SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIO PULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME : CPB AND ITS COMPLICATIONS

3RD YEAR

TOPIC : AIR LOCK AND AIR EMBOLISM

AIR LOCK
&
AIR EMBOLISM

AIR LOCK

Air entering the venous outflow line can result in complete cessation of flow to the venous reservoir, and this is called air lock.

➢ This leads to decrease in the reservoir volume. This decreases the systemic flow that indicates the perfusion is not good.

AIR LOCK

CAUSES:

- Air from cardiac chambers
- Improper venous cannulation
- Improper snugging of venous cannula
- Atrial tear
- Loose atrial purse string suture
- Loose connector or laceration in the venous drainage tubing.

AIR LOCK

The presence of large air bubbles within the venous cannula or tubing prevents blood flow due to surface tension and low pressure gradient.

OCCURRENCE:

Air lock occurs at the time of initiation of bypass.

AIR LOCK

MANAGEMENT:

- Check for the source of air, entering the circuit.
- Check for proper cannulation and snugging etc.
- If the air lock is minimal then it can be removed by lifting the venous line and removed out
- If air lock is more, it ceases the drainage,

Then come off the bypass

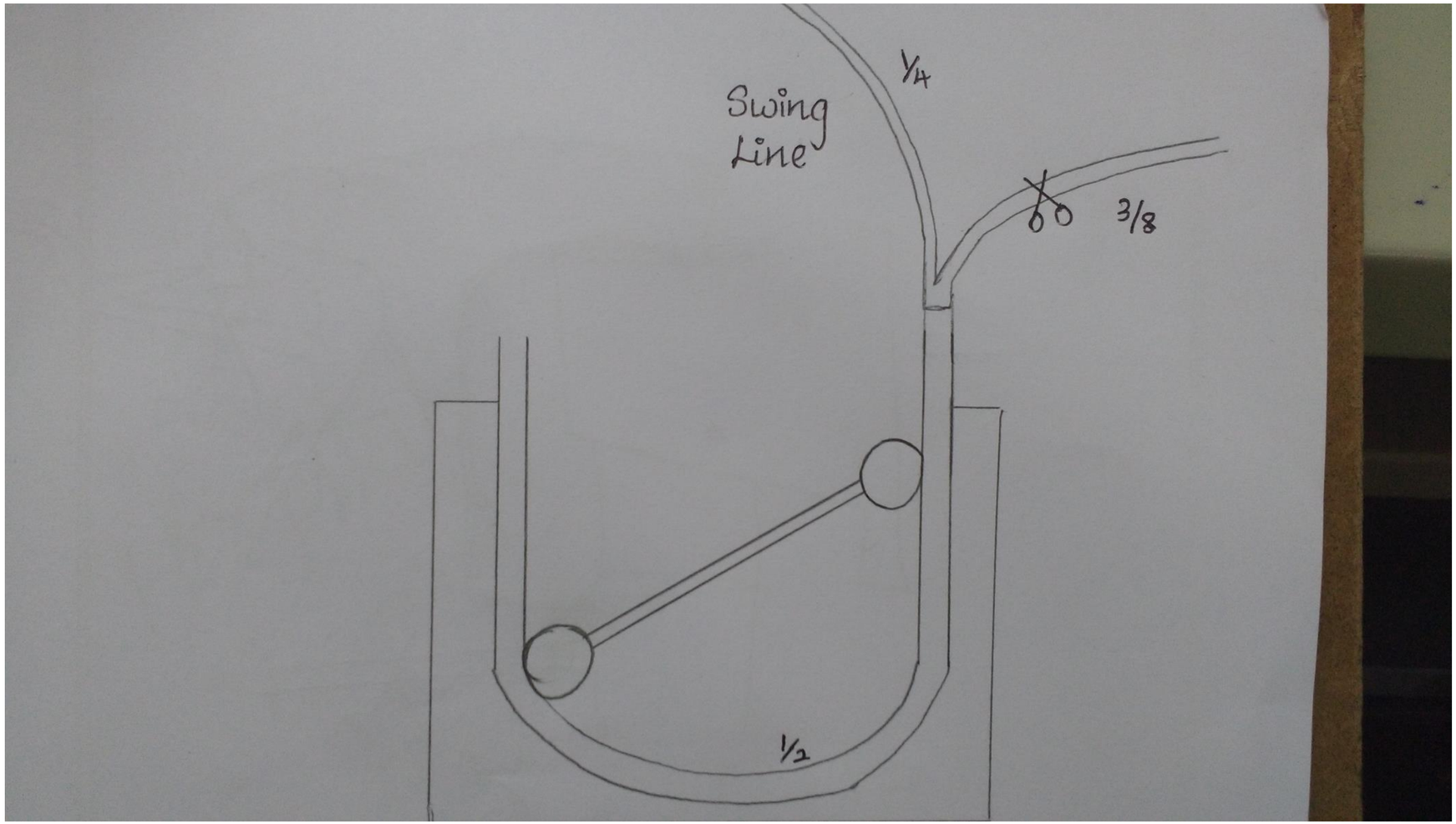
AIR LOCK

- The Venous line near to the oxygenator inlet is clamped and distal part of venous cannula is clamped.
- Disconnect the venous line from cannula and quickly fill the line with normal saline or other solution and then connect lines with cannula
- Then go on bypass.

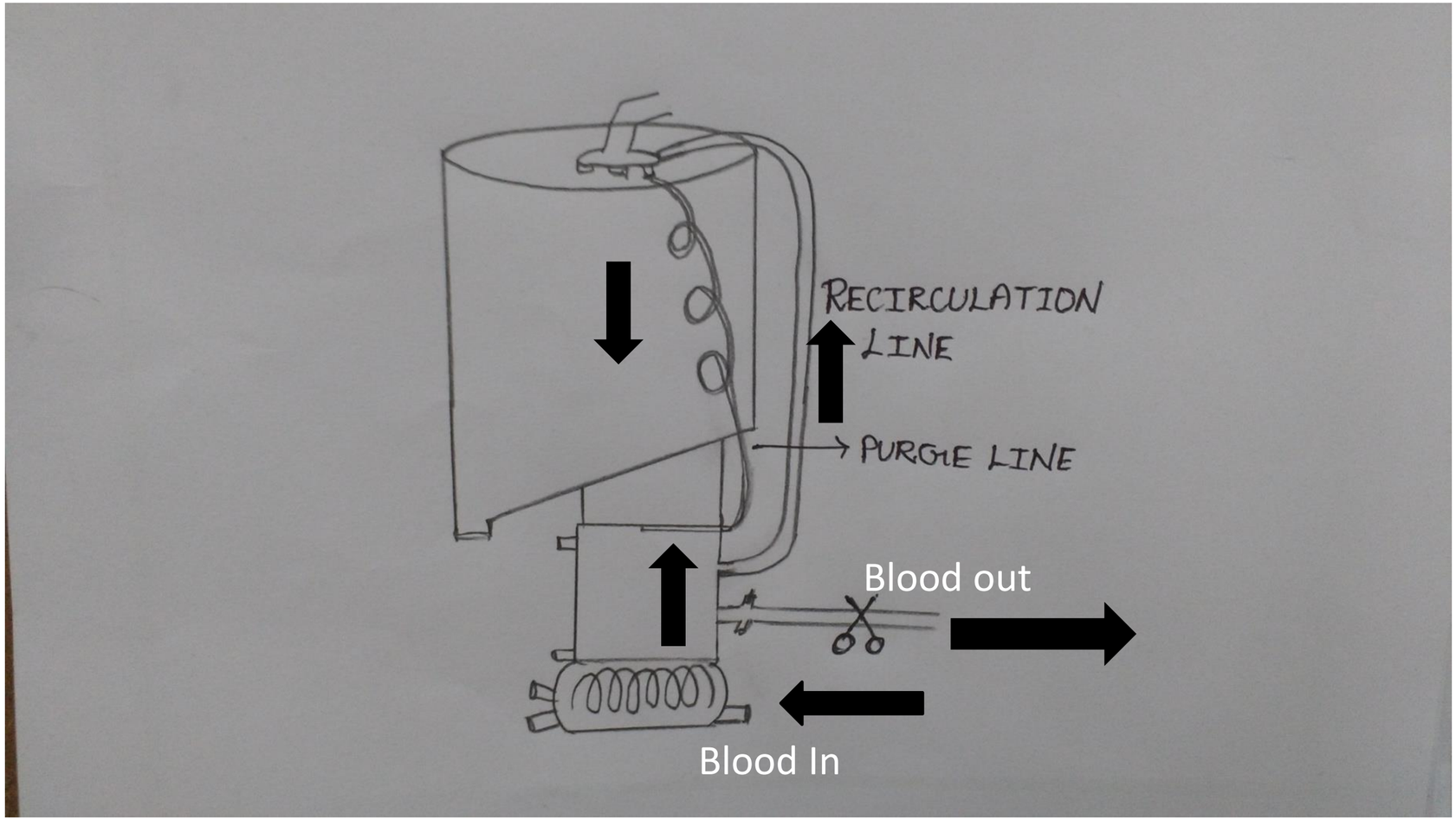
TREATMENT:

- If air enters the –ve side can be taken from the swing line.
- If the air enters the positive side can be taken from the recirculation and purge lines.
- If the air enters the arterial outlet of oxygenator then it can taken by vent in arterial filter.
- If the air reaches out of arterial filter can be taken from AV bridge/stop the pump open the arterial line & flush the air.
- If air enters the patient then come off bypass and go for RCP.

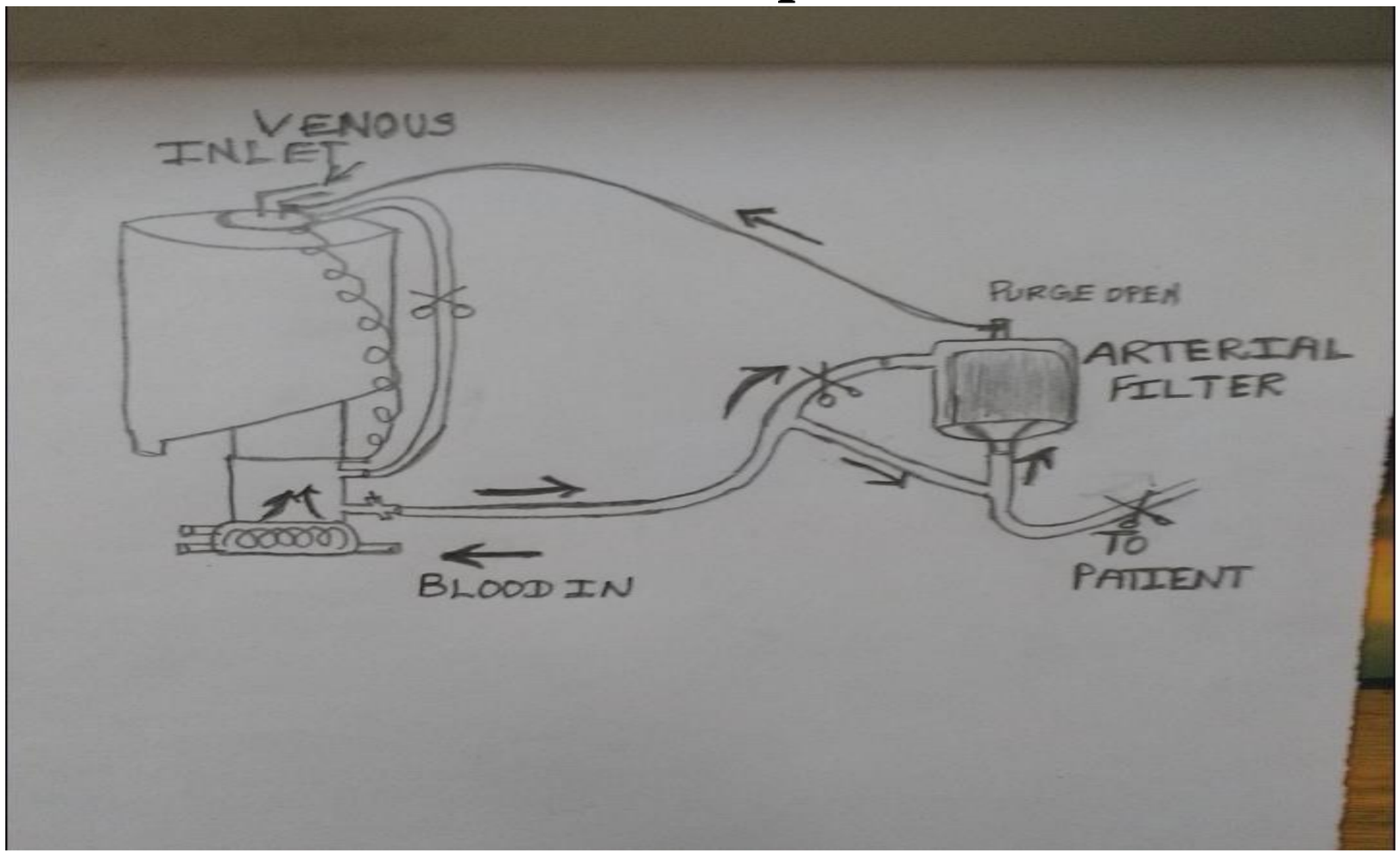
If air enters into the negative side can be taken from swing line. The swing line is connected to the reservoir of any filtered port to purge out air along with fluid.

