



A lifetime of specialist care

Royal Brompton & Harefield **NHS**
NHS Foundation Trust

The Cardiovascular System

By Ian Naldrett

AICU, Royal Brompton
Hospital

BACCN Southern Board



A lifetime of specialist care

Royal Brompton & Harefield
NHS Foundation Trust



Structure of discussion

The Pump

The Pipes

The Control System



A lifetime of specialist care

Royal Brompton & Harefield
NHS Foundation Trust



The Heart

- 4 Chambers
- 4 Key Valves
- Totally Divided –
Unless congenital
heart disease present





A lifetime of specialist care

The Chambers - Atria

- Atria – The left and right atria at the top of the heart are thin walled small chambers that facilitate the filling of the left and right ventricle.
- Characteristics – Weak, Thin walled, Easily damaged.





A lifetime of specialist care

The Chambers - Ventricles

Left ventricle

- The left ventricle powers the blood around the body
- The Left ventricular wall is thicker and more muscular
- The End diastolic volume of a RV is around 144mls

Right Ventricle

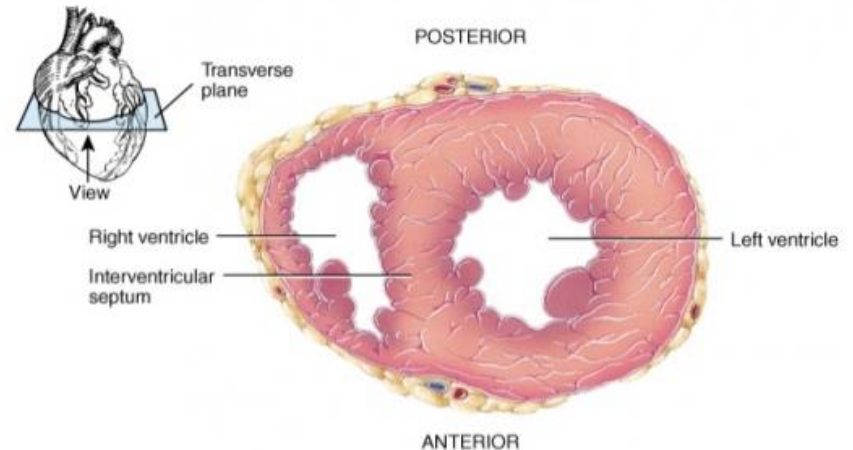
- The right ventricle powers blood around the lungs
- The right Ventricular wall is thin and easily damaged.
- The End diastolic volume of the LV is around 142mls



A lifetime of specialist care

Structure of the Ventricular wall

- The ventricular wall is made up of myocytes that contain sarcomeres.
- The myocardium is adapted to be resistant to fatigue and contains myoglobin that can store oxygen.

