One Heart

Introduction to Cardiopulmonary Bypass

Learning Objectives

- Become familiar with CPB
- Formulate a framework to bring a patient off CPB
- Have fun!

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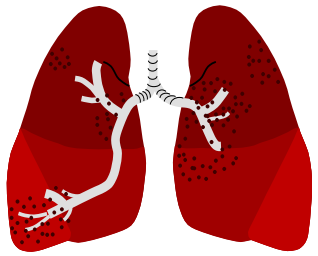
On-Bypass

SVC

RA → RV →  → LA → LV → AORTA

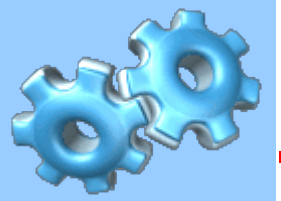
IVC

"LUNGS OFF"

VENOUS LINE

ARTERIAL LINE

HEART-LUNG MACHINE



O_2 CO_2

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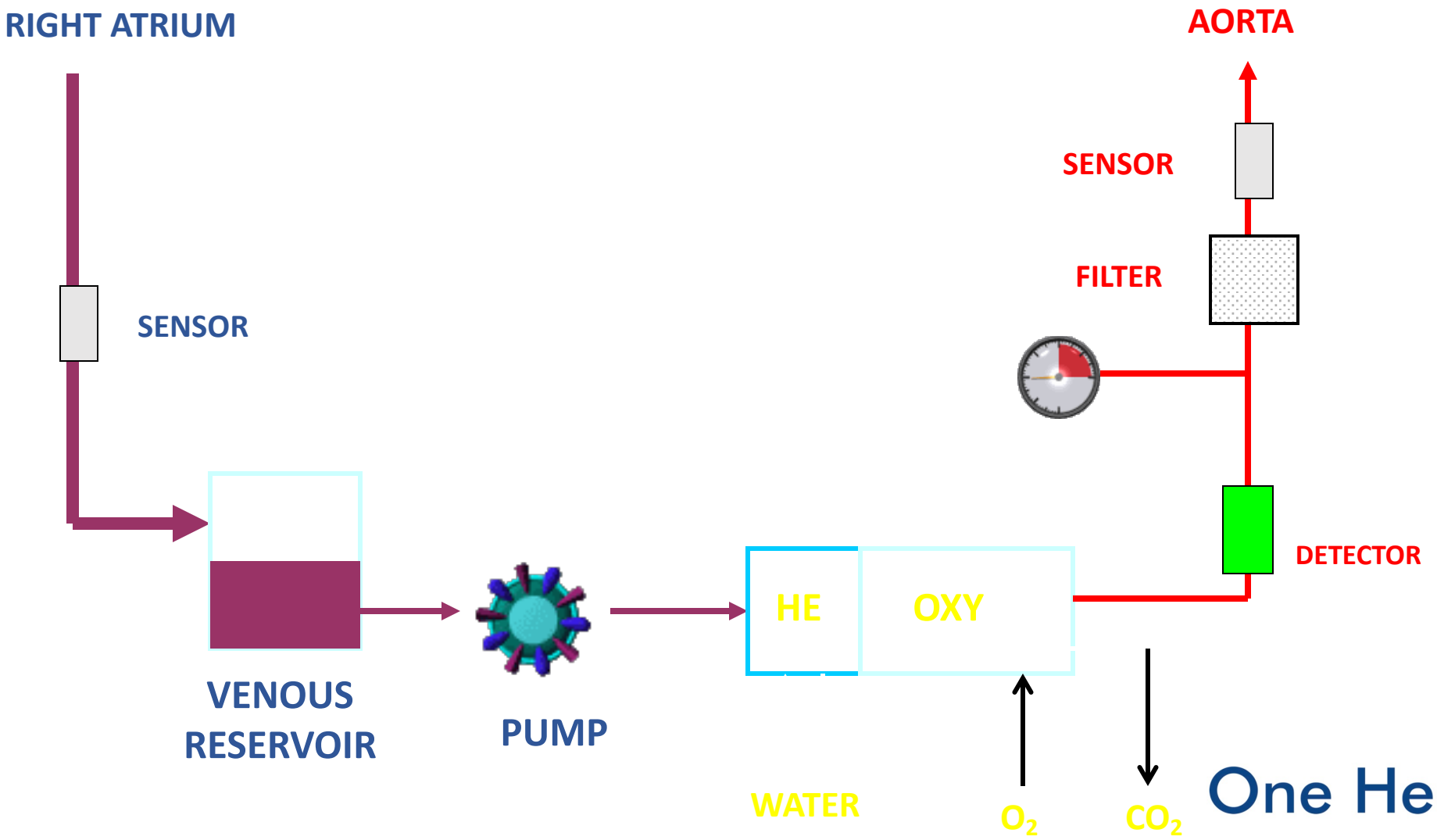
Components of the Circuit

