Bristol Royal Hospital For Children
Faculty of Children's Nurse Education

South Wales and South West Congenital Heart Disease Network

NHS University Hospitals Bristol and Weston NHS Foundation Trust

Paediatric Cardiac Workbook

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With special thanks to
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Based on previous work by Sandra Batcheler, Cardiac/PICU Nurse Educator

Contents

Introduction

This workbook is designed to give you an overview of Paediatric Cardiology. There are several activities to complete throughout the workbook. The content may be new knowledge for some and revision for others.

Aimed at

This workbook is aimed at paediatric nurses working with patients who have congenital heart lesions within the South Wales and South West Network. It aims to cover basic anatomy and physiology of the heart as well as developing knowledge of common cardiac conditions.

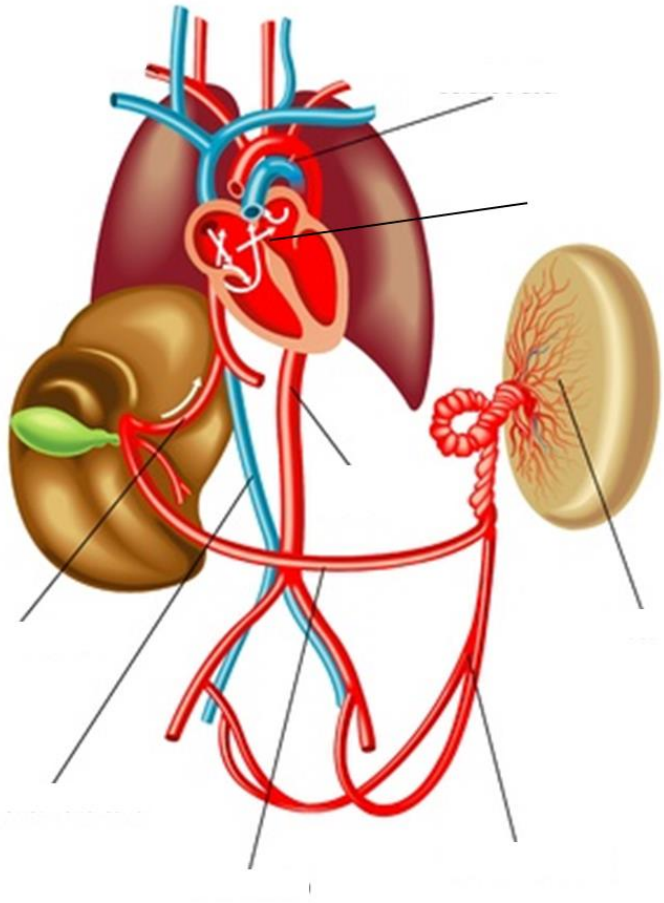
The answers should be discussed with your cardiac link nurse for your centre. This should be in partnership with the education available from the Faculty of Education at Bristol Royal Hospital for Children.

Learning Outcomes

On completing the workbook, you will be able to:

- Describe foetal circulation and explain the changes that take place after birth
- Discuss the relevance of these changes in relation to altered cardiac anatomy
- Identify the normal position of the heart within the thoracic cavity
- Label a diagram of the key structures of the normal heart and blood vessels
- Identify the key components of the conduction system of the heart and relate this to the ECG and the cardiac cycle
- Recognise common cardiac lesions and describe the altered anatomy and physiology

Foetal Circulation



On the diagram, identify the different components of foetal circulation using the following labels:

- Ductus arteriosus
- Foramen Ovale
- Ductus Venosus
- Placenta
- Inferior vena cava
- Umbilical Vein
- Umbilical Arteries
- Abdominal Aorta

Describe the changes which take place in the transition between foetal circulation and when the baby is born:

Maintaining the patency of the ductus arteriosus with Prostaglandins

In some circumstances it is catastrophic for the ductus arteriosus to close after birth due to abnormalities within the heart and circulation. In these infants an infusion of prostaglandin will be used to maintain the patency of the ductus arteriosus to allow mixing of the systemic and pulmonary blood circuits.

The foetus receives prostaglandin in-utero from the placenta. After birth either Alprostadil (Prostaglandin 1) or dinoprostone (Prostaglandin 2) can be used to maintain the patency of the duct. This is given as a continuous infusion centrally or peripherally, although it can be administered either via the intra-osseous route or orally. The absorption and efficacy via the enteral route can be unreliable so is usually avoided except for emergencies where intravenous access is unavailable or for longer-term use in a stable patient.

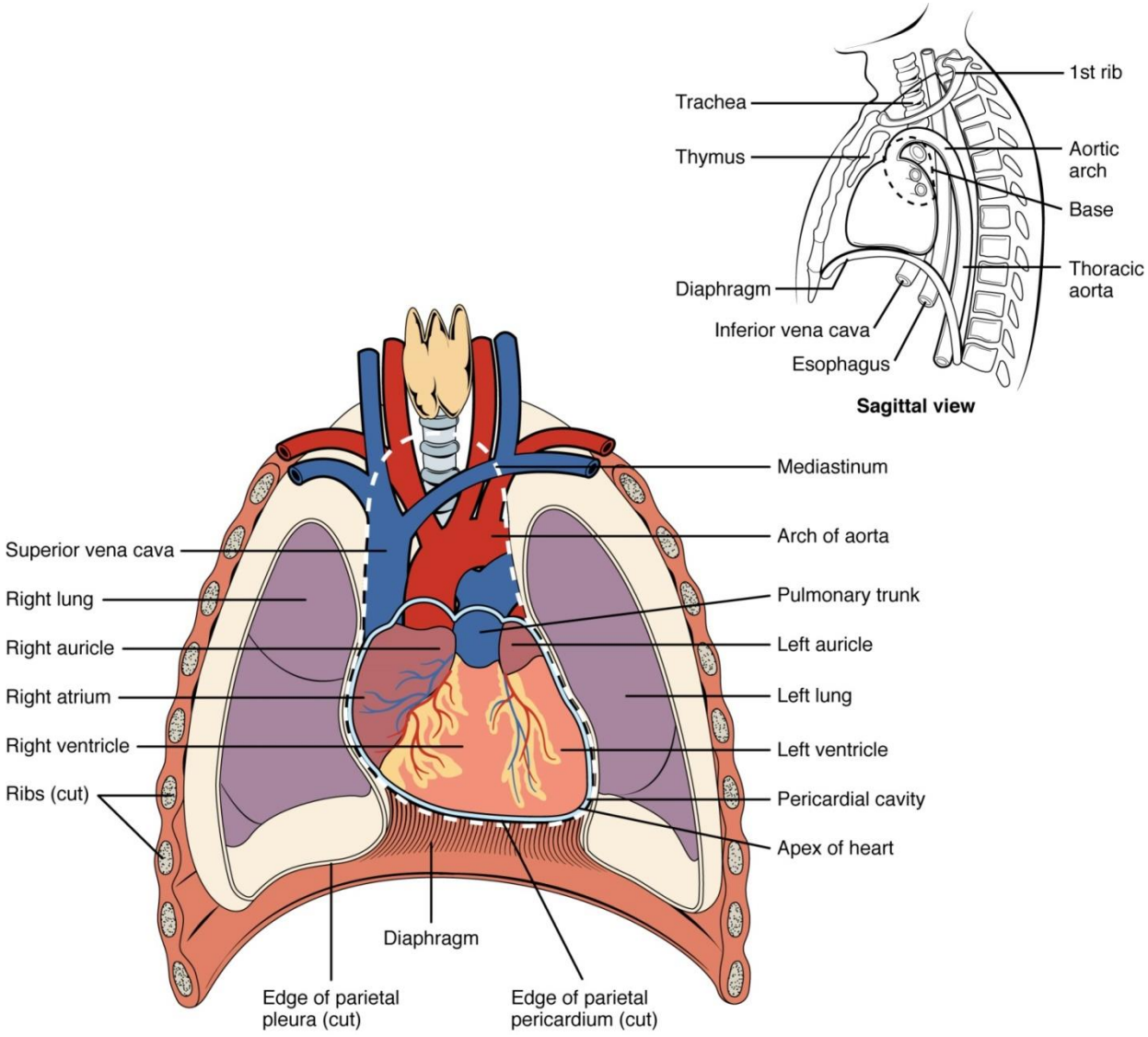
What cardiac conditions can you think of that may require prostaglandin to maintain ductal patency after birth?

