

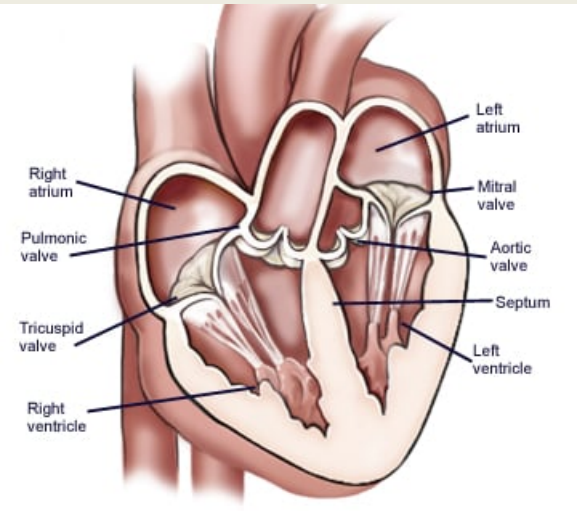
Medicine for Managers

Dr Paul Lambden BSc MB BS BDS FDSRCS MRCS LRCP DRCOG MHSM

Valves of the Heart

The heart has four chambers through which blood circulates. There are two atria, which are the upper chambers, and two ventricles, which are the lower chambers. Blood passes through one of the valves as it leaves each chamber of the heart and each valve is in effect a non-return blood flow regulator, opening and closing when required, allowing the blood to pass into the next part of the system.

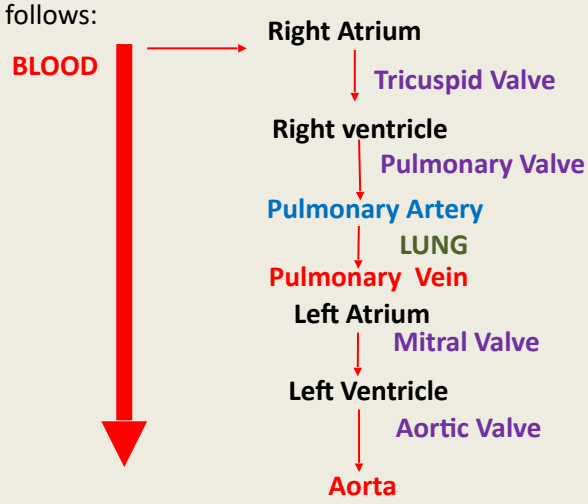
Let us start with a little revision of the structure and operation of the heart



[Diagram from Cleveland Clinic]

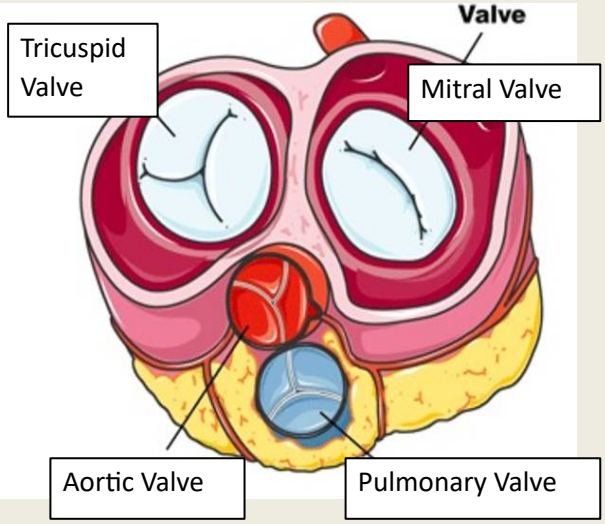
Blood enters the right side of the heart from the body through the great veins and passes into the right atrium. The blood then passes through the ***tricuspid valve*** into the right ventricle and on in the pulmonary artery to the lungs, passing through the ***pulmonary valve***. After the blood is oxygenated in the lungs it re-enters the heart through the pulmonary vein into the left atrium. It then passes through the ***mitral valve*** into the left ventricle and then out into the aorta through the ***aortic valve***.

The passage of blood through the heart occurs because the chambers of the heart contract and relax in sequence to push the de-oxygenated blood into the lungs and the oxygenated blood into the aorta and thence round the body. This is facilitated by the valves which open, as each chamber contracts, to allow the blood to pass into the next part of the system. When the chamber has emptied, the valve then closes to stop the blood moving backwards into that chamber. So, the movement of the blood is as follows:



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The valve action is co-ordinated in order to achieve the flow required. Therefore, for example, when the right ventricle is filled and contracts to pass blood into the pulmonary artery, the pulmonary valve opens to allow forward flow and the tricuspid valve closes to prevent backward flow. Similarly, when the left ventricle contracts to pass blood to the body via the aorta, the aortic valve opens and the mitral valve closes.



All the valves have three cusps (except the mitral valve between the left atrium and the left ventricle which has two). The cusps are composed of tough sheets of connective tissue and act like flaps. They only open in one direction allowing blood to pass onwards through the valve but closing to prevent backflow.

Heart valvular disease occurs when the valves do not work efficiently and allows blood to leak through when they should be closed. If a valve becomes diseased it may malfunction in one of two ways. It may fail to close properly causing ***regurgitation*** (leakage) of the valve resulting in blood flowing backwards from the ventricles to the atria (in the case of the mitral and tricuspid valves) and from to great blood vessels into the ventricles (in the case of the aortic and pulmonary valves). If the valves become damaged through infection or scarring the result is ***narrowing*** (***stenosis***) which impedes the passage of blood forwards out of the atria or ventricles. The result is that the heart must pump harder to push the blood onwards. Such conditions may affect one or more of the valves and both malfunctions may exist in any one valve at the same time.