- Hardware
  - Heart-lung machine
    - Blood pumps
    - Gas delivery system

- Extracorporeal circuit
  - Tubing
  - Gas exchanger (artificial lung/oxygenator)
  - Heat exchanger
  - Reservoir

SURVEY OF CPB CIRCUIT



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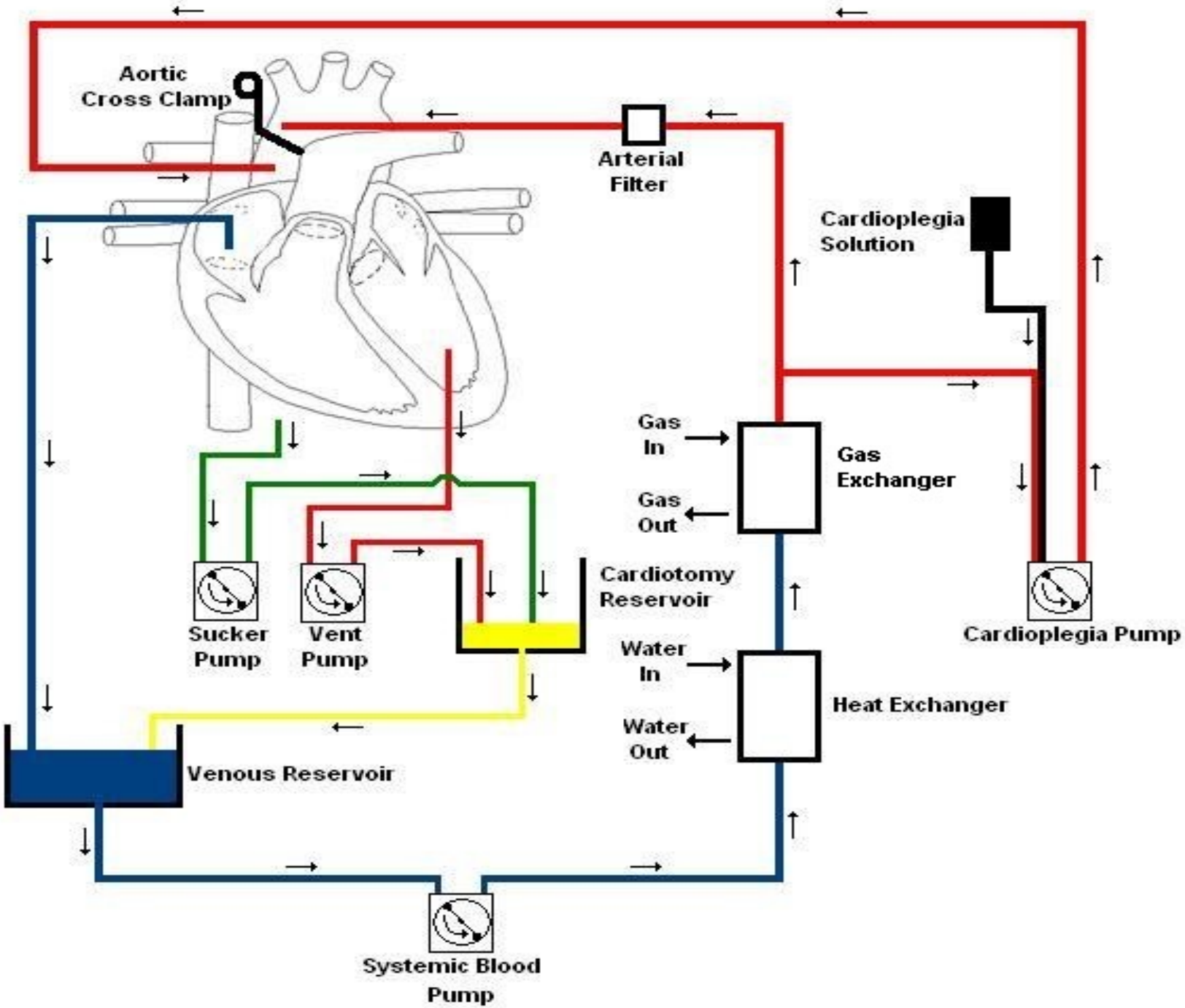

