Evaluation of Cardiac Murmurs

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Objectives

The learner will be able to...
• Describe normal anatomy and physiology of the cardiovascular system
• Identify the characteristics of normal (innocent) and pathologic murmurs
• List common etiologies for murmurs in children
• List common etiologies for murmurs in Adults
• Describe methods of evaluating cardiac murmurs

Prevalence of Murmurs

• Studies report that as many as 3 in 4 children will have an audible murmur at some point.
• As many as 1 in 10 adults will have a detectable murmur.

Why is this important?

• Cardiac auscultation is one of the most useful bedside diagnostic tools that a clinician can use to detect alterations in cardiovascular anatomy and physiology.
• Significant valvular heart disease is often first diagnosed based upon the finding of a murmur.
• Auscultation has a reported sensitivity of 70 percent and a specificity of 98 percent for detection of valvular heart disease.

Why is this important?

• However, the sensitivity and specificity vary substantially with the expertise of the examiner.
• Expertise and proficiency in auscultation has been waning in the modern era, which has led to a greater dependence on more expensive imaging techniques.
What is a Murmur?

- An auditory finding during auscultation created from blood flow through the heart or great vessels.
- Cardiac murmurs are the direct result of **turbulent** blood flow.
- The degree of turbulence and associated intensity of a cardiac murmur depends on the size of the vessel or orifice the blood travels through and the pressure difference or gradient across the narrowing and the volume of blood flow.

What is a Murmur?

- Murmurs are generally loudest at the point of origin because sound radiates away from the source and intensity decreases with distance.
- Intensity is also influenced by the transmission characteristics of the tissue it travels through.

Cardiovascular Examination

Cardiac Anatomy

Blood Flow
Cardiovascular Examination

ANATOMY:
- Sternum: Sternal angle (angle of Louis):
  – Identifies the 2nd rib
- Rib spaces: The rib interspace is numbered to correspond with the rib immediately above it. i.e. the first interspace is directly below the first rib, and so on.

Cardiac Examination Landmarks

- **Suprasternal notch:** Formed by sternum and clavicle heads
- **Midclavicular line:** Imaginary line that bisects the clavicle and extends down the patient’s chest
- **Anterior axillary line:** Extends from ant aspect of axilla down Pt’s chest

Chest Deformities
- **Pectus Excavatum:** Sternum is concave
- **Pectus Carinatum:** Sternum protrudes outward

Cardiac Landmarks

Auscultation Areas

- **Aortic Region:** 2nd right intercostal space (ICS)
- **Pulmonic Region:** 2nd left ICS
- **Second Pulmonic (Erb’s point):** 3rd Left ICS
- **Tricuspid Region:** 4th left ICS
- **Mitral Region:** 5th left ICS at MCL
- Other locations as indicated e.g. neck, L axilla, infrascapular area of back, etc...3
Cardiovascular Physiology

- Blood flow is driven by a difference in pressure between the arteries and the veins. The amount of blood flow produced for a given pressure gradient depends on how much resistance to flow is present in the vascular system.
- Flow of fluid occurs as the result of a difference in pressure between two points. In a closed system of fluid-filled tubes, such as the cardiovascular system, the difference in pressure between the aorta and the large central veins drives blood flow through the systemic circulation. Blood is an incompressible fluid, and its volume cannot decrease when the ventricles contract. Instead, blood is pressurized, creating the potential energy for blood flow.

Review of Related History

**HPI:** (CP, SOB, Palpitations, etc...)
- Onset, duration and frequency
- Character
- Location
  - Radiation
- Severity
- Associated symptoms
- Modifying factors (made worse by/made better by)
- Treatments
  - Rx/OTC taken

**PMH:**
- Chest pain
- Cardiac surgery or hospitalizations for cardiac evaluations
- History of Rheumatic Fever
- Chronic illnesses (DM, HTN, hyperlipidemia, CAD, etc...)

