

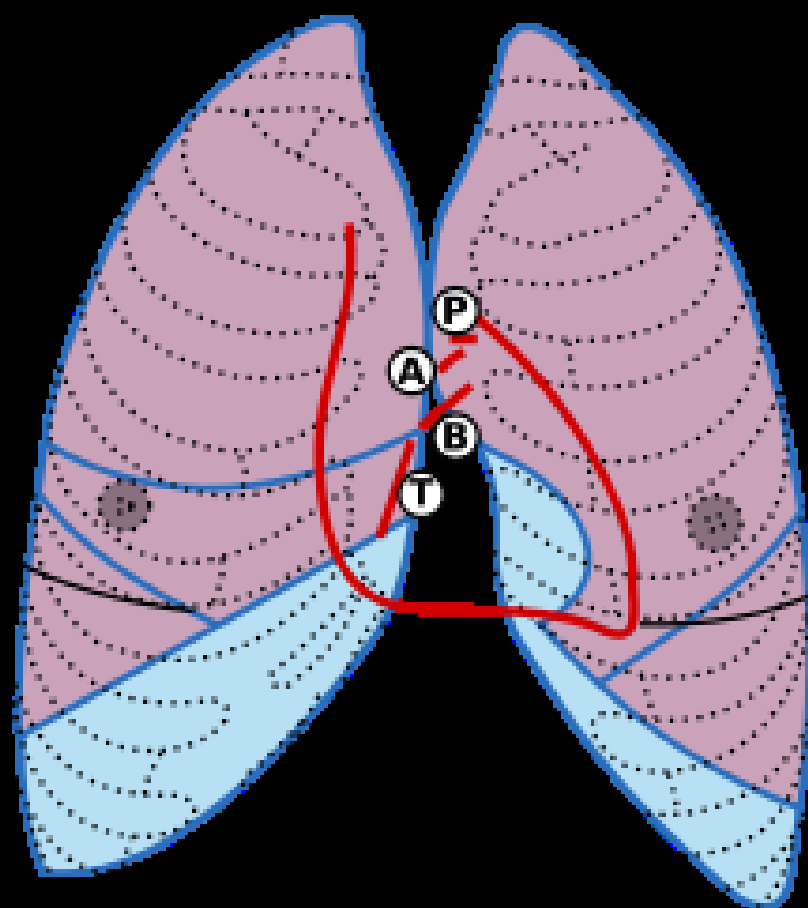
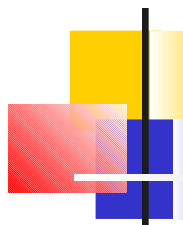


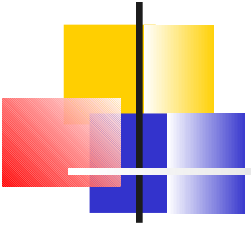
*Physiology & applied aspects
of Heart sounds*



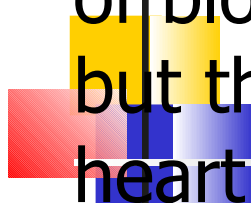
HEART SOUNDS

- The **heart sounds** are the noises (sound) generated by the beating heart and the resultant flow of blood through it. This is also called a **heartbeat**.
- In cardiac auscultation, an examiner uses a stethoscope to listen for these sounds, which provide important information about the condition of the heart.

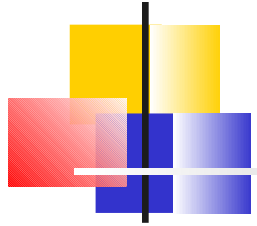




- In healthy adults, there are two **normal heart sounds** often described as a *lub* and a *dub* (or *dup*), that occur in sequence with each heart beat.
- These are the **first heart sound** (S1) and **second heart sound** (S2), produced by the turbulent flow against the closed AV valves and semilunar valves respectively.
- In addition to these normal sounds, a variety of other sounds may be present including *heart murmurs* and *adventitious sounds*.

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- Heart murmurs are also generated by turbulent flow of blood, which may occur inside or outside the heart, but the sound has different characteristics than normal heart sounds.
 - Murmurs may be *physiological* (benign) or *pathological* (abnormal).
 - Abnormal murmurs can be caused by stenosis restricting the opening of a heart valve, resulting in turbulence as blood flows through it.
 - Valve *insufficiency* (or *regurgitation*) allows backflow of blood when the incompetent valve closes with only partial effectiveness.
 - Different murmurs are audible in different parts of the cardiac cycle, depending on the cause of the murmur.

Normal heart sounds



First heart sound **S1**, the "lub" (components **M1** and **T1**)

- The first heart tone, or **S1**, is caused by the sudden block of reverse blood flow due to closure of the atrioventricular valves, viz. mitral and tricuspid, at the beginning of ventricular contraction, or systole.
- When the pressure in the ventricles rises above the pressure in the atria, venous blood flow entering the ventricles is pushed back toward the atria, catching the valve leaflets, closing the inlet valves and preventing regurgitation of blood from the ventricles back into the atria.