What are the side-effects related to administration of dinoprostone (prostaglandin 2)?

Cardiac Anatomy

The heart is located in the thoracic cavity, in the mid-sternal region, with approximately two thirds of its mass to the left of the sternum. The heart is roughly the size of the person's closed fist.

The normal position of the cardiac apex is the 5th intercostal space in the mid-clavicular line
When the apex of the heart is positioned to the left it is described as levocardia. When the heart is described as dextrocardia it means that the apex is positioned to the right.



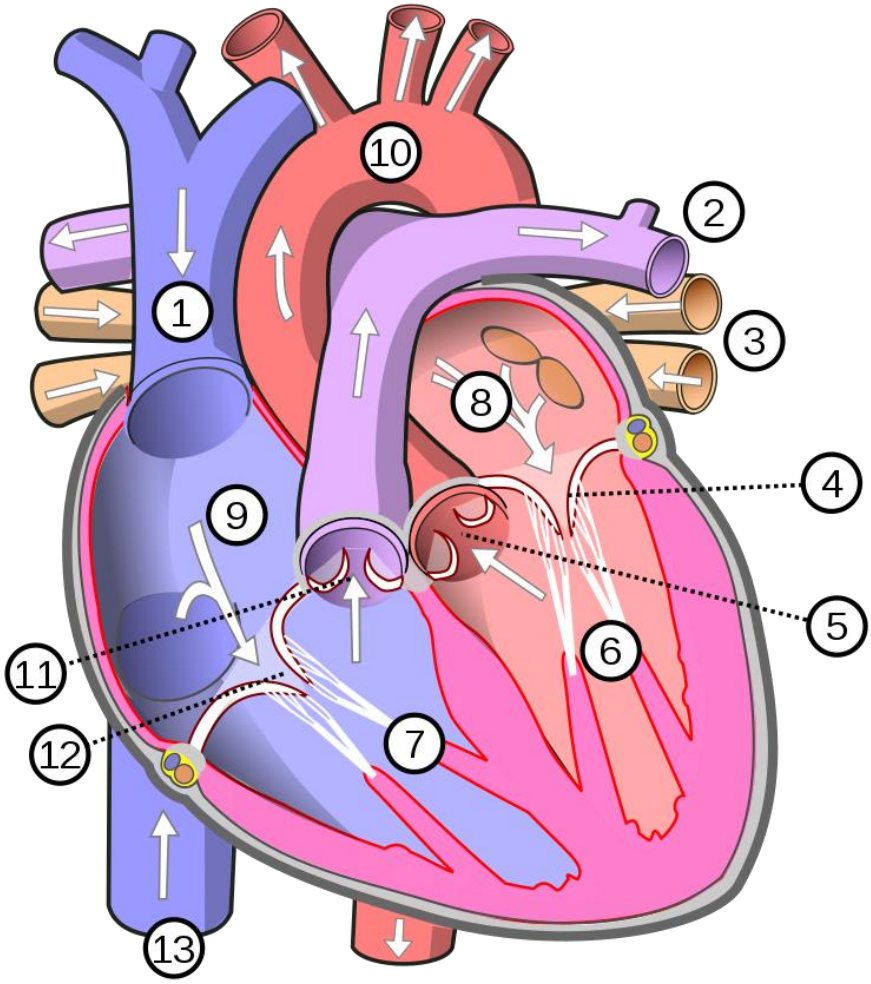
OpenStax College (https://commons.wikimedia.org/wiki/File:2001_Heart_Position_in_ThoraxN.jpg), „2001 Heart Position in ThoraxN", https://creativecommons.org/licenses/by/3.0/legalcode

Consider the size of a newborn's heart. What impact does this have on cardiac surgical and interventional cardiology procedures?