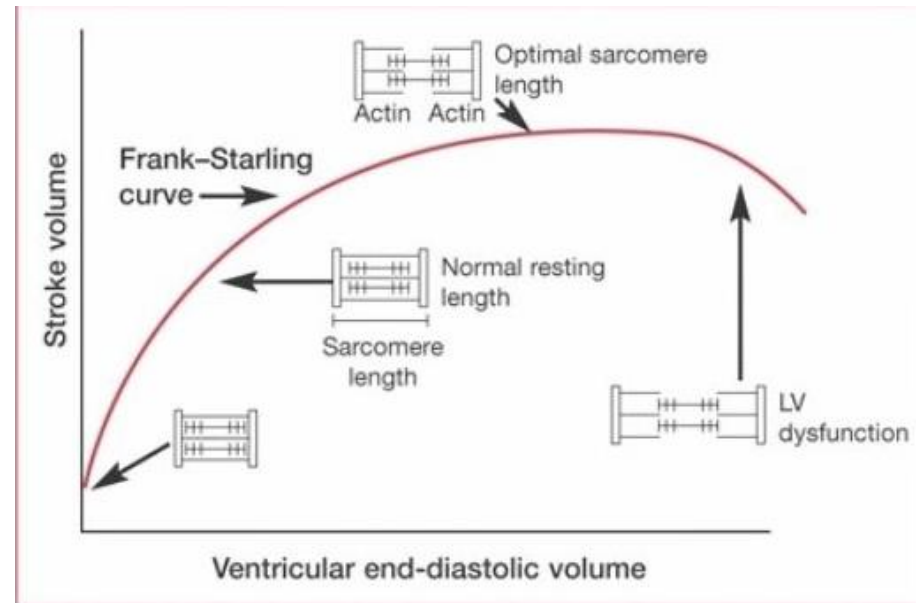




A lifetime of specialist care

Frank Starlings Law

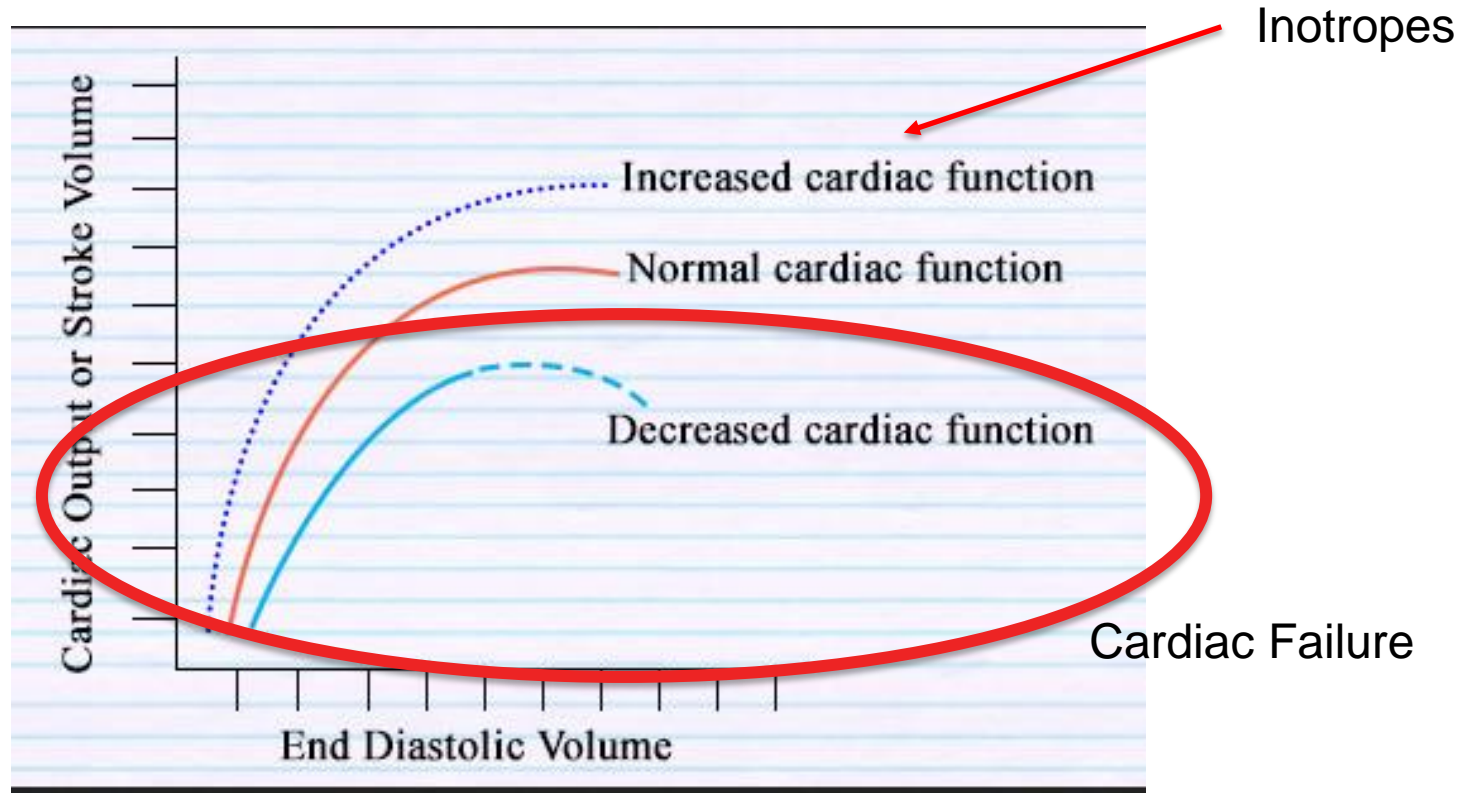
- A greater end-diastolic volume will increase contractile strength and will increase stroke volume
- More stretch= Greater volume
- Increased sensitivity to Calcium ions





A lifetime of specialist care

F-S Law in the failing Heart





A lifetime of specialist care

Royal Brompton & Harefield



NHS Foundation Trust

LV Failure causes

- Ischemia and Infarction
- Myocarditis (Viral)
- Dilated Cardiomyopathy
- Drug induced
- Adrenal Tumour
- Myocardial Stunning



A lifetime of specialist care

LV failure - signs

- Low Cardiac output – Echo/ CO studies
- Pulmonary Oedema
- Dyspnoea, failure to wean from ventilation
- Reduced Pulse pressure
- Metabolic – Lactate/BE-ve



A lifetime of specialist care

Royal Brompton & Harefield
NHS Foundation Trust



LV Failure – Treatment

- Treat underlying cause – MI? Arrhythmia
- Inotropic drugs – Milrinone, Dobutamine, Levosimendan
- Fluid reduction – Diuretics/CVVHDF
- Mechanical Support – LVAD, IABP, VA-ECMO



A lifetime of specialist care

RV failure - Causes

- Ischemia and Infarction
- Pulmonary Hypertension
- ARDS
- Ventilation/PEEP
- Tamponade/Pericardial collection



A lifetime of specialist care

RV Failure – Signs

- Assessment via patient and Echo –
- Low CO output – PA Catheter/Echo
- High CVP/JVP
- Liver Dysfunction –Hepatic Congestion
- Metabolic – Lactate/BE-ve