CPB CIRCUIT DESIGN

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Heart Lung Machine

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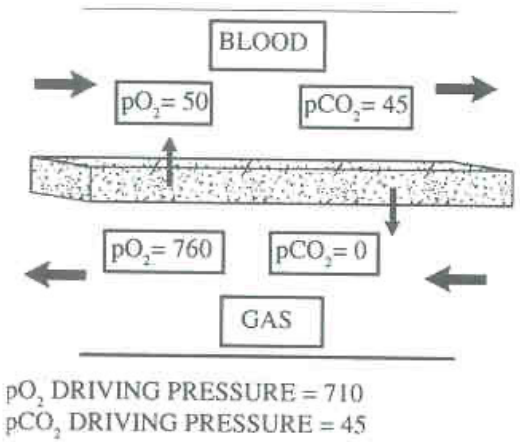
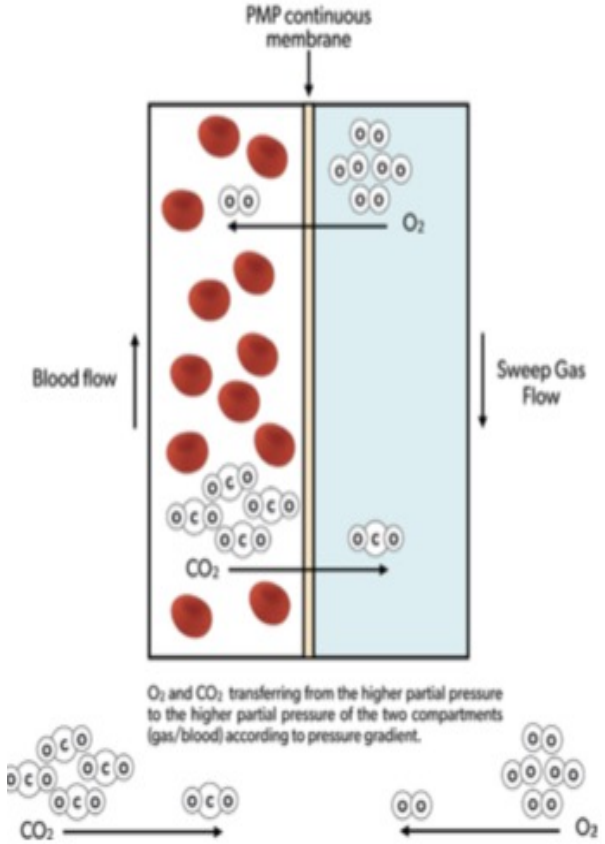
MEMBRANE OXYGENATOR (MO)





- Gas permeable
- Small surface area
- Increased diffusion distance
- Higher gas driving pressure required
- PaO_2 control
  - Adjust FiO_2 on gas blender
- $PaCO_2$ control
  - Adjust Sweep Gas Flow on gas blender

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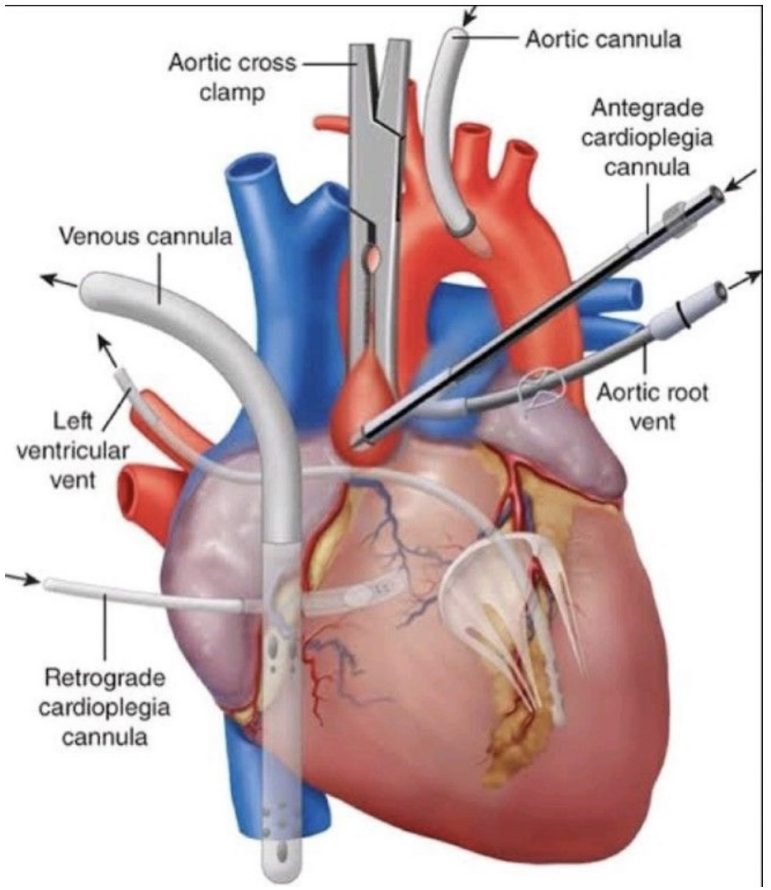
CIRCUIT PRIME

- Usually asanguinous for adult CPB
- Crystalloid solution
- Colloid solution?
- Heparin
- Sodium Bicarbonate?
- Mannitol?
- Blood products? RBCs, FFP, HAS

CANNULATION



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ACTIVATED CLOTTING TIME (ACT)

- Quick and ‘crude’ assessment of patient heparinisation status
- Increases available surface area for blood to clot via activator
- Activates clotting system via extrinsic (contact) pathway
- Baseline ACT : 90 -130 s
- CPB ACT : > 480 s

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INITIATION OF CPB

- Cannulae inserted
  - Correct position of arterial cannula -check pressure on aneroid gauge
- **Patient heparinized** - ACT > 480 s
- Slowly start ‘heart pump’ and release clamp from venous line
- Increase pump to full calculated blood flow rate
- Observe adequate venous drainage
- Observe arterial line pressure gauge
- Observe oxygenation of blood returning to patient
- Adjust heat exchanger temperature accordingly
- Full CPB
- Turn off ventilation

MONITORING DURING CPB

- Adequate venous reservoir level
- Venous return - SVC, IVC pressures, venous reservoir level
- Blood flow rate
- Oxygenation
- Arterial line pressure
- Perfusion pressure
- SvO_2
- Temperature
- Blood gases, electrolytes, glucose, haematocrit, acid-base balance
- ECG
- Anticoagulation status - ACT measurements
- Urine output

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MYOCARDIAL PROTECTION

- Enables procedures to be performed on the heart
- Allows a ‘controlled’ cardiac arrest period with motionless blood-free surgical field
- Hyperkalaemic cardioplegic solutions used - produce depolarized diastolic arrest of heart
  - Crystalloid cardioplegia
  - Blood cardioplegia
- Intermittent Fibrillation & Cross-clamp Technique

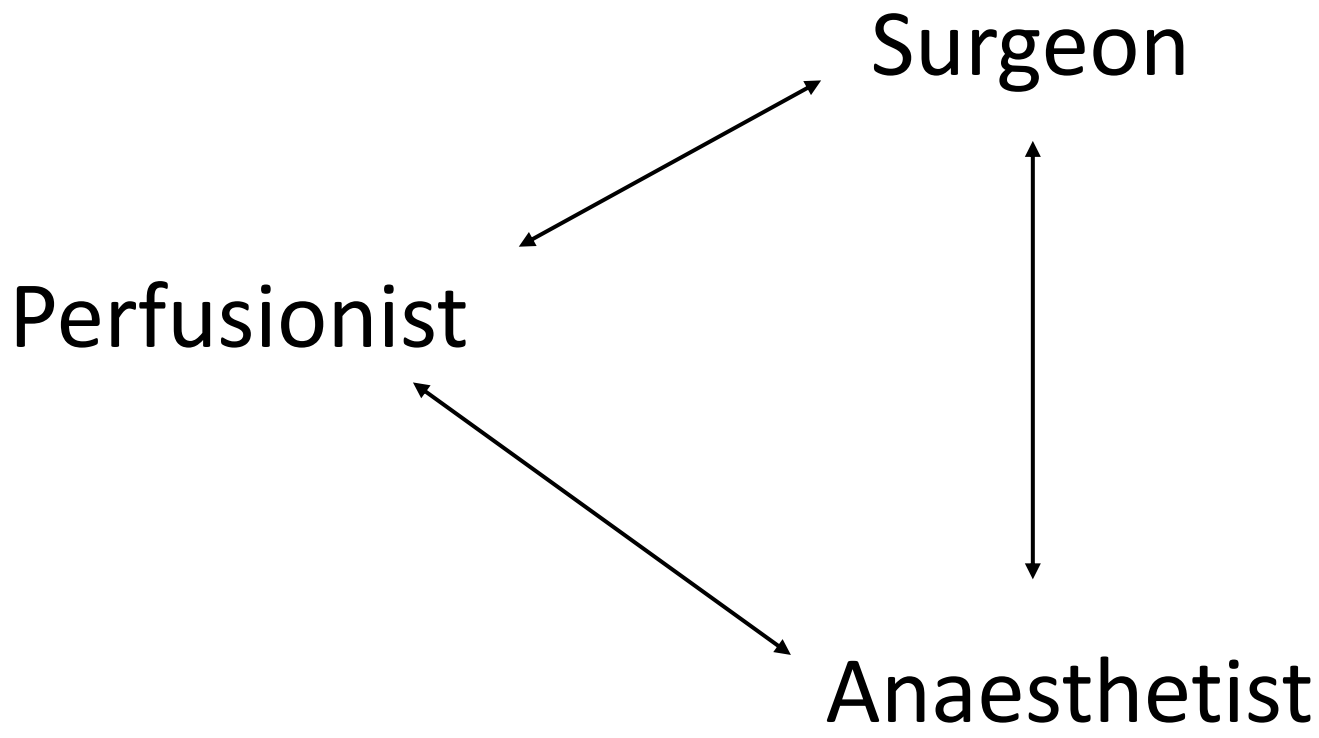
TEMPERATURE MANAGEMENT

- Hypothermic CPB
  - Mild (30-34^{o}C); Moderate (25-30^{o}C); Deep (15-22^{o}C)

- Normothermic CPB

Weaning from CPB

- Teamwork - names



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Weaning from CPB Checklist - TRIBAL

- Temperature
  - normothermic >36.5
- Rhythm
  - ideally SR, otherwise consider pacing
- Inotropes / reperfusion
  - how long has the cross clamp been off, are inotropes required?
- Blood gas
  - is it physiologically acceptable, can you optimise it?
- Alarms
  - are all the anaesthetic alarms reactivated?
- Lungs
  - is the ventilator on, 100% O2?

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WEANING FROM CPB

- Fill patient to pre-determined pressures
  - Systolic pressure ?
  - CVP ?
  - Empty / good ejection ?
  - Partially clamp venous (drainage) line
    - ¾ → ½ → ¼ Flow → Off CPB
  - Fully clamp venous (drainage) line
    - Off CPB
  - Patient stable
    - Cardiotomy (pump) suckers off
    - Administer protamine (slowly)
    - Check coagulation status
      - ACT
      - TEG
      - Clotting screen (Platelet count, Fibrinogen levels, INR etc)

Summary

- Team work
- TRIBAL

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