Considerations: Valve size, Conduit size, Weight of the patient

Structure of the Heart

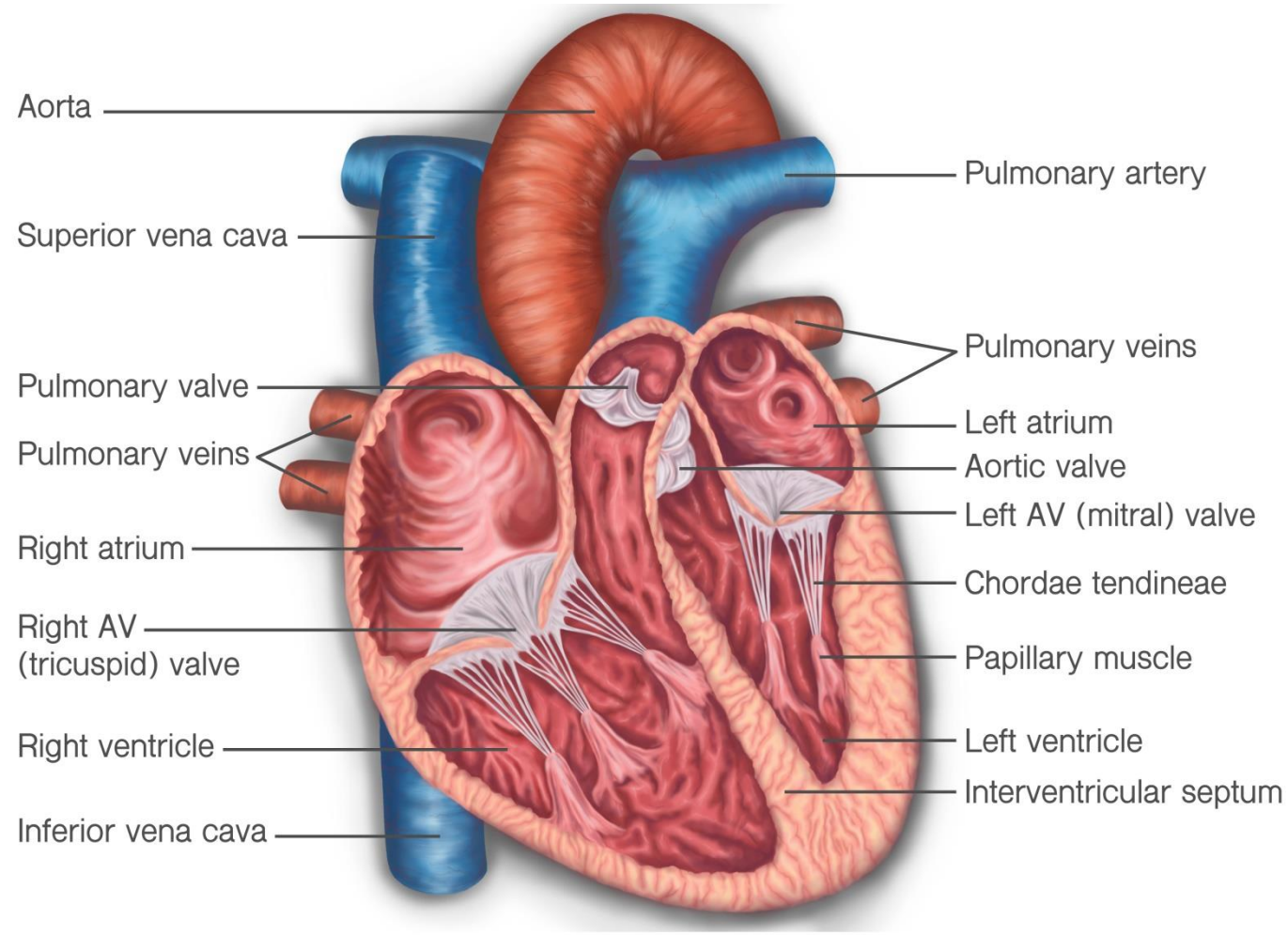
Label this diagram of the heart and draw the direction of the blood flow. Identify whether the blood is oxygenated or deoxygenated.



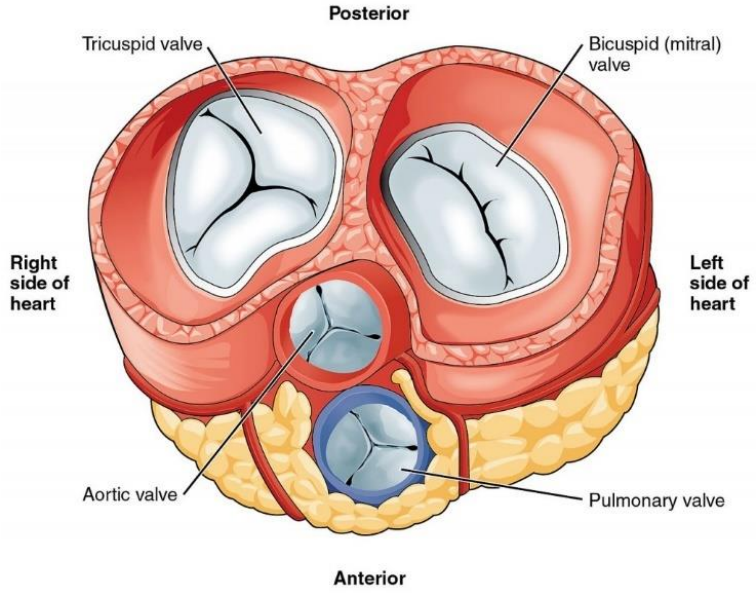
- Aorta
- Pulmonary Artery
- Superior Vena Cava
- Right Atrium
- Right Ventricle
- Left Atrium
- Left Ventricle
- Aortic Valve
- Pulmonary Valve
- Mitral Valve
- Tricuspid Valve
- Inferior Vena Cava
- Pulmonary veins

The Heart Valves

Valves prevent the back flow of blood within the heart. They separate the upper and lower chambers of the heart (atria and ventricles) and the ventricles from the great vessels.



The image below shows the four valves of the heart visible with the atria and great vessels removed.



OpenStax College (https://commons.wikimedia.org/wiki/File:2011_Heart_Valves.jpg), „2011 Heart Valves", https://creativecommons.org/licenses/by/3.0/legalcode

Name the two atrioventricular valves.

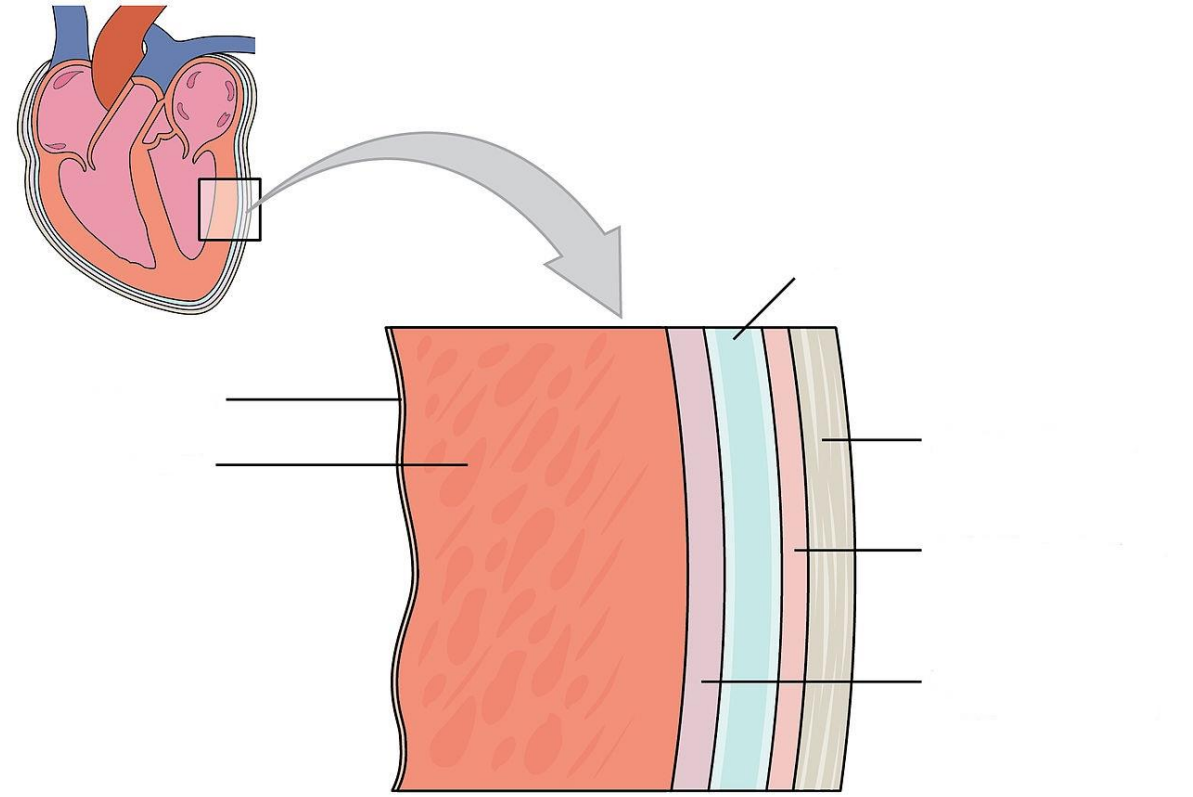
How many leaflets does each have?

