: Principles and Practice. 3rd Edition (2008).By Glenn P. Gravlee

7. Annexure:

Document Change Record:

Review #	Review Date (dd-mm-yyyy)	Description Of Change	Identification of Change
03	06-Jun-2015	Change in new format	Choose an item
04	01-Feb-2016	Formatting as per service line. Change in document no.	-
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06	24-July-2023	Formatting as per Department / Division	