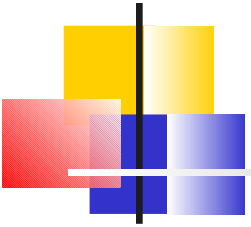
Second heart sound S2 the "dub" (components A2 and P2)

- The second heart tone, or **S2**, is caused by the sudden block of reversing blood flow due to closure of the aortic valve and pulmonary valve at the end of ventricular systole, i.e beginning of ventricular diastole.
- As the left ventricle empties, its pressure falls below the pressure in the aorta, aortic blood flow quickly reverses back toward the left ventricle, catching the aortic valve leaflets and is stopped by aortic (outlet) valve closure.
- Similarly, as the pressure in the right ventricle falls below the pressure in the pulmonary artery, the pulmonary (outlet) valve closes.

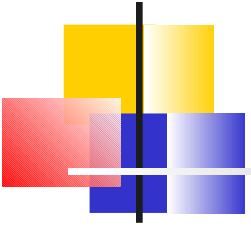


Splitting of the second heart sound

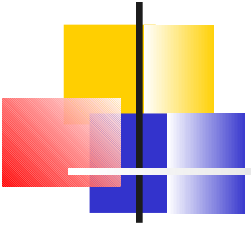
- During inspiration, the increased negative intrathoracic pressure which allows lung expansion also induces both increased blood return from the body into the right ventricle and simultaneous reduced blood volume return from the lungs into the left ventricle.
- Because of the increased blood volume in the right ventricle, the pulmonary valve stays open longer during ventricular systole whereas the aortic valve closes slightly earlier due to slightly reduced left ventricular volume.
- Thus the P2 component of S2 is delayed relative to the A2 component. This delay in P2 versus S2 is heard as a slight broadening or even "splitting" of the second heart sound, though usually only in the pulmonic area of the chest because the P2 is soft and not heard in other areas.



- During expiration, the less negative (than during inspiration) intrathoracic pressure no longer increases blood return to the right ventricle versus the left ventricle, the right ventricle volume is no longer increased, the pulmonary valve closes earlier, P2 occurs earlier and overlaps A2.
- It is physiological to hear a "splitting" of the second heart tone in younger people, during inspiration and in the "pulmonary area", i.e. the 2nd ICS (intercostal space) at the left edge of the sternum. During expiration, the interval between the two components normally shortens and the S2 sounds become merged.

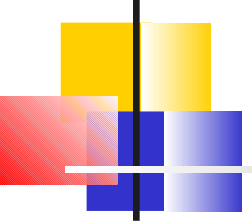


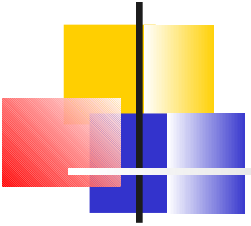
- A bundle branch block will produce continuous splitting but the degree of splitting will still vary with respiration.
- If splitting does not vary with inspiration, it is termed a "fixed split S2" and is usually due to an atrial septal defect (ASD) or ventricular septal defect (VSD).
- The ASD or VSD creates a left to right shunt that increases the blood flow to the right side of the heart, thereby causing the pulmonic valve to close later than the aortic valve independent of inspiration/expiration.



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- Reverse splitting indicates pathology. Aortic stenosis, hypertrophic cardiomyopathy, left bundle branch block and a ventricular pacemaker could all cause a reverse splitting of the second heart sound.

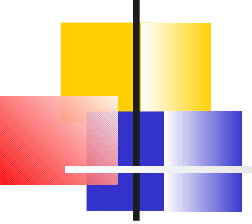
Third heart sound S3

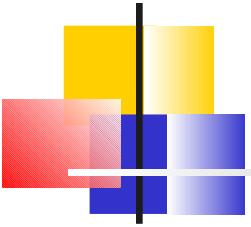
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- Rarely, there may be a third heart sound S3. The third heart sound or **protodiastolic sound** is not of valvular origin, as it occurs at the beginning of diastole approximately 0.12 seconds after S2. S3 is lower in pitch than S1 or S2. S3 occurs when the rush of blood into the filling ventricle is suddenly halted, resulting in a vibration of the ventricle and surrounding structures.



- The third heart sound is normal in children, young adults, and some trained athletes but normally disappears before middle age.
- Abnormal reemergence of this sound late in life indicates a pathological state, often a sign of a failing left ventricle as in dilated congestive heart failure (CHF). This sound is also called a **protodiastolic gallop** or **ventricular gallop**, a type of gallop rhythm.
- Finally, it is informally called the "kentucky" gallop as an onomatopoeic reference to the rhythm and stress of S1, S2, and S3 together (with S3 representing the "-cky" syllable).