Name the two semilunar valves.

How many leaflets does each have?

If the valves are 'incompetent', what does this mean and what is the consequence for blood flow?

Layers of the Heart



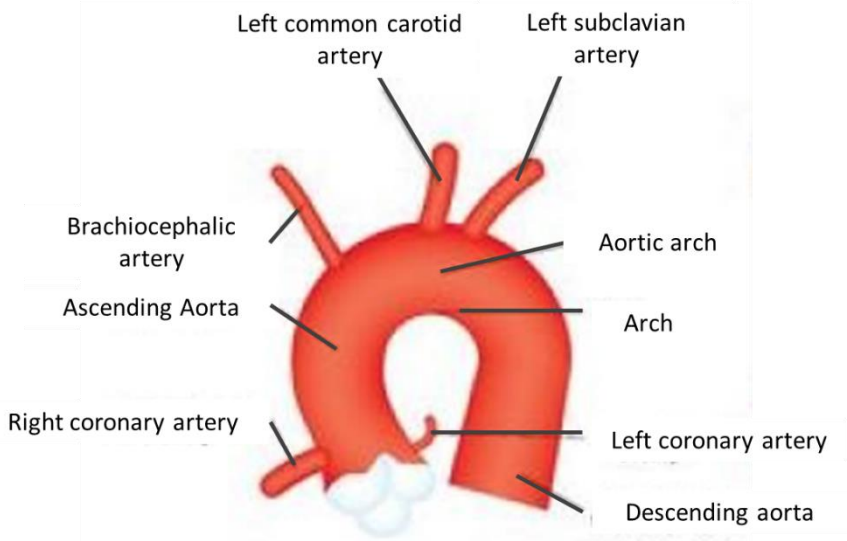
OpenStax College (https://commons.wikimedia.org/wiki/File:2004_Heart_Wall.jpg), „2004 Heart Wall", remove labels by Alison Wood, https://creativecommons.org/licenses/by/3.0/legalcode

Label the layers of the heart using the following labels:

Pericardial cavity
Fibrous pericardium
Parietal layer of serous pericardium
Visceral layer of serous pericardium (epicardium)
Endocardium
Myocardium

What is important about the structure of each of the layers in relation to their function?

Branches of the Aortic Arch



Major arteries Superior to the heart

Label the three vessels which arise from the aortic arch.

Where do the coronary arteries arise from?

What is the main difference when comparing coronary perfusion to systemic perfusion?

To where do the coronary veins drain?

Conduction System of the Heart

The heart possesses the property of auto rhythmicity, which means it generates its own electrical impulses and beats independently of nervous or hormonal control. It is supplied with both sympathetic and parasympathetic nerve fibres, which increase and decrease respectively the intrinsic heart rate.

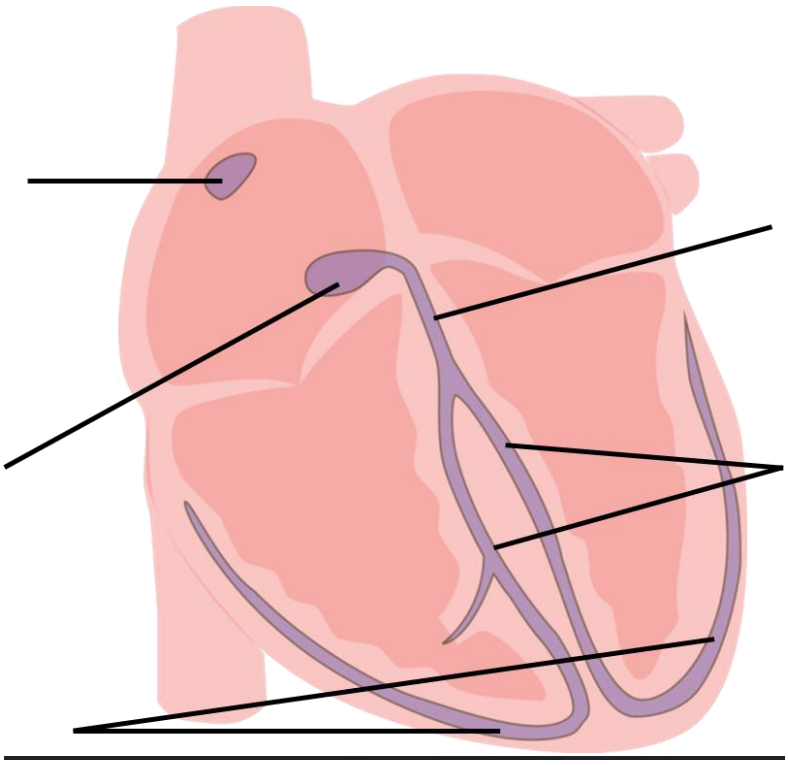
In addition, the heart responds to a number of circulating hormones, including adrenaline and thyroxine. Small groups of specialised neuromuscular cells in the myocardium initiate and conduct impulses, causing coordinated and synchronised contraction of the heart muscle.

Describe the pathway of the electrical impulse as it passes through the heart.