**Family History:**
- Diabetes, heart disease (angina, MI or arrhythmias), hyperlipidemia, hypertension, congenital heart disease, sudden death, etc...
- Personal and Social History:
- Employment, tobacco usage, alcohol usage, illegal drug usage, nutritional status, personality assessment, etc...
Review of Related History

**ROS:**
- Chest pain, back pain, jaw pain, GI pain, syncope, dizziness, diaphoresis, SOB, PND (paroxysmal nocturnal dyspnea), orthopnea, palpitations, edema, leg pain, exercise tolerance

Cardiac Examination

**GENERAL APPROACH:**
- Quiet room with good lighting.
- Patient should remove all clothing from the waist up and wear a gown. Drape appropriately.
- Utilize an exam table capable of varying degrees of incline.

Cardiac Examination

**INSPECTION:** sitting, supine, and left lateral decubitus position observe each of the cardiac locations
- A tangential light source may be useful to detect subtle pulsations:
- Look for abnormalities of chest wall symmetry or contour: Prominence of one hemithorax, pectus, etc...
- Inspect anterior chest wall for presence of Point of Maximum Impulse (PMI):

Cardiac Examination

**PALPATION:**
- Carried out in sitting, supine, and left lateral decubitus position.
- Use the fingertips for palpating impulses, and the ball of your hand for vibrations (thrills).

![Sequence for palpation of the precordium](image)


Cardiac Examination

- Locate the PMI by palpation and note:
  - size: Not > 2.5 cm in diameter
  - location: usually at the 4th or 5th LICS at the MCL
  - duration: 2/3 of systole, a tap
- Palpate each cardiac location for lifts or heaves. Presence of lift or heave indicates ventricular hypertrophy
- Palpate each cardiac area for thrill
Cardiac Examination

AUSCULTATION: carried out in sitting, leaning forward while exhaling, supine, and left lateral decubitus position.

- Listen in all 4 valve areas and the left axilla at a minimum.
- Use of the diaphragm-high pitched sounds.
- Use of the bell-low pitched sounds.

S1 and S2

- S1 = Closing of the mitral and tricuspid valves
- S2 = Closing the aortic and pulmonic valves
- Normally very crisp
- You should hear S1 loudest at mitral area
- You should hear S2 loudest at aortic area

Split S2

- Physiologically split S2
  - Natural delay in closure of pulmonic valve
  - Why... increase in pulmonary blood flow that occurs with inspiration when increased venous return to the right side of the heart delays the closure of the pulmonic valve
- Fixed Split S2= ASD
  - Increase pulmonary blood flow from increased preload from L>R shunt of blood across ASD delays closure of pulmonic valve (larger volume of blood)
  - This split doesn’t typically change with respiration because ASD is more hemodynamically significant than the small increase in volume of blood that results from inspiration

S3

- A third heart sound occurs early in diastole. In young people and athletes it may be a normal phenomenon. In older individuals it often indicates the presence of congestive heart failure.
- The third heart sound is caused by a sudden deceleration of blood flow into the left ventricle from the left atrium. In the anatomy tab you will see a thin-walled, dilated left ventricle with generalized decreased vigor of contraction.
- The third heart sound is a low frequency sound best heard with the bell of the stethoscope pressed lightly on the skin of the chest.
S4

- The fourth heart sound occurs in late diastole just prior to the first heart sound and correlates with atrial contraction component of the cardiac cycle.
- The fourth heart sound is produced by an increase in stiffness or noncompliant left ventricle.
- A fourth heart sound can also be caused by a greatly thickened left ventricular wall such as with essential hypertension or aortic stenosis.
- The fourth heart sound is a low frequency sound best heard with the bell of the stethoscope pressed lightly on the skin of the chest.