A lifetime of specialist care

RV Failure – Treatment

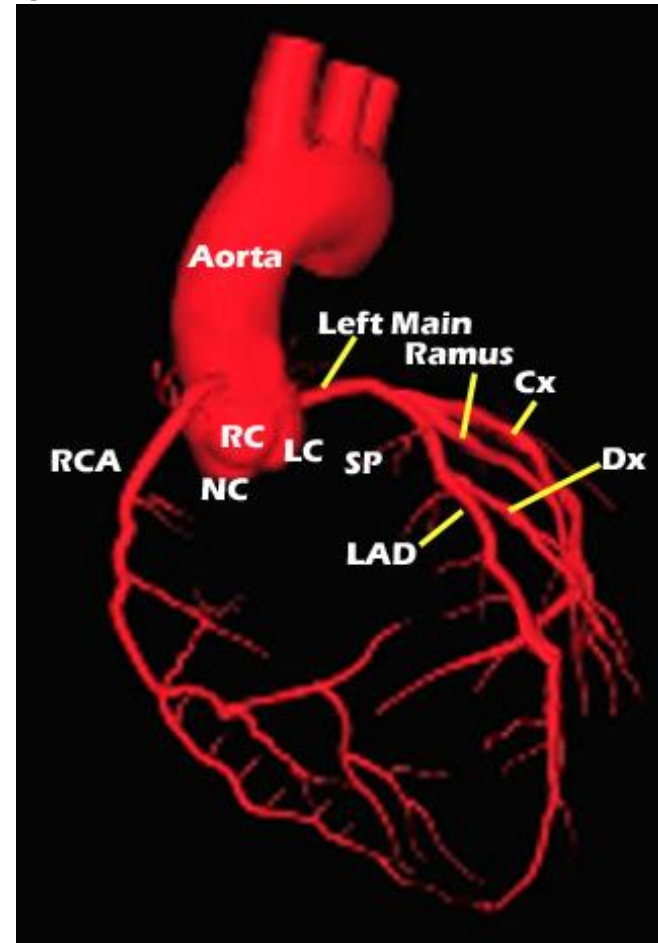
- Treat primary/secondary cause
- Volume replacement – Slow Fluid bolus
- Inotropic support – Low dose Adrenaline, Milrinone.
- Pulmonary Vasodilation – Sildenafil/ Nitric oxide therapy/Inhaled Epoprostinol
- Mechanical support – RVAD/VA ECMO



A lifetime of specialist care

Coronary Arterial Blood supply

- The coronary arteries are the oxygenated blood supply for the myocardium
- The relative blood supply is very large for the muscle size
- The Coronary arteries drain in to coronary sinus and in to right atrium





A lifetime of specialist care

Supply

Many things can affect the supply of blood to the coronary arteries

- Atherosclerosis – plaque formation/MI
- Low cardiac output poor perfusion
- Non Pulsatile flow
- Low CAO₂
- Congenital heart disease
- Cultural issues



A lifetime of specialist care

Demand

- The Demand blood supply to the coronary arteries can fluctuate due to.
- Tachyarrhythmia
- Sepsis – Hyperdynamic state
- Inotropic drugs – induced hyperdynamic state
- Ischemia



A lifetime of specialist care

Maintaining Supply in ICU

- Through assessment of Cardiac output – ECHO
- Correctly titrated Inotropic drugs
- Reducing CO in hyperdynamic states
- Timely treatment of Arrhythmia

Goal – Prevent Ischemia



A lifetime of specialist care

Royal Brompton & Harefield



NHS Foundation Trust

Structure of discussion

The Pump

The Pipes

The Control System



A lifetime of specialist care

Royal Brompton & Harefield



NHS Foundation Trust

Structure of Arteries

- Arteries have multiple layer and a small lumen
- Blood travels at high speed and under pressure
- Arteries are resistant to collapse



A lifetime of specialist care

Structure of Veins

- Less layers and muscle and large lumen
- Low speed/pressure system
- Veins collapse easily under pressure



A lifetime of specialist care

Royal Brompton & Harefield



NHS Foundation Trust

Capillary beds

- Tiny Lumen
- Low pressure
- Low Speed
- Capillary lumen 1 cell thick
- Easily thrombosed in critical illness
- Microvascular leak/clot common.



A lifetime of specialist care

Royal Brompton & Harefield
NHS Foundation Trust



Special Case – Pulmonary Arteries

- Low pressure artery
- Large flow – All of CO
- Deoxygenated blood
- Damaged easily
- Irreversibility of damage can be life limiting
- Treatment limited



A lifetime of specialist care

Royal Brompton & Harefield
NHS Foundation Trust



Structure of discussion

The Pump

The Pipes

The Control System



A lifetime of specialist care

Nervous system control

- Sympathetic Nerves –
Speed up HR
increasing CO
- Parasympathetic/Vagal nerves – Slow HR
Decreasing CO
- Numerous Hormonal control – Renin-Angiotensin II, Atrial Natriuretic Peptide. Etc.,.



A lifetime of specialist care

Control - Considerations for ICU

- Consider level of sedation
- Stimulation
- Suctioning -
- Altered Physiology
- Affect of Positive Pressure ventilation
- Valsava



A lifetime of specialist care

Royal Brompton & Harefield



NHS Foundation Trust



Many thanks for listening

Any Questions ?