On this diagram (page 14) identify:

Sinoatrial node Atrioventricular node Bundle of His Purkinje Fibres

Right and Left Bundle Branches



U Bhalraam (https://commons.wikimedia.org/wiki/File:Heart_vector_electrical_rest.png), added labels blank by Alison Wood, https://creativecommons.org/licenses/by-sa/4.0/legalcode

Depolarization / Repolarization

Heart muscle cells are polarized at rest. The inside of the membrane is negatively charged due to ion concentrations being different on either sides of the cell membrane. During depolarization the cell undergoes a change in the electrical charge distribution resulting in a less negative charge inside the cell. This causes contraction of the cardiac myocyte and therefore contraction of the heart muscle.

Repolarization occurs as the cells return to their original, negatively-charged state and the cardiac muscle relaxes

PACEMAKER

The SA node is the heart's natural pacemaker. The SA node consists of a cluster of cells that are situated in the upper part of the wall of the right atrium (the right upper chamber of the heart). These cells are electrically unstable and discharge or depolarize regularly causing the atria to contract.

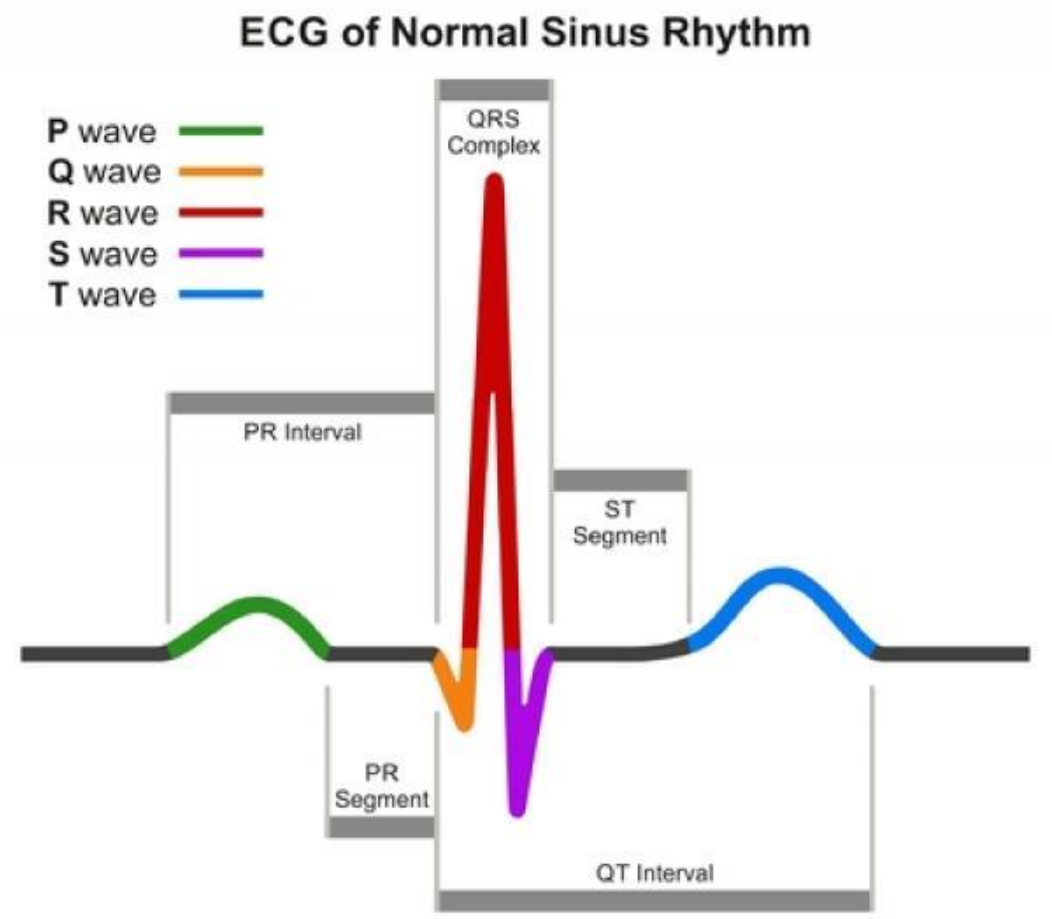
If the SA node suddenly stops working, however, the heart has "backup generators" that will take over. One of these backups is the atrioventricular node, which can maintain a heart rate of about 50 to 60 beats per minute. This is the rate that you may see in heart block.

Electrocardiogram (ECG)

The electrical activity within the heart can be detected with the use of an ECG monitor. The normal ECG pattern shows five waves with are identified using the letters P, Q, R, S and T.
P wave – the electrical impulse travels across the atria from the sino-atrial node to the atrioventricular (AV) node, initiating atrial contraction. This is followed by a pause where the electrical impulse is held by the AV node

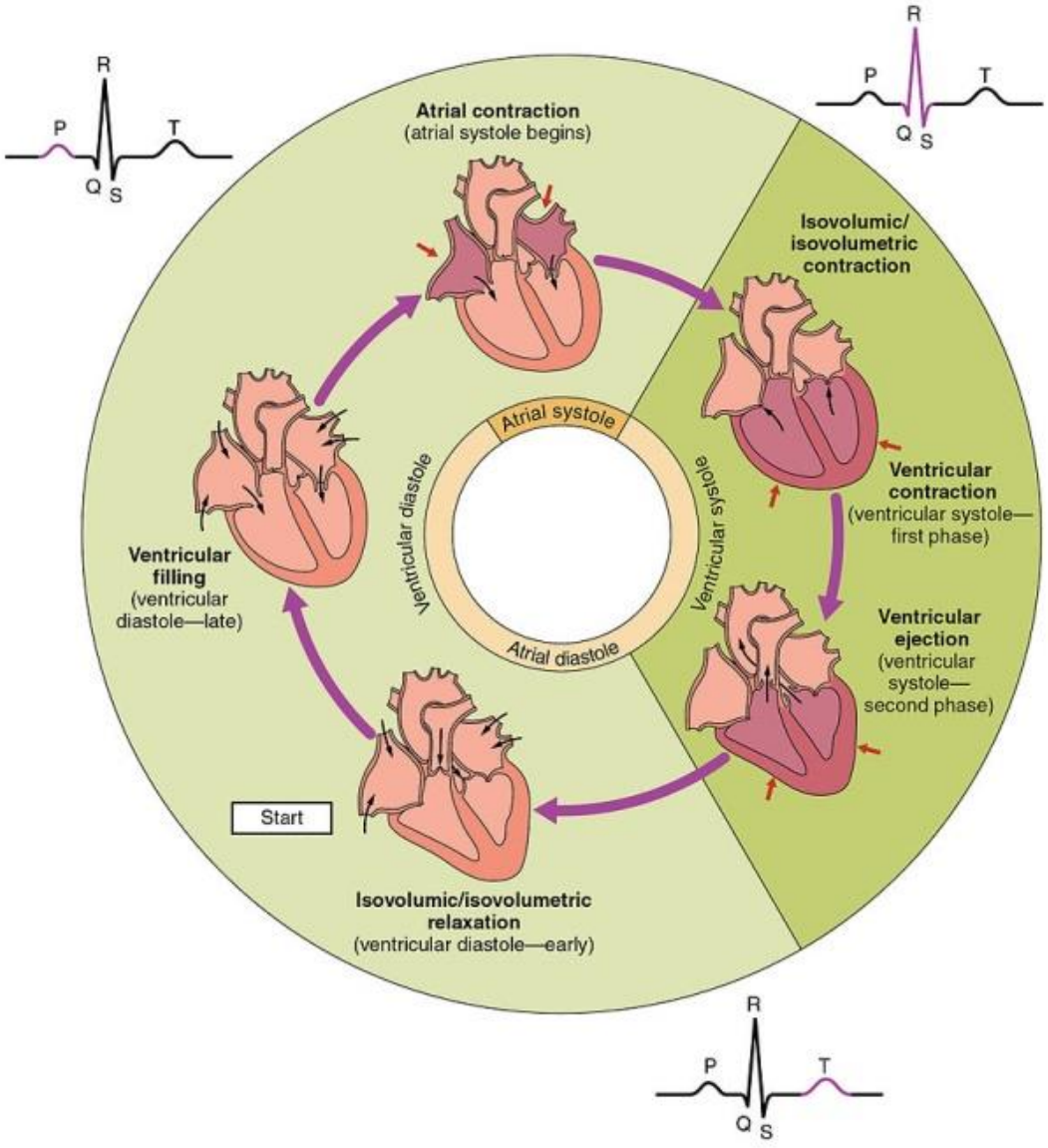
Q, R, S waves or complex – the impulse passes from the atrioventricular node, down the Bundle of His, the right and left bundle branches and through the Purkinje fibres. This electrical activity causes contraction of the ventricles