Timing of S3 and S4

Rubs

- Pericardial rub= pericarditis
- This is a velcro sound that you can hear throughout the cardiac cycle
- Pericarditis
  - Recent upper resp tract infection
  - Chest pain that is better with leaning forward and worse with lying down

Cardiac Examination

- Listen to heart rate and rhythm:
- Systematically assess:
  1. First heart sound
  2. Second heart sound
  3. Third heart sound
  4. Fourth heart sound
  5. Extra sounds in systole: clicks
  6. Extra sounds in diastole: opening snaps
  7. Systolic murmurs
  8. Diastolic murmurs

Murmur Characterization

If a murmur is present note & record the following characteristics:

- **Timing:** systolic, diastolic, etc...
- **Location of maximal intensity:** Identify the cardiac area it is loudest at.
- **Radiation:** What area is the murmur transmitted to?

Cardiac Examination

**Intensity/Grade:**

<table>
<thead>
<tr>
<th>No Thrill</th>
<th>IV/VI - Loud and thrill present</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/VI - Barely audible</td>
<td></td>
</tr>
<tr>
<td>II/VI - Quiet but clearly audible</td>
<td></td>
</tr>
<tr>
<td>III/VI - Moderately loud</td>
<td></td>
</tr>
<tr>
<td>Thrill</td>
<td>V/VI - Very loud hear with stethoscope at 45 degree angle</td>
</tr>
<tr>
<td></td>
<td>VI/VI - Audible without stethoscope</td>
</tr>
</tbody>
</table>
Cardiac Examination

- **Pitch**: High, Medium or Low
- **Quality**: Harsh, blowing, musical, vibratory
- **Pattern/Configuration**:
  - Crescendo (increasing)
  - Decrescendo (decreasing)
  - Plateau (unchanged)

Special Maneuvers:

**Maneuvers Affecting Preload**

- Decreased Preload: Valsalva, standing, hypovolemia, tachycardia, and vasodilators
- Increased Preload: Squatting, passive leg-raising and bradycardia

Systolic Murmurs

Derived from increased turbulence associated with:

1. Increased flow across normal semilunar valve or into a dilated great vessel
2. Flow across an abnormal semilunar valve or narrowed ventricular outflow tract - e.g. aortic stenosis
3. Flow across an incompetent AV valve - e.g. mitral regurgitation
4. Flow across the interventricular septum

Early Systolic Murmurs

1. Acute severe mitral regurgitation
   - decrescendo murmur
   - best heard at apical impulse
   - Caused by:
     - Papillary muscle rupture
     - Infective endocarditis
     - Rupture of the chordae tendineae
2. Tricuspid regurgitation with normal PA pressures
3. Congenital, small muscular septal defect
Midsystolic (ejection) Murmurs

- Are the most common kind of heart murmur
- Are usually crescendo-decrescendo
- They may be:
  1. Innocent
     - common in children and young adults
  2. Physiologic
     - can be detected in hyperdynamic states
     - e.g. anemia, pregnancy, fever, and hyperthyroidism
  3. Pathologic
     - are secondary to structural CV abnormalities
     - e.g. Aortic stenosis, Hypertrophic cardiomyopathy, Pulmonic stenosis

Aortic Stenosis

1. Loudest in aortic area; radiates towards the carotid arteries
2. Intensity varies directly with CO
3. A2 decreases as the stenosis worsens
4. Other conditions which may mimic the murmur of aortic stenosis w/o obstructing flow:
   - Aortic sclerosis
   - Bicuspid aortic valve
   - Dilated aorta
   - Increased flow across the valve during systole

Physical Exam: Cardiac

- RUSB with diaphragm; radiates to carotids bilaterally

Hypertrophic Cardiomyopathy

- Loudest between the left sternal edge and apex; Grade 2-3/6
- Does NOT radiate into neck; carotid upstrokes are brisk and may be bifid
- Intensity increases with maneuvers that decrease LV volume