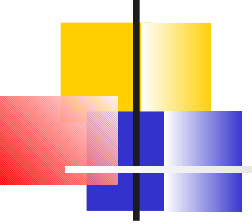
Fourth heart sound S4

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- The rare fourth heart sound S4 is sometimes audible in healthy children and again in trained athletes, but when audible in an adult is called a **presystolic gallop** or **atrial gallop**. This gallop is produced by the sound of blood being forced into a stiff/hypertrophic left ventricle. It is a sign of a pathologic state, usually a failing left ventricle.



- The sound occurs just after atrial contraction ("atrial kick") at the end of diastole and immediately before S1, producing a rhythm sometimes referred to as the "tennessee" gallop where S4 represents the "tenn-" syllable.
- The combined presence of S3 and S4 is a **quadruple gallop**.
- At rapid heart rates, S3 and S4 may merge to produce a **summation gallop**.

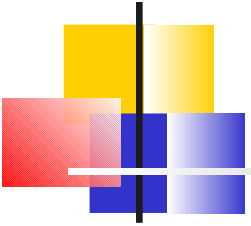
Abnormal sounds

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- **Heart murmurs** are produced as a result of turbulent flow of blood, turbulence sufficient to produce audible noise.
 - The term murmur only refers to a sound believed to originate within blood flow through or near the heart; rapid blood velocity is necessary to produce a murmur. Though not fully reliable, soft murmurs are less likely to reflect a serious, if any, health problem; loud murmurs essentially always reflect a problem. Yet most heart problems do not produce any murmur and most valve problems also do not produce an audible murmur.



Murmurs most commonly heard in adults who do not have major congenital heart abnormalities.

- Regurgitation through the mitral valve is by far the most commonly heard murmur, sometimes fairly loud to a practiced ear, even though the volume of regurgitated blood flow may be quite small.
- Stenosis of the aortic valve is typically the next most common heart murmur, a systolic ejection murmur. This is more common in older adults or in those individuals having a two, not a three leaflet aortic valve.



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- Either regurgitation through, or stenosis of, the tricuspid or pulmonary valves essentially never produces audible murmurs.
 - Other audible murmurs are associated with abnormal openings between the left ventricle and right heart or from the aortic or pulmonary arteries back into a lower pressure heart chamber.



GRADATION OF MURMURS

- **Grade****Description**
- Grade 1 Very faint, heard only after listener has "tuned in"; may not be heard in all positions.
- Grade 2 Quiet, but heard immediately after placing the stethoscope on the chest.
- Grade 3 Moderately loud.
- Grade 4 Loud, with palpable thrill (ie, a tremor or vibration felt on palpation)
- Grade 5 Very loud, with thrill. May be heard when stethoscope is partly off the chest.
- Grade 6 Very loud, with thrill. May be heard with stethoscope entirely off the chest.



clicks

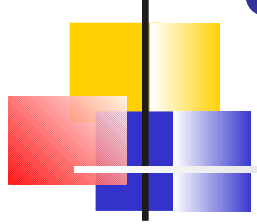
- With the advent of newer, non-invasive imaging techniques, the origin of other, so-called *adventitial sounds* or "clicks" has been appreciated. These are short, high-pitched sounds.
- The atrioventricular valves of patients with mitral stenosis may open with an *opening snap* on the beginning of diastole.
- Patients with mitral valve prolapse may have a mid-systolic click along with a murmur.
- Aortic and pulmonary stenosis may cause an ejection click immediately after S1.



Rubs

- Patients with pericarditis may have an audible pericardial friction rub.
- This is a characteristic scratching, creaking, high-pitched sound emanating from the rubbing of both layers of inflamed pericardium.
- It is the loudest in systole, but can often be heard at the beginning and at the end of diastole.
- It is very dependent on body position and breathing, and changes from hour to hour.

Effects of inhalation and expiration on murmur sounds





During inhalation

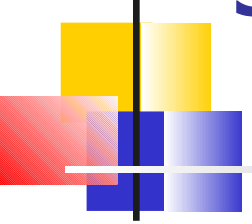
- Inhalation pressure causes an increase in the venous blood return to the right side of the heart.
- Therefore, *right-sided murmurs generally increase in intensity with inspiration.*
- The increased volume of blood entering the right sided chambers of the heart restricts the amount of blood entering the left sided chambers of the heart.
- This causes left-sided murmurs to generally decrease in intensity during inspiration.

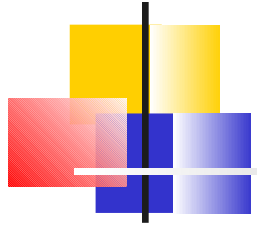


During expiration

- With expiration, the opposite haemodynamic changes occur.
- This means that left-sided murmurs generally increase in intensity with expiration.
- Having the patient lie supine and raising their legs up to a 45 degree angle facilitates an increase in venous return to the right side of the heart producing effects similar to inhalation-increased blood flow.

Interventions that change murmur sounds

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- There are a number of interventions that can be performed that alter the intensity and characteristics of abnormal heart sounds.
 - These interventions can differentiate the different heart sounds to more effectively obtain a diagnosis of the cardiac anomaly that causes the heart sound.



thank you