T wave – the ventricular muscle cells are repolarizing and the ventricles relax. Atrial repolarization is hidden on the ECG by the QRS complex



The Cardiac Cycle

The cardiac cycle refers to the complete process of filling and emptying the heart of blood from the beginning of one heart beat to the next. This comprises systole (contraction of the heart muscle) and diastole (relaxation of the heart muscle).



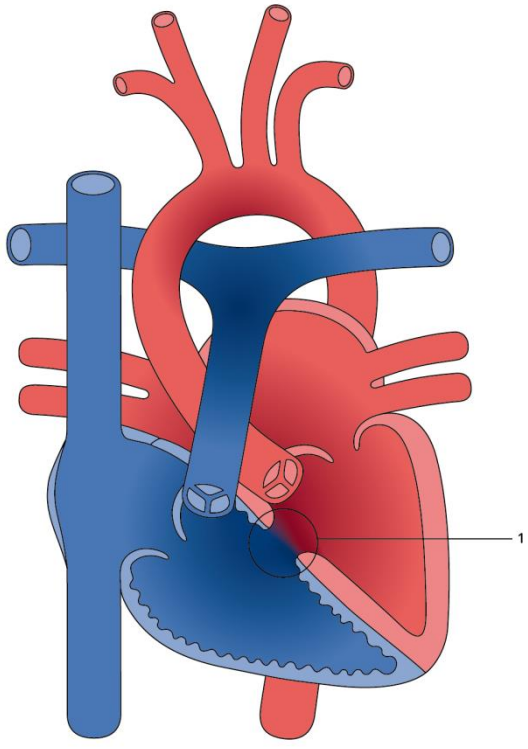
OpenStax College (https://commons.wikimedia.org/wiki/File:2027_Phases_of_the_Cardiac_Cycle.jpg), „2027 Phases of the Cardiac Cycle", https://creativecommons.org/licenses/by/3.0/legalcode

Describe the activity within the heart at each stage in the cardiac cycle represented in the diagram on page 17

Common Cardiac Conditions

There are a multitude of cardiac conditions and each child will present differently. There is a list of resources at the end of this workbook that will help you to find more information about different cardiac anomalies. Use the questions in the tables to help you gain a deeper understanding of the cardiac conditions listed.

VENTRICULAR SEPTAL DEFECT (VSD)



This is the most common congenital heart defect, affecting about a third of all patients with CHD and can often be present with other heart problems. The severity of the condition will vary from patient to patient. The defect may run in families and may also occur with other genetic problems such as chromosomal abnormalities.

1. **Describe the altered anatomy and blood flow of this defect**

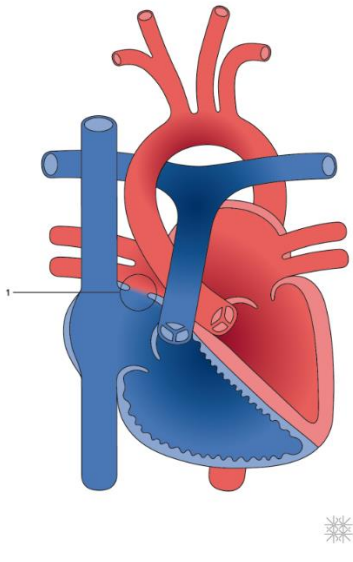
2. **What symptoms might you expect to see in a patient if this is not repaired?**

3. **What surgery/treatment is required?**

4. **What follow up/future treatment might they have**

ATRIAL SEPTAL DEFECT

Atrial septal defects are also relatively common, affecting up to 10% of patients with congenital heart disease. Spontaneous closure of the defect occurs by 2 years of age in 50% of cases detected in early infancy.



1. **Describe the altered anatomy and blood flow of this defect**

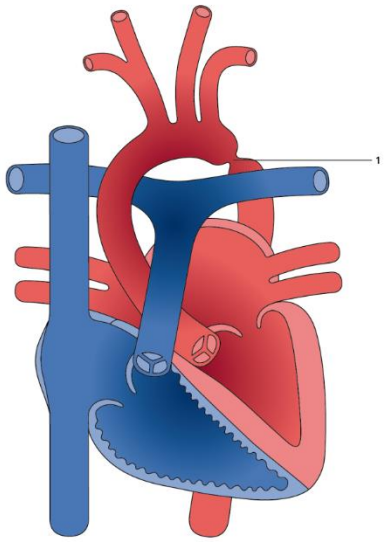
2. **What symptoms might you expect to see in a patient if this is not repaired?**

3. **What surgery/treatment is required?**

4. **What follow up/future treatment might they have?**

COARCTATION OF THE AORTA

Affecting approximately 6-8% of patients with congenital heart disease, coarctation is often difficult to diagnose antenatally, and babies with severe coarctation may present in the newborn period with acute collapse. Milder forms of the disease may not be evident until adult life.



