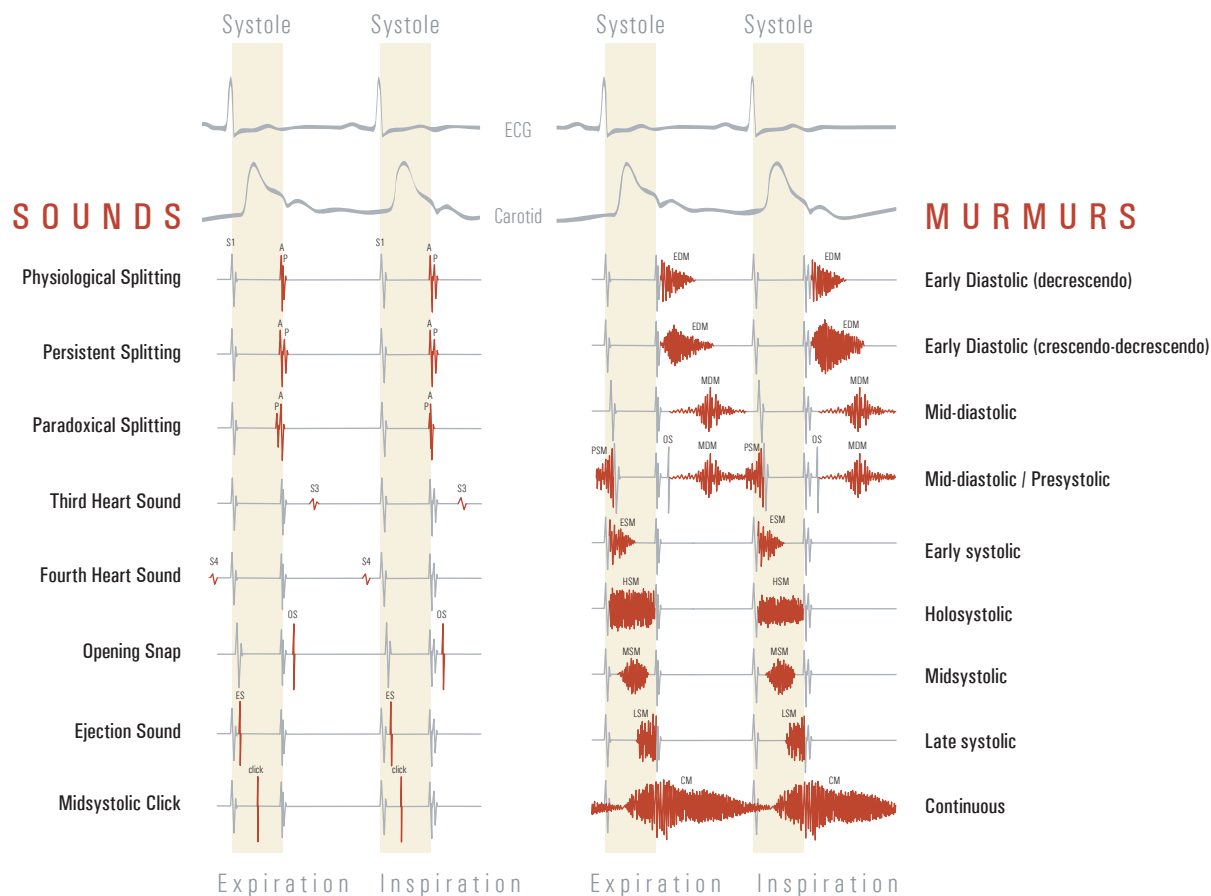


Summary of Heart Sounds & Murmurs with Related Pathology

These graphics represent normal and pathological heart sounds encountered in subjects with heart conditions that are summarized in the following tables.



Extra Heart Sounds

3rd Heart Sound	4th Heart Sound	Opening Snap	Ejection Sound	Systolic Click
<i>absolute or relative increase in passive inflow volume</i>	<i>heightened force of atrial contraction</i>	<i>abrupt cessation of valve opening by fusion of leaflets</i>	<i>abrupt cessation of valve opening by fusion of leaflets or forceful expansion of dilated great artery</i>	<i>abrupt checking of prolapsing leaflets' excursion into the atrium by chordae</i>
Mitral, Tricuspid, Aortic & Pulmonic Regurgitation, Atrial Myxoma	Aortic & Pulmonic Stenosis	Mitral & Tricuspid Stenosis	Aortic & Pulmonic Stenosis	Mitral Prolapse & Hypertrophic Cardiomyopathy
Normal Adolescent, Pregnancy & Anemia	Systemic & Pulmonary Hypertension		Systemic & Pulmonary Hypertension	
Dilated & Hypertrophic Cardiomyopathy	Dilated & Hypertrophic Cardiomyopathy		Tetralogy of Fallot	
LV & RV Dysfunction			Aortic Regurgitation	

Abnormalities of the Second Heart Sound

Persistently Split S2	Paradoxically Split S2
<i>late onset and/or completion of RV systole or early completion of LV systole</i>	<i>late onset and/or late completion of LV systole</i>
Atrial Septal Defect	LBBB, RV Pacemaker
RBBB	Aortic Stenosis
Mitral Regurgitation ¹	Hypertrophic Cardiomyopathy
Ventricular Septal Defect ¹	
Pulmonic Stenosis	
Acute elevation of PA pressure (pulmonary embolism) ²	

1 The aortic valve may close early as a result of the low resistance alternative path to aortic ejection in these conditions.

2 **Chronic** elevation of pulmonary artery pressure leads to near-synchronous closure of aortic and pulmonic valves.