The causes of heart valve disease may include:

- Changes due to aging
- Coronary artery disease and heart attack
- Bacterial endocarditis
- Birth defect
- Other diseases such as syphilis

In mild valvular disorders there may be no symptoms. In more severe cases of valvular damage the patient may experience palpitations, fatigue or dizziness and may show signs of heart failure such as breathlessness or ankle swelling. In the particular case of ***bacterial endocarditis,*** which is an infection affecting the inner lining of the heart and the valves, the symptoms may be accompanied by a persistent fever.

Diagnosis may be made using a number of methods.

- Examination of the patient may demonstrate heart failure and applying a stethoscope to the chest will allow the doctor to hear the changes associated with valve malfunction, associated with blood turbulence as the blood passes over the valve.
  Such changes are called ***murmurs*** which may be easy or difficult to hear.
  The nature and timing of the murmur will allow a doctor (particularly a specialist cardiologist) to identify the valve affected and the type of abnormality.

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Other tests will include:

- ***Electrocardiogram*** (recording of the heart's electrical activity) and a ***chest X-ray***.
- ***Stress test*** where the patient is exercised on a treadmill and the electrical activity of the heart, heart rate and blood pressure are monitored.
- ***Echocardiogram*****.** A non-invasive test using sound waves to evaluate the heart's chambers and valves. The echo sound waves create an image on a monitor as the transducer is passed over the heart. Many feel that this is the best test to evaluate heart function.
- ***Transoesophageal echocardiogram***. In this investigation, the transducer is passed down the oesophagus. Again images are created on a monitor and avoid the lungs or ribs obstructing the image.
- ***Cardiac catheterisation***. In this simple procedure a catheter is passed via the blood vessels into the heart to measure pressure abnormalities or to identify backflow using radio-opaque dye which can demonstrate respectively stenosis or regurgitation.
- ***CT scan***, enhanced by the use of contrast medium such as ***rubidium,*** and ***Magnetic Resonance Imaging*** can be used to produce detailed heart images.

The degree of efficiency of the heart can be measured by the ***ejection fraction,*** which is the volume of blood as a proportion of the predicted amount which is pumped out of the heart when it contracts.

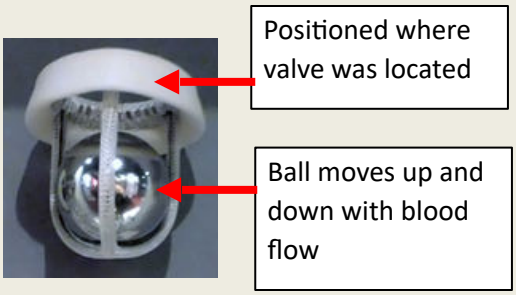
Treatment of valvular disease depends on the severity and the general condition of the patient. Treatments include:

- ***Medication*** Drugs such as digoxin, beta-blockers and calcium channel blockers reduce symptoms by controlling heart rate, improving the contraction force and preventing abnormal rhythms. Anti-hypertensives and diuretics (water tablets), control blood pressure and avoid fluid accumulation.

- ***Surgery***. Repairs or replaces heart valves.
  Repair. Can be carried out by remodelling valves or inserting prosthetic rings.
  Replacement. The operation of choice when valves are severely malformed or destroyed. Replacement valves may be made of animal valvular tissue, donated human valves, or mechanical valves consisting of metal, plastic or other material.
- ***Balloon valvuloplasty***. A catheter is passed from the groin into the heart. The tip of the balloon is guided into the heart valve. Once in place the balloon is inflated to stretch the valve and open it further. It is used to treat pulmonary stenosis and sometimes aortic stenosis.

I cannot finish an article on heart valve disease and treatment without mentioning the ***Starr-Edwards Valve***.

In the 1960s, the Starr-Edwards valve was the first artificial heart valve to be successfully implanted into humans. It consists of a ball in a chamber. The circular ring is placed in the heart where the damaged valve was



formerly located. The ball moves up when blood pushes it but seals the opening when blood

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presses on it from the other side. A number of other designs of prosthetic (artificial) valves are also available.

Though it has ceased to be used now, it was used for decades with outstanding results.

Patients whose life expectancy had previously been short acquired a good prognosis with this development.

It is being identified today in patients in whom these valves are still functioning well after more than forty years.

In part, I owe my qualification as a doctor to a Starr-Edwards valve. Preparing for my final medical practical examination, I joined a medical registrar's round in Farnborough Hospital in Kent.

He excitedly demonstrated a patient's chest and when I listened I heard a sort of whirring noise with a marked 'clunk' on each beat. It was absolutely distinctive.

The registrar introduced me to my first Starr-Edwards valve. The following day, in the Guy's Hospital examination room, I was apprehensive about the practical exam.

Imagine my relief when the examiner said, "go and listen to that chest", and, when I applied the stethoscope, I heard a whirring sound with a 'clunk' on each beat. Two Starr-Edwards valves in two days, and the first of a number in subsequent years. It proves that, as a doctor, you need luck!

paullambden@compuserve.com

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