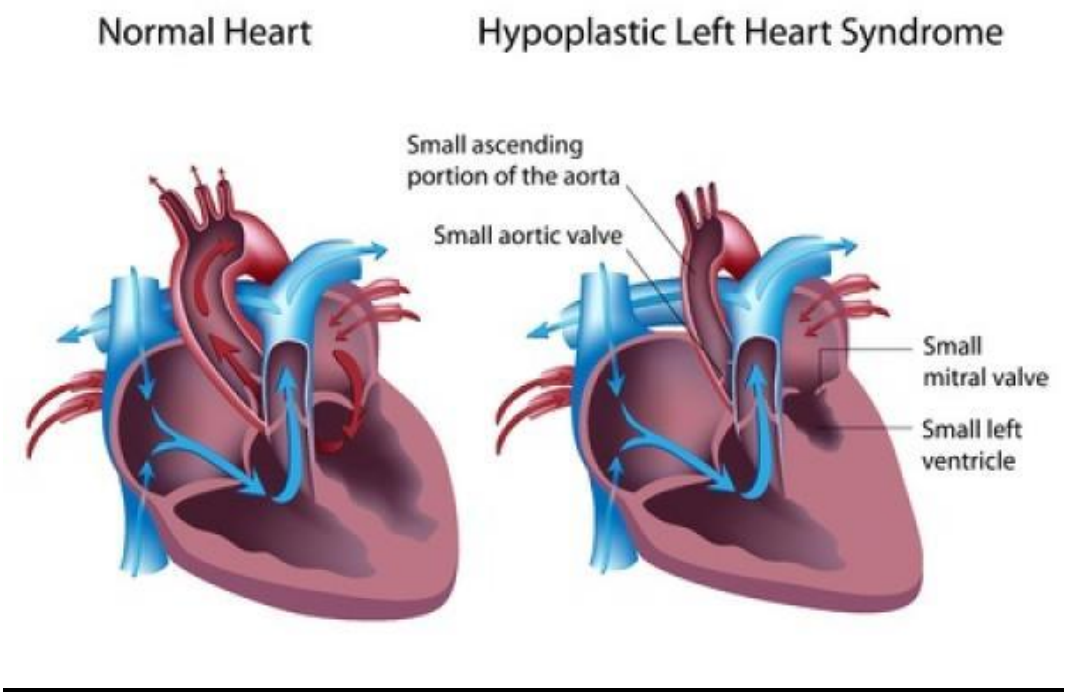
1. **Describe the altered anatomy and blood flow of this defect**

2. **What symptoms might you expect to see in a patient if this is not repaired?**

3. **What surgery/treatment is required?**

4. **What follow up/future treatment might they have?**

HYPOPLASTIC LEFT HEART SYNDROME (HLHS)



This condition is very rare (approximately 2% of all congenital heart defects) as well as being one of the most severe and for this reason is more complicated to repair. The term hypoplastic means 'not developed', therefore in hypoplastic left heart syndrome, the left ventricle (the main pumping chamber) and other left sided structures of the heart have not formed adequately to support blood flow to the body.

HLHS is fatal without early intervention and requires frequent monitoring throughout infancy and early childhood to minimise the risk factors. The outcomes for this condition throughout adult life are not yet known as the surgical repair (the Norwood operation) was not established until 1980s. Increasing numbers of young people with this condition are now transferring to adult services.

1. **Describe the altered anatomy and blood flow of this defect**

2. **What symptoms might you expect to see in a patient if this is not repaired?**

3. **What surgery/treatment is required (in each stage)?**

4. **What follow up/future treatment might they have?**

Can you answer these questions for other cardiac conditions you have come across (think of the 8 common lesions):

- AVSD
- Tetralogy of Fallots
- Transposition of the Great Arteries
- Aortic Stenosis
- Pulmonary Stenosis

Useful Information

OXYGEN

Many people ask when they should give oxygen to patients with cardiac defects or, more importantly, when should it be avoided.

Firstly, it is necessary to understand the effect that oxygen has on the pulmonary vasculature and what impact that will have on the blood flow for the patient depending on their anatomy. Oxygen causes vasodilation within the pulmonary circulation and therefore will reduce pulmonary blood pressure. When a patient has a heart problem that has increased pulmonary blood flow, such as a VSD, then reducing the pulmonary pressures can further increase the left to right shunt of blood within the heart. This causes even more blood to flow to the lungs and will exacerbate respiratory compromise. In patients with cyanotic heart lesions this vasodilation may cause 'pulmonary steal' where more blood flows to the lungs and there is an inadequate blood supply to the rest of the body's vital organs.

It is also important to remember that an increase in oxygen pressures will cause constriction of the ductus arteriosus, so oxygen administration should be avoided in patients who are receiving a dinoprostone infusion to maintain patency of the duct.

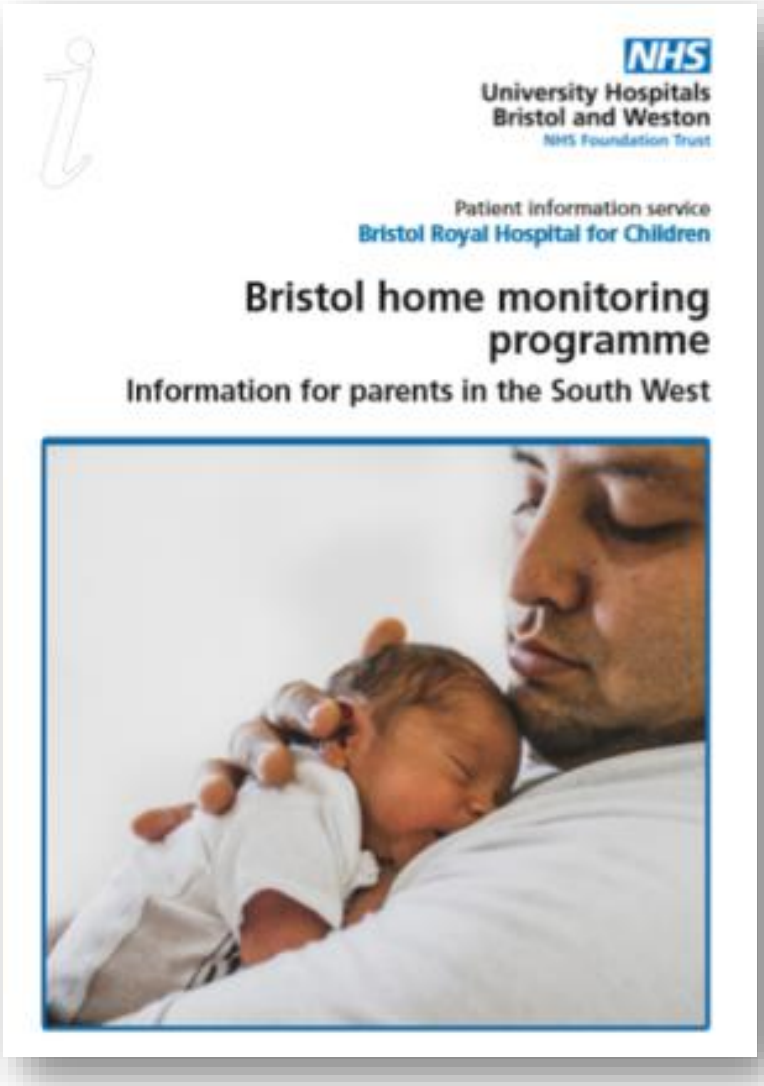
REMEMBER

Give oxygen in an emergency situation

Think about the effect of giving oxygen on the pressures of the heart in relation to blood flow.

