

Evaluation of Cardiac Murmurs in the Clinic Setting

Competency:

The resident should be able to auscultate heart sounds and describe cardiac murmurs, obtain relevant history, perform maneuvers to assist in identification of a murmur, and recognize murmurs concerning for possible structural or valvular heart disease that require cardiology consultation and work-up.

Case:

A mother brings her 3 year-old son to your clinic for the first time with concerns about asthma. She notes that she has not heard any wheezing, but that he 'caught colds' all the time. She reports that there is a strong family history of asthma (she has asthma), and that she has given him albuterol treatments from her own MDI when he was coughing, without any apparent effect. She reports that he was full-term, and that the pregnancy and delivery were uncomplicated. However, she notes that when she left the hospital, she was told that he had a murmur, that it was normal, and not to worry about it. You plot him on a growth curve, and find that his height and weight are just below the 5th percentile, although his birth weight was normal. His dietary history indicates that he is taking an appropriate number of calories.

Questions:

1. What is the relevance of auscultation in the clinic setting?
2. What elements of the history are helpful in assessing cardiac murmurs?
3. How does one characterize cardiac murmurs?
4. What maneuvers can one perform to help identify a murmur?
5. How can one distinguish between an innocent/pathological murmur?
6. What murmurs require further work-up and referral?

References:

1. Bloch, A., J. Crittin, and A. Jaussi (2001). Should functional cardiac murmurs be diagnosed by auscultation or by Doppler echocardiography? *Clin Cardiol.* **24**:767-769.
2. Carabello, B.A., K. Chatterjee, A.C. de Leon, D.P. Faxon, M.D. Freed, W.H. Gaasch, B.W. Lytle, R.A. Nishimura, P.T. O'Gara, R.A. O'Rourke, C.M. Otto, P.M. Shah, and J.S. Shanewise (2006). ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease. A Report of the American College of Cardiology / American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients with Valvular Heart Disease). *Journal of the American College of Cardiology.* **48**:e1-e148.
3. Park, M.K. (2002). Pediatric Cardiology for Practitioners, 4th Edition. Mosby, St. Louis.
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Questions:

1. What is the relevance of auscultation in the clinic setting?

Cardiac auscultation is one of the core components of the basic physical exam. It is a widely available method of screening and assessing changes in cardiac status and abnormalities in cardiac anatomy and physiology. A vast majority of valvular or congenital heart disease is first detected using auscultation.

The evidence suggests that sensitivity of cardiac auscultation is high, and its correlation with echocardiography is strong in adult studies. In routine ED screening of systolic murmurs by non-cardiologists, sensitivity of 82% and specificity of 69% compared to echocardiography was noted. In a study comparing auscultation to Doppler echocardiography to evaluate cardiac murmurs, there was a concordance of 98.1% in diagnosis of a functional versus pathologic murmur. These findings indicate a strong role for auscultation in screening.

2. What elements of the history are helpful in assessing cardiac murmurs?

There are a number of components in the history that are important in placing the cardiac examination in context and in assessing the risk to the patient.

Birth history, particularly gestational age, gestational complications, birth weight, intra-uterine infections, or tobacco, chemical, drug/medication, or other exposures, are helpful.

a. Birth Weight. Low birth weight may be indicative of intrauterine infection, typically rubella, but also possibly CMV, HSV, or Coxsackie B, which can cause cardiac defects early in pregnancy and myocarditis later in pregnancy. High birth weight, particularly in infants of diabetic mothers, is associated with a higher incidence of cardiac anomalies.

b. Intra-uterine exposures. There are a number of medications and drugs associated with cardiac defects. Amphetamines have been associated with ventricular septal defect (VSD), patent ductus arteriosus (PDA), atrial septal defect (ASD), and transposition of the great arteries (TGA). Antiepileptics, particularly phenytoin, have been associated with TGA, tetralogy of Fallot (TOF), and hypoplastic left heart syndrome. Ethanol exposure has been associated with VSD, PDA, ASD, and TOF.

c. Maternal conditions. Infants of diabetic mothers are at high risk of both cardiomyopathy and congenital heart defects (TGA, VSD, and PDA). Infants born to mothers with congenital heart disease, even if surgically corrected, have a higher incidence of congenital heart disease.

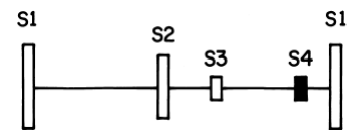
d. Family History. A history including congenital heart disease, rheumatic fever, sudden unexpected death, diabetes, arteriosclerotic disease, hypertension, and other hereditary diseases should be taken to help assess risk.

Other useful aspects of the cardiac history include weight gain, development, and feeding patterns, dyspnea, tachypnea, puffy eyelids, exercise intolerance, (suspicious for congestive heart failure), cyanosis, “blue spells,” and frequent squatting (concerning for cyanotic heart disease), chest pain, neurologic symptoms, medication history, frequency of respiratory infections, and history of previous auscultation of cardiac murmurs.

3. How does one characterize cardiac murmurs?

Begin by identifying the major heart sounds, S1 and S2 (and occasionally S3 and/or S4).

The first heart sound (S1) is associated with closure of the mitral and tricuspid valves. It is best heard at the apex or the left lower sternal border. Occasionally, an ejection click may closely follow S1, sounding like a split. This is most audible at the upper sternal borders, and is normal. The second heart sound (S2) is associated with closure of the aortic and pulmonic valves. It is best heard at the left upper sternal border. The first component of a normal S2 is A2 (aortic), followed by P2 (pulmonic). A2 is louder than P2. The spacing between these two sounds can vary with respiration (increasing with inspiration and decreasing with expiration). S3 is a low-frequency sound that can be heard in early diastole, and is associated with rapid ventricular filling. S4 is heard in late diastole and is associated with decreased ventricular compliance or congestive heart failure – it is always pathologic.



The characterization of a cardiac murmur consists of several components: intensity, timing, location, transmission, and quality.

Intensity:

- Grade I: Barely audible
- Grade II: Soft, but easily audible
- Grade III: Moderately loud, but not accompanied by a thrill
- Grade IV: Louder and associated with a thrill
- Grade V: Audible with the stethoscope barely on the chest
- Grade VI: Audible with the stethoscope off the chest

Timing:

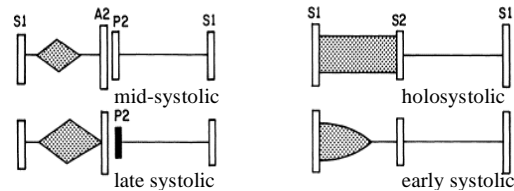
Cardiac murmurs can be described as systolic, diastolic, or continuous. First, identify S1 and S2, and place the murmur that you hear relative to those heart sounds.

a. Systolic Murmurs

Systolic murmurs are heard between S1 and S2.

They can be classified as:

- Early systolic
- Mid-systolic (systolic ejection)
- Mid to late systolic
- Holosystolic

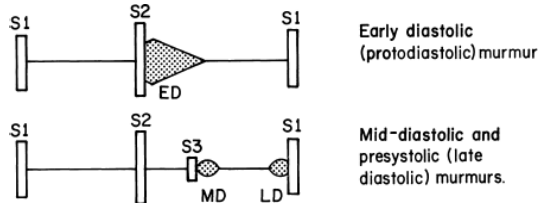


b. Diastolic Murmurs

Diastolic murmurs are heard between S2 and S1.

They can be classified as:

- Early diastolic
- Mid-diastolic
- Late diastolic (pre-systolic)



Note: Diastolic murmurs are always pathological and suggestive of valvular abnormalities.

c. Continuous Murmurs.

These murmurs begin in systole and continue through S2 into diastole. The differential diagnosis for continuous murmurs includes aortopulmonary or arteriovenous connections (e. g. PDA, AV fistula, or s/p systemic-to-PA surgery), disturbances in venous flow (e. g. venous hum), and disturbances in arterial flow (e. g. coarctation or PA stenosis).

Location:

Determine the point at which the murmur is loudest. Most common locations are: the right upper sternal border (RUSB - aortic area), left upper sternal border (LUSB - pulmonic area), left lower sternal border (LLSB - tricuspid area), and apex (mitral area).

Transmission:

Determine whether the murmur radiates to other locations, including the back, neck, axilla, and right side of the chest.

Quality:

The quality of the sound can be useful in differentiating between murmurs. Possibilities include high-pitched (blowing), rough (harsh), mechanical, or vibratory (humming).

4. **What maneuvers can one perform to help identify a murmur?**

There are several maneuvers that can assist in diagnosing a murmur.

a. Positional changes

The murmur should be auscultated and compared when the patient is supine and then sitting or standing. Most murmurs will decrease when transitioning from supine to sitting or standing as preload decreases. However, hypertrophic cardiomyopathy (HCM) and mitral valve prolapse (MVP) are significant exceptions.

b. Respiration

Right-sided murmurs usually increase with inspiration, and left-sided murmurs usually increase with expiration.

c. Valsalva

Most murmurs decrease in length and intensity, except HCM and MVP.

d. Exertion

Isometric exercise, such as hand squeezing, can be used to enhance murmurs due to valvular stenosis or regurgitation, as well as VSD.

5. **How can one distinguish between an innocent and pathological murmur?**

The most important part about making the diagnosis of an innocent (functional) murmur is history and other findings on physical exam. In order to make a diagnosis of an innocent murmur, the child must be asymptomatic. The presence of any of the following conditions point towards a pathological murmur:

1. Cardiac symptoms
2. Abnormal cardiac size or silhouette on CXR
3. Abnormal pulmonary vasculature on CXR
4. Abnormal EKG
5. Diastolic murmur
6. Loud systolic murmur (grade III or above - a thrill is pathological) that is long in duration and radiates to other parts of the body
7. Cyanosis
8. Abnormally strong or weak pulses
9. Abnormal heart sounds other than the murmur

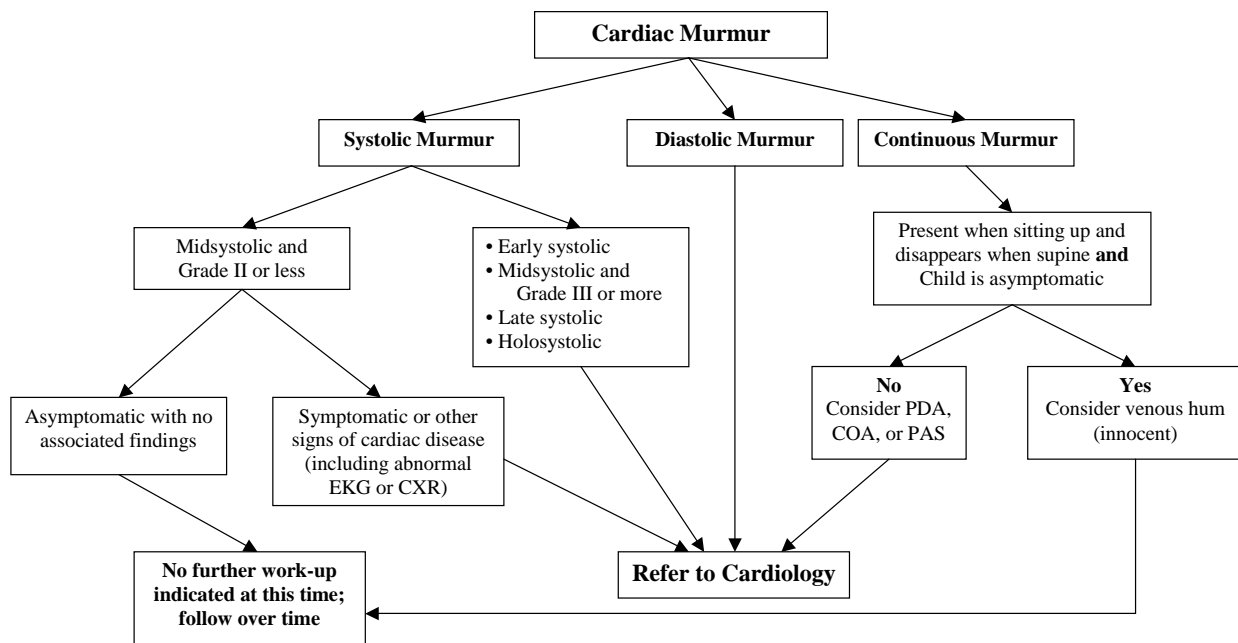
Common innocent murmurs:

Type	Description	Age Group
Still's Murmur	Intensity: II-III/VI Timing: Systolic ejection Location: MLSB or between the LLSB and apex Quality: Low-frequency, vibratory Maneuvers: Frequently decreases or disappears when sitting or standing.	3-6 years, occasionally infant
Peripheral Pulmonic Stenosis (pulmonary flow murmur of the newborn)	Intensity: I-II/VI Timing: Systolic ejection Location: LUSB Quality: Musical Transmission: Both sides of the chest, axilla, and back	Newborns, usually disappearing by 3-6 months

Pulmonary Ejection	Intensity: I-III/VI Timing: Early to midsystolic Location: LUSB Quality: Blowing	8-14 years
Venous Hum	Intensity: I-III/VI Timing: Continuous, diastolic louder than systolic Location: Supra/infraclavicular Maneuvers: Disappears when supine; intensity varies with head rotation	3-6 years

6. What murmurs require further work-up and referral?

The following flowchart provides a guideline for evaluation of cardiac murmurs and indications for consultation and further evaluation:



Adapted from Carabello et al. (2006) JACC 48: e1.

Case Follow-up:

On examination, the patient is comfortable in no distress, though he appears small for his age. His vital signs are unremarkable. A II/VI harsh holosystolic murmur is heard, loudest at the left lower sternal border, with no transmission to other areas of the chest. Lung sounds are normal with no wheezing. Due to your concerns about possible structural or valvular heart disease, you refer your patient to a cardiologist. On echocardiography, the left ventricle was noted to be moderately enlarged. A medium-to-large VSD was identified, with a moderate left to right shunt and increased right-sided pressures. Closure of the defect is recommended.

References:

1. Bloch, A., J. Crittin, and A. Jaussi (2001). Should functional cardiac murmurs be diagnosed by auscultation or by Doppler echocardiography? *Clin Cardiol.* **24**:767-769.
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Appendix: More Commonly Encountered Systolic and Diastolic Murmurs

Right Upper Sternal Border (Aortic Area)

Type	Findings
Aortic Stenosis	Intensity: II-V/VI Timing: Systolic ejection Location: Right 2nd-3rd intercostal space Transmission: Neck (carotids) Other findings: May have single S2
Subaortic Stenosis	Intensity: II-IV/VI Timing: Systolic ejection Other findings: Frequently associated with aortic regurgitation murmur

Left Upper Sternal Border (Pulmonic Area)

Type	Findings
Pulmonic Stenosis	Intensity: II-V/VI Timing: Systolic ejection Transmission: Back
Atrial Septal Defect	Intensity: II-III/VI Timing: Systolic ejection Other Heart Sounds: Widely split and fixed S2
Peripheral Pulmonic Stenosis	Intensity: I-II/VI Timing: Systolic ejection Transmission: Back and axilla
Pulmonary Flow Murmur	Intensity: II-III/VI Timing: Systolic ejection Transmission: Rare
Pulmonary Artery Stenosis	Intensity: II-III/VI Timing: Systolic ejection, sometimes continuous Transmission: Back and both lung fields
Tetralogy of Fallot (TOF)	Intensity: II-IV/VI Timing: Systolic ejection, long Location: Louder at MLSB Other: Associated with clubbing and cyanosis
Aortic Regurgitation	Intensity: I-V/VI Location: Best at the left 3rd intercostal space Timing: Early diastolic Quality: High pitched Transmission: Apex
Pulmonic Regurgitation	Intensity: I-III/VI Location: Best at the left 3rd intercostal space Timing: Early diastolic Quality: Medium to high pitched Transmission: Left sternal border
Patent Ductus Arteriosus	Intensity: I-II/VI Location: Left supra/infraclavicular, LUSB Timing: Systolic to continuous Quality: Machinery-like

Left Lower Sternal Border (Tricuspid Area)

Type	Findings
Tricuspid Regurgitation	Intensity: II-III/VI Timing: Early systolic to holosystolic

	Other Findings: May be associated with cyanosis
Ventricular Septal Defect	Intensity: II-V/VI Timing: Early systolic to holosystolic Other findings: Occasional loud P2
Still's Murmur (innocent)	Intensity: II-III/VI Timing: Systolic ejection Quality: Musical or vibratory
Idiopathic Hypertrophic Subaortic Stenosis (IHSS)	Intensity: II-IV/VI Timing: Systolic ejection Quality: Medium pitched Other: May be associated with a MR murmur
Tricuspid Stenosis	Intensity: I-V/VI Location: LLSB Timing: Mid-diastolic Quality: Low pitched

Apex (Mitral Area)

Type	Findings
Mitral Regurgitation	Intensity: II-III/VI Timing: Early systolic, occasionally holosystolic Transmission: Left axilla
Mitral Stenosis	Intensity: I-V/VI Timing: Mid-diastolic Quality: Low pitched
Aortic Stenosis	Occasionally heard here (versus RUSB)
IHSS	Occasionally heard here (versus LLSB)
Mitral Valve Prolapse	Intensity: II-III/VI, preceded by click Timing: Mid-systolic click, followed by mitral regurgitation murmur Maneuvers: Murmur is longer when standing

By William Ching, M.D., Ph.D.; reviewed by Frank Zimmerman, M.D.