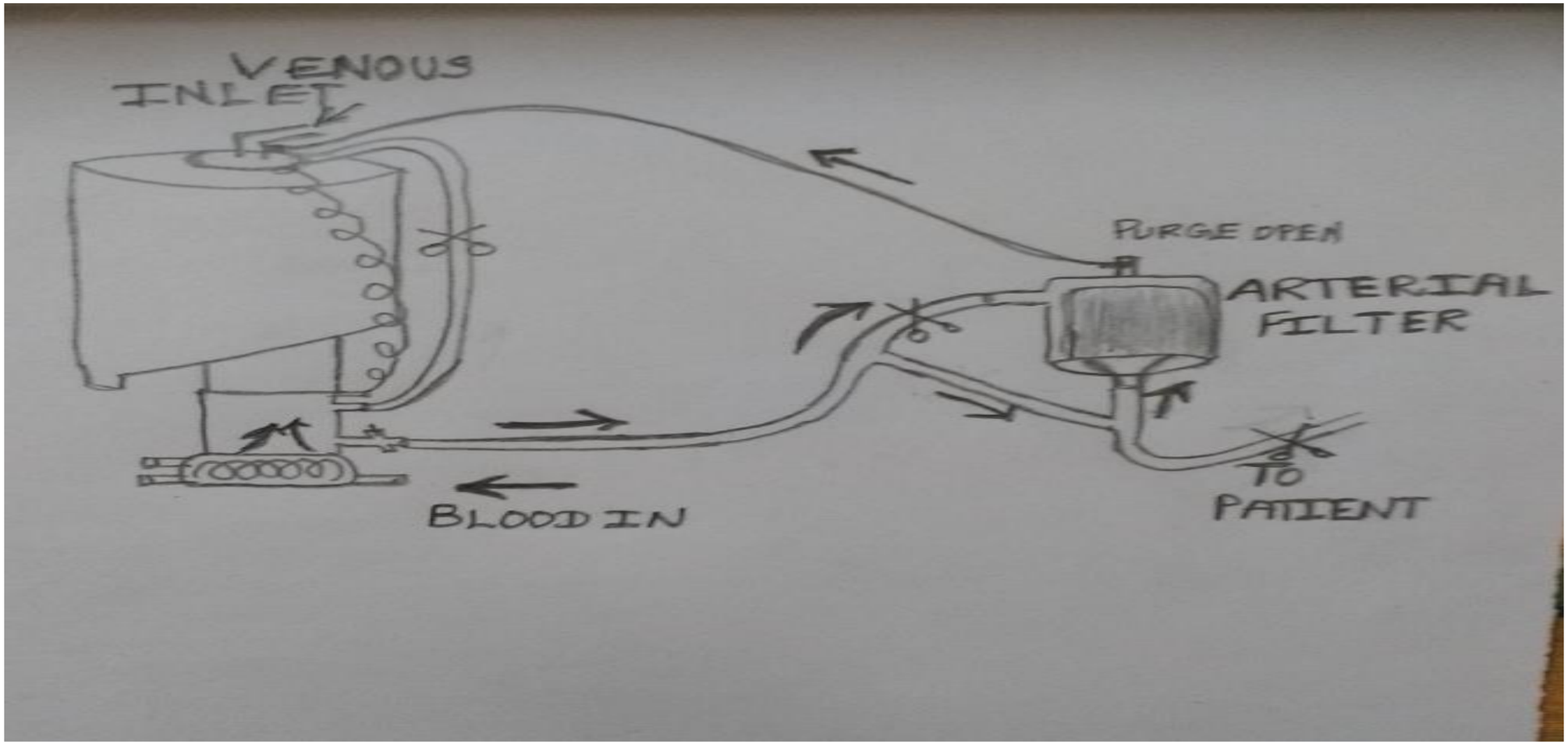


If air enters into the oxygenator, can be taken from recirculation or purge line.