The Bristol Cardiac Home monitoring programme is for babies who have a variety of heart defects or lesions that have required palliative surgery/intervention which puts them at high risk for sudden collapse at home.

Once discharged home the child will require saturation monitoring and weight management as prescribed by the cardiac medical team. The parameters are those acceptable for that child in the community.



Contacts based at Bristol Royal Hospital for Children:

Sheena Vernon, Lead Nurse, Congenital Heart Disease Network: Sheena.Vernon@uhbw.nhs.uk

Jess Hughes, Lead Nurse, Congenital Heart Disease Network: Jessica.Hughes@uhbw.nhs.uk

Cardiac Nurse Specialist Team: 0117 3428286

Zoe Trotman, Ward Manager, Dolphin Ward: 0117 3428332

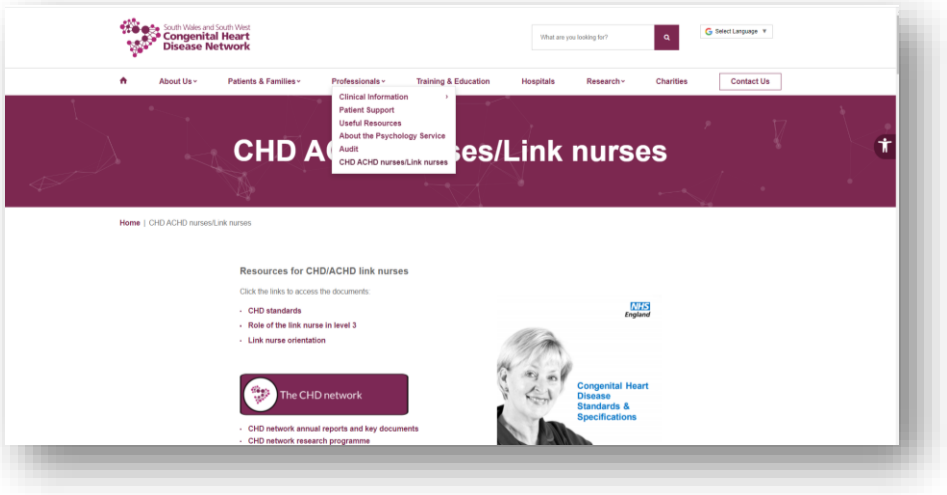
Alison Wood, Cardiac Nurse Educator: alison.wood@uhbw.nhs.uk

Carla Sims and Suzanne Conner, Clinical Support Facilitator, Dolphin Ward: 0117 3428332

Faculty of Children's Nurse Education: FacultyOfChildrensNurseEducation@uhbw.nhs.uk

South Wales and South West CHD Network Website

- Visit the website: **www.swswchd.co.uk**



- Once on the network website: hold your curser over the 'professionals' tab which will then show a drop-down menu

- Click on CHD/ACHD Nurses/Link Nurses

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www.nottingham.ac.uk Cardiology Teaching Package. Available from: http://www.nottingham.ac.uk/nursing/practice/resources/cardiology/function/sinus_tachycardia.php [Accessed 27th July 2020]

Cardiac Education Courses

There are cardiac modules available through the Faculty of Children's Nurse Education, based at Bristol Royal Hospital for Children, which you may wish to undertake to increase your knowledge of cardiac anomalies. These are led by the Cardiac Nurse Educator, Alison Wood, who is an experienced cardiac ward nurse.

Children's Cardiac Nursing 1 course covers foundation knowledge of normal cardiac anatomy and physiology, ECG and arrhythmias, as well as considering the common cardiac defects and the care pathways for these patients. This course would be suitable for registered paediatric nurses working regularly with children with infants and children with congenital heart conditions.
Children's Cardiac Nursing 2 is an advanced course aimed at developing a deeper level of understanding of heart conditions including some of the less common defects. This course would suit paediatric nurses working within either a cardiac speciality area or a Paediatric Intensive Care Unit which frequently provides care for children with heart conditions.

For more details you can email directly (alison.wood@uhbw.nhs.uk) or for course dates and availability contact the course administrator (FacultyOfChildrensNurseEducation@uhbw.nhs.uk).

Key Resources - Literature

- Aaronson, P.I., Ward, J.P.T. and Connolly, M.J. (2013) The Cardiovascular System at a Glance (4th Ed.). Chichester: Wiley-Blackwell.
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Key Resources – Journals

- American Heart Journal
- Archives of Diseases in Childhood
- British Journal of Nursing
- European Heart Journal
- European Journal of Heart Failure
- Evidence-based child health
- Evidence Based Nursing
- Intensive and Critical Care Nursing
- Issues in Comprehensive Paediatric Nursing
- Journal of Child Health Care
- Journal of Clinical Nursing
- Journal of Advanced Nursing
- Journal of Paediatrics
- Journal of Paediatrics and Child Health
- Journal of Paediatric Nursing
- Nursing in Critical Care
- Paediatrics and Child Health
- Paediatric Clinics of North America
- Paediatric Nursing

Key Resources - Websites

- http://mmcts.oxfordjournals.org
- http://www.swswchd.co.uk
- http://www.dh.gov.uk
- http://www.nice.org.uk
- http://www.nmc-uk.org
- http://www.pted.org/
- http://www.rcn.org.uk
- http://www.resus.org.uk

Cardiac Charities

- British Heart Foundation: https://www.bhf.org.uk/informationsupport/conditions/congenital-heart-disease

- Heart Heroes: https://www.heartheroes.co.uk

- Little Heart Matters: https://www.lhm.org.uk

- Youth at Heart: https://www.youthatheart.co.uk

A printer friendly version of this poster is available for download from the network website: www.swswchd.co.uk

A printer friendly version of this poster is available for download on the network website www.swswchd.co.uk

Feedback on our Cardiac Workbook

We would love feedback on our work book. Please email carla.sims@uhbw.nhs.uk with any suggestions of improvements/material you would like us to add that would be useful.

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We hope you have enhanced your Paediatric Cardiac Knowledge by completing our Cardiac Workbook

Thank you