Holosystolic (Pansystolic) Murmurs

- Are pathologic
- Murmur begins immediately with S1 and continues up to S2
  1. Mitral valve regurgitation
     - Loudest at the left ventricular apex
     - Radiation reflects the direction of the regurgitant jet
       - To the base of the heart = anterosuperior jet (flail posterior leaflet)
       - To the aorta and back = posterior jet (flail anterior leaflet)
     - Also usually associated with a systolic thrill, a soft S3, and a short diastolic rumbling (best heard in left lateral decubitus
  2. Tricuspid valve regurgitation
  3. Ventricular septal defect
10/9/18

VSD

- Congenital – hole in ventricular septum
- Left heart pressures greater than right heart
- During systole, some blood in the left ventricle goes through the defect into the right ventricle creating a murmur
- Holosystolic murmur, much like mitral regurgitation
- Only difference is that it is usually over the sternal border

Diastolic Murmurs

Considered abnormal. Almost always indicate heart disease

Two basic types:
1. Early decrescendo diastolic murmurs
   - signify regurgitant flow through an incompetent semilunar valve
     - e.g. aortic insufficiency, pulmonic insufficiency
2. Rumbling diastolic murmurs in mid or late diastole
   - suggest stenosis of an AV valve
     - e.g. mitral stenosis or perhaps ASD with a fixed split S2

Aortic Regurgitation

- Best heard in the 2nd ICS at the left sternal edge
- High pitched, decrescendo
- Blowing quality => may be mistaken for breath sounds
  - Sitting lean forward and hold breath following expiration
- Radiation:
  i. Left sternal border = assoc. with primary valvular pathology;
  ii. Right sternal edge = assoc. w/ primary aortic root pathology

Aortic Regurgitation

Diastolic Murmurs

- Aortic Regurgitation (Upper Sternal)
  - radiates inferiorly
  - best heard with patient sitting up and leaning forward (in expiration)
Mitral Stenosis

- Two components:
  1. Middiastolic - during rapid ventricular filling
  2. Presystolic - during atrial contraction; therefore, it disappears if atrial fibrillation develops
- Is low-pitched and best heard over the apex (with the bell)
- Little or no radiation
- Murmur begins after an Opening Snap; S1 is accentuated

Continuous Murmurs

Begin in systole, peak near S2, and continue into all or part of diastole.

1. Cervical venous hum
   - Audible in kids; can be abolished by compression over the IJV
2. Mammary souffle
   - Represents augmented arterial flow through engorged breasts
   - Becomes audible during late 3rd trimester and lactation
3. Patent Ductus Arteriosus
   - Has a harsh, machinery-like quality
4. Also consider Pericardial Friction Rub
   - Has scratchy, scraping quality

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### Pediatrics

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### Evaluation and Management of Heart Murmurs in Children

**Jennifer E. Frank, MD, and Kathryn M. Jacob, MD, University of Wisconsin Fox Valley Family Medicine Residency Program, Appleton, Wisconsin**

Heart murmurs are common in healthy infants, children, and adolescents, although most are not pathologic. A murmur may be a sign of serious heart disease. Clinical data that suggest pathologic include family history of sudden cardiac death in a young affected relative, recent exposure to acute myocarditis or bacterial endocarditis, maternal diabetes mellitus, history of rheumatic fever or Kawasaki disease, and certain genetic disorders. Physical examination should focus on vital signs, age-appropriate respiratory or gastrointestinal manifestations of congenital heart failure, and a thorough cardiovascular examination, including puffing of the sternal, assessment of peripheral pulses, and auscultation over the heart valves. Red flags that increase the likelihood of a pathologic murmur include a holosystolic or diastolic murmur, grade 5 or higher murmur, harsh quality, an abnormal S2, maximal maximum systolic at the upper left sternal border or a systolic click or increased intensity when the patient stands. Electrocardiography and chest radiography must assist in the diagnosis. Refer to a pediatric cardiologist for patients with any other unusual physical examination findings, a history of conditions that increase the likelihood of a structural heart disease, symptoms suggesting underlying cardiac