Diastolic Murmurs

Early Diastolic Murmurs result from semilunar valve backflow and begin with the second sound (onset of diastole) and extend for variable length into or through all of diastole (holodiastolic); a shorter murmur usually implies a more severe lesion.

Mid Diastolic Murmurs result from inflow, which begins about 0.12 second after S2.

Presystolic Murmurs extend into to the first sound.

Early Diastolic Decrescendo	Early Diastolic Crescendo-Decrescendo	Mid Diastolic (only)	Mid Diastolic & Presystolic
<i>backflow from semilunar valve</i>	<i>backflow from semilunar valve; (crescendo from dicrotic waveform)¹</i>	<i>disturbed inflow through stenotic valve or high volume inflow through non-stenotic valve</i>	<i>disturbed inflow through stenotic valve or impingement of mitral valve by aortic regurgitation</i>
Aortic Regurgitation ²	Pulm. Regurgitation ³	Acute Severe Aortic Regurgitation (Austin Flint) ²	Chronic Severe Aortic Regurgitation (Austin Flint) ²
Pulmonic Regurgitation (Graham Steell) ³		Mitral or Tricuspid ⁴ Stenosis with A Fib	Mitral & Tricuspid ⁴ Stenosis with NSR
		Mitral & Tricuspid ⁴ Regurgitation	Mitral Stenosis in AF with rapid rate ⁵
		L-R shunts: ASD, VSD, PDA	

1 A large dicrotic wave in the pulmonary artery produces an **early crescendo phase**.

2 Intensity of murmurs related to aortic regurgitation will often increase with **handgrip**.

3 Murmur is usually caused by **pulmonary hypertension**.

4 Intensity of murmurs of right heart origin will usually increase with **inspiration**.

5 **Presystolic crescendo murmurs** can be heard in mitral stenosis with atrial fibrillation during rapid ventricular response (shortened diastoles).

Systolic Murmurs

Early Systolic Murmurs begin with the 1st heart sound and do not extend to the 2nd.

Mid Systolic Murmurs are separate from the 1st and 2nd sounds and are usually, but not always, associated with ejection through an outflow tract.

Holosystolic Murmurs by definition start with the 1st sound and extend to or through the 2nd sound. The term is preferable to "pansystolic" which means *every systole* (as in Pan American), whereas holosystolic means *all of systole*.

Late Systolic Murmurs begin after the 1st sound, and extend to or through the 2nd.

Early Systolic	Mid Systolic	Late Systolic	Holosystolic
Acute Mitral Regurgitation	Outflow Stenoses: Aortic and Pulmonic (valvar, sub & supra-valvar)	Mitral Prolapse	Mitral Regurgitation
Mitral Regurgitation in Dilated Cardiomyopathy	High Volume Outflow: Anemia, Pregnancy, Atrial Septal Defect, Aortic Regurgitation	Hypertrophic Cardiomyopathy ¹	Tricuspid Regurgitation ²
Mild-Moderate Pulmonic Stenosis ³	High Outflow Velocity: Hypertrophic CM ¹	Aortic Coarctation	Ventricular Septal Defect
	Dilated Aorta or Pulmonary Artery	Mammary Souffle (Pregnancy, Lactation)	Hypertrophic Cardiomyopathy ¹
	Innocent Murmur (Still's Murmur)	Patent Ductus with Pulmonary Hypertension	Severe Pulmonic ³ Stenosis

1 Hypertrophic Cardiomyopathy can be associated with almost all of the types of murmurs listed above, and as with Mitral Prolapse, can change markedly with:

- Standing: longer and louder
- Squatting: shorter and softer
- Valsalva Strain: longer and louder

2 Murmur intensity of Tricuspid Regurgitation will usually increase with inspiration.

3 The murmur of severe pulmonic stenosis may be holosystolic because the murmur begins with the first sound and spills through the aortic component of the second. The murmur will usually increase with inspiration.

Continuous Murmurs

Continuous Murmurs extend from systole **through the second sound** into diastole and should not be confused with the **to-and-fro** murmurs of aortic regurgitation in which there is a distinct pause between the systolic (anterograde) and early diastolic (retrograde) flow. In contrast, **continuous murmurs** result from unidirectional flow from a high pressure source to a lower pressure recipient.

Aorta or Systemic Artery to Pulmonary	Pulmonary A-V Fistulae	Systemic A-V Fistulae	Constriction or Aorta or PA	Miscellaneous
Patent Ductus Arteriosus ¹	Osler-Weber-Rendu	Congenital A-V Fistulae	Coarctation of Aorta	Venous Hum (Innocent)
Bronchial to Pulmonary Collaterals		Traumatic Gunshot or StabWound	Branch Pulmonic Stenosis or Stenoses	Systemic Arterial Stenoses
Coronary-Cameral Fistulae		Hemodialysis Access		Pulmonary Embolism
Blalock-Taussig and Potts Shunts				Takayasu's Arteritis
Sinus of Valsalva Rupture into Cardiac Chamber				VSD with Aortic Regurgitation ³
Anomalous Origin of Left Coronary Artery ²				Collateral Arteries

- 1 The murmur of patent ductus arteriosus will be confined to late systole if the diastolic pressure in the pulmonary artery rises to match the aortic as shown in the patient illustrated below.
- 2 Anomalous origin of the left coronary artery from the pulmonary artery (**Bland-Garland-White Syndrome**) leads to the formation of collateral channels from the right coronary artery to the left, with continuous retrograde flow in the left coronary artery.
- 3 **Supracristal** (subpulmonic) **ventricular septal defects** are often associated with **aortic regurgitation**, causing a holosystolic murmur in combination with an early diastolic murmur, which blend together to give the impression of a "continuous murmur."