If air enters into the arterial outlet can be taken from bubble trap or arterial filter.




VENOUS
INLET
PURGE OPEN
ARTERIAL
FILTER
TO
PATIENT
BLOOD IN

EMBOLISM

- An embolism is defined as the sudden obstruction in the blood vessel due to a blood clot or a gas or a foreign matter, that gets struck while travelling through the blood stream.
- An emboli can be,
  - Gaseous
  - Biologic
  - Foreign material

AIR EMBOLISM

Gaseous micro emboli is one of the major accident that occurs during cardiac surgery.

More recent surveys have indicated that iatrogenic air embolism continues to occur during CPB although the incidence has been greatly reduced.

AIR EMBOLISM

CAUSES:

- Bubble oxygenator
- Clotted oxygenator
- High gas to blood flow ratio
- Low cpb reservoir level
- Improper rewarming
- Fast addition of fluids
- Inadequate debubbling of the circuit especially arterial filter
- Excess flow through small diameter connectors.

AIR EMBOLISM

CAUSES:

- Gaseous or vaporous cavitation
- Damaged membrane material
- Over pressurization of oxygenator
- Ineffective filter of venous reservoir can cause froth in reservoir can be sucked out by pump
- Pulsatile flow through microporous membrane oxygenator.
- The counter-diffusion phenomenon

AIR EMBOLISM

CAUSES:

- Accidental disconnection, punctures or cut or opening such as stop cocks to the atmosphere.
- Improper deairing of the heart at the time of ACC release
- Reversal of left ventricular vent flow.
- Reversed roller pump flow in vent line
- Air enters into the aortic root from cardioplegic delivery tubing and cannula.
- Balloon rupture.

AIR EMBOLISM

CAUSES:

- Areas with elevated transmembrane pressure ratios may cause bubble formation on the blood side of the membrane.
- Free microbubbles initiate foreign surface contact that leads to, activation of platelets, leukocyte depletion, alternation in RBC count, Denaturation of plasma proteins, acceleration of coagulation factors.

AIR EMBOLISM

PREVENTION:

- Tight connections
- Proper selection of tubing & oxygenator
- Proper deairing of the circuit.
- Maintaining recommended blood gas flow ratio.
- The use of safety devices like arterial line filter, bubble trap, level sensor, bubble detector.
- The temperature gradient should be maintained while rewarming from hypothermia.

AIR EMBOLISM

PREVENTION:

- Incase of using bubble oxygenators the defoaming material should be used along with arterial filters.
- Efforts to reduce the amount of air aspirated from the operating field and monitoring the suction pump speed may reduce the chance of embolization.
- Flushing the surgical field with CO2 reduces emboli

AIR EMBOLISM

PREVENTION:

- With open heart procedures air often entrained on the luminal surface of the heart or trapped within the muscular trabeculae. So, cardiac ejections should be avoided until complete filling of the heart.
- Systemic air embolism can be prevented by insertion of vent in left ventricle.

AIR EMBOLISM

PATHOPHYSIOLOGY:

- Coronary air is associated with impaired ventricular function etc.
- Cerebral pathology may include cerebral edema, stroke, cerebral hemorrhage, neurological dysfunctions etc. (glucocorticoids are administered to prevent cerebral edema)

(Hyperbaric oxygenation therapy should be given)

MANAGEMENT OF MASSIVE AIR EMBOLISM

- Stop CPB immediately.
- Clamp arterial and venous line, and notify surgeon and anesthesiologist.
- Locate and confirm the source of air, if due to pressurized CPB component; isolate component from patient before relieving the pressure.
- Ensure that gas outlet or vent is obstructed.
- Purge air from CPB systemic flow line and refill with fluid.

MANAGEMENT OF MASSIVE AIR EMBOLISM

- Surgeon will aspirate air from the arterial cannula, if possible initiate the cardiac massage until CPB started.
- Anesthesiologists place patient in steep head-down position; be prepared to temporarily occlude carotid arteries.
- Confirm sufficient volume in the CPB reservoir and resume CPB with active aortic root venting
- Administer vasopressors to raise perfusion pressures.

MANAGEMENT OF MASSIVE AIR EMBOLISM

- If suspected cerebral air embolism, cool patient on cpb and pack the patient head within ice & start retrograde cerebral perfusion , by connecting arterial pump line to the svc cannula with caval tape tightened.
- Blood at 20-24 degree Celsius is injected to the SVC at 10 to 15 ml per kg for 1-3 mins and air and blood is drained from aortic cannulation site.

MANAGEMENT OF MASSIVE AIR EMBOLISM

- If air is removed then disconnect the aortic cannula from svc, place the cannulas in proper position and then come on the bypass.
- Ventilate lungs vigorously with 100% oxygen and administer corticosteroids(methyl prednisolone 30mg/kg)
- Administer mannitol 25g and maintain for 48hrs postoperatively.
- Consider CT or MRI if patient fails to awaken or any delayed mental deterioration.
- Treat with hyperbarbic oxygen therapy.

OTHER TYPES OF EMBOLI

BLOOD BORNE

Blood borne micro emboli associated with CPB consists primarily of autologous cellular products or aggregates of various cellular types.

Micro emboli – Fibrin, lipid material, protein (denaturized) , bone or muscle fragments.

aggregates-platelet , neutrophil , red blood cells .

These are commonly observed during and after bypass .

- Blood borne emboli can also be derived from homologous transfused blood that accumulate proportionately with storage time.
- Fibrin deposit likely formed in the areas of stagnant blood flow, where turbulence or cavitation or roughed surface.
- Specific sites includes intra luminal projections, oxygenator connections, within bubble oxygenators, within arterial filters .

MANAGEMENT OF BLOOD BORNE EMBOLI

Appropriate heparin dosage if necessary , heparin blocks coagulation within cascade at multiple points , mainly by potentiating anti thrombin 3

Heparin administration within ACT of greater than 300 to 400 sec is considered adequate for prevention of fibrin formation within the circuit .

FAT EMBOLI

- Fat particle are generated during CPB and are found in capillaries of kidney, lungs, heart, brain, liver, spleen and pericardial blood .
- Fat emboli developed within CPB circuit enter via cardiotomy suction.
- Fat emboli may vary from 4 to 200 micro meter in diameter
- Fat emboli are commonly observed with bubble oxygenator .

A number of fatty acid and other lipid molecule have been linked with post perfusion lung parenchymal damage.

MANAGEMENT :

Generation of immiscible fat however is reduced by hemodilution

PROTEIN DENATURATION :

These occurs when plasma proteins come in contact with foreign surfaces

PLATELET AGGREGATION :

- Blood contact with foreign surface activate platelets that leads to thrombocytopenia .
- Platelet aggregates are commonly observed in stored whole blood, packed red blood cells, stored platelet concentrates.

MANAGEMENT:

Preservation of platelet numbers has been reported with prostacyclin use and reduction in aggregate formation, thus reducing the micro embolic risk associated with bypass.

NEUTROPHIL AGGREGATION:

- Neutrophil aggregation appears to depend on the nature of the foreign material that the neutrophils contact.
- After aggregation, lysosomal enzymes releases that increases the microvascular endothelial permeability to protein. This contributes to the post perfusion lung syndrome.

RED CELL AGGREGATION:

Patients who posses cold reacting antibodies usually of the IgM class, may be a risk for red cell aggregate microembolization with cold cardioplegia or other hypothermic techniques used during surgery.

MANAGEMENT:

The biologic emboli production is mostly decreased by the use of appropriate circuit based on the duration of the procedure.

The use of coated oxygenators to avoid aggregate formation and inflammatory reactions.

FOREIGN MATERIALS THAT CAUSES EMBOLI

- Foreign material can be present in multiple components of the ECC circuit and in priming solutions used for bypass or they may arise from the interaction of various components
e.g. Pump-tubing interaction.
- Micro emboli that are usually large in diameter may be released into the circuit from tubing. Eg. spallation

PREVENTION:

The use of membrane oxygenators have enabled significant reduction in the occurrence of embolic events.

The use of PVC tubings may cause less spallation compared to the silicone based rubber tubing.

Proper occlusion settings decreases the micro emboli production.

thank you