Heart Sounds: Normal and Abnormal Heart sounds

Heart sounds are produced by the mechanical events of the cardiac cycle—primarily the closure of heart valves. These sounds can be heard during auscultation and provide valuable information about cardiac function.

Normal heart sounds include **S1 (first heart sound)** and **S2 (second heart sound)** . Additional sounds, such as **S3** and **S4** , and **murmurs** , may indicate physiological or pathological changes.

Normal Heart Sounds

First Heart Sound (S1)

- **Cause** : Closure of the atrioventricular (AV) valves—mitral (M1) and tricuspid (T1).
- **Timing** : Marks the **beginning of systole** .
- **Auscultation** : Heard best at the **apex** of the heart.
- **Physiological Note** : M1 slightly precedes T1, though typically perceived as a single sound.
- **Clinical Correlates** :
    - **Increased** : Mitral stenosis (due to elevated left atrial pressure).
    - **Decreased** : Low cardiac output states.

Second Heart Sound (S2)

- **Cause** : Closure of the semilunar valves—aortic (A2) and pulmonary (P2).
- **Timing** : Marks the **end of systole** .
- **Auscultation** : Loudest at the **base** (left sternal border, 2nd intercostal space).
- **Characteristics** :
    - **Shorter, softer** , and **higher-pitched** than S1.
- **Clinical Correlates** :
    - **Increased A2** : Systemic hypertension.
    - **Increased P2** : Pulmonary hypertension.
    - **Decreased** : Aortic stenosis, aortic regurgitation, low output states.

Splitting of S2

- **Normal (Physiological)** :
    - During **inspiration** , venous return to the right heart increases ? delays P2.
    - Blood is pooled in lungs ? reduced return to left heart ? A2 occurs earlier.
    - Heard best at **2nd left intercostal space** .
- **Abnormal Splitting** :
    - **Wide splitting** : Pulmonary stenosis, right bundle branch block (RBBB), mitral regurgitation, VSD.
    - **Fixed splitting** : Atrial septal defect (ASD).

- **Paradoxical (reverse) splitting** : Aortic stenosis, left bundle branch block (LBBB), hypertrophic cardiomyopathy (HOCM).

Mnemonic :
? *“moRe to the Right, Less to the Left”* — during inspiration, right heart volume increases; left heart volume decreases.

Extra Heart Sounds

Third Heart Sound (S3) – “Ventricular Gallop”

- **Timing** : Early diastole, just after S2.
- **Cause** : Rapid ventricular filling; vibrations of the ventricular walls.
- **Normal** in:
  - Children
  - Young adults
  - Athletes
- **Pathologic (S3)** : Associated with **systolic heart failure** , dilated cardiomyopathy.
- **Sound** : Low-pitched, best heard with the bell at the **apex** in **left lateral decubitus** position.
- **Rhythm** : Gallop

Fourth Heart Sound (S4) – “Atrial Gallop”

- **Timing** : Late diastole (presystole), just before S1.
- **Cause** : Atrial contraction against a **non-compliant ventricle** .
- **Always pathologic** .
- **Conditions** :
  - Hypertension
  - Aortic stenosis
  - Ischemic heart disease
  - Left ventricular hypertrophy
- **Sound** : Low-pitched; best heard at the **apex** with the bell.

Summation Gallop

- When **S3 and S4 coexist** , particularly in **tachycardia** , they may merge to form a **summation gallop** , indicating severe ventricular dysfunction.

Opening Snap (OS)

- **Timing** : Early diastole.
- **Cause** : Opening of a stenotic mitral valve.
- **Best heard** : At the **apex** or **left lower sternal border** .
- Often seen in **mitral stenosis** .

Heart Murmurs

Definition

A murmur is a **blowing, swooshing sound** caused by **turbulent blood flow** , usually across a heart valve.

Classification

1. Physiologic (Innocent) Murmurs

- Due to **increased blood flow** through normal valves.
- Conditions: Fever, pregnancy, anemia, exercise, thyrotoxicosis.
- Features:
    - Always **systolic** .
    - **Soft, short** , early peaking.
    - Best heard at the **base** of the heart.
    - Normal physical exam otherwise.

2. Pathologic Murmurs

- Due to **valvular abnormalities** (stenosis or regurgitation).
- May be **systolic or diastolic** .

Systolic Murmurs

Occur between S1 and S2

a. Midsystolic Ejection Murmur

- **Shape** : Crescendo-decrescendo.
- **Location** : Aortic or pulmonary area.
- **Causes** :
    - Aortic stenosis
    - Pulmonary stenosis
    - Can be physiological

b. Late Systolic Murmur

- Begins after a gap following S1.
- Often associated with **mitral valve prolapse** or **mitral regurgitation** .

c. Pansystolic (Holosystolic) Murmur

- **Extends from S1 to S2** without variation in pitch or intensity.
- **Causes** :
    - Mitral regurgitation
    - Tricuspid regurgitation
    - Ventricular septal defect (VSD)

Diastolic Murmurs

Occur after S2 and are always pathological

a. Early Diastolic Murmur

- Starts with S2.
- **High-pitched** , decrescendo quality.
- **Causes** :
  - Aortic regurgitation
  - Pulmonary regurgitation

b. Mid-Diastolic Murmur

- Occurs in mid-to-late diastole.
- **Low-pitched** , rumbling sound.
- Best heard at the apex (mitral) or left lower sternal border (tricuspid).
- **Causes** :
  - Mitral stenosis
  - Tricuspid stenosis

Summary Table: Heart Sounds and Murmurs

Sound/Murmur	Timing	Cause	Clinical Correlate
S1	Beginning systole	AV valve closure	Loud in MS, soft in low output
S2	End of systole	Semilunar valve closure	Split during inspiration
S3	Early diastole	Rapid ventricular filling	HF, volume overload
S4	Late diastole	Atrial contraction into stiff ventricle	LVH, ischemia, AS
Midsystolic murmur	Mid-systole	Flow across semilunar valve	AS, PS
Pansystolic murmur	Throughout systole	Regurgitation or VSD	MR, TR, VSD
Diastolic murmur	After S2	Semilunar or AV valve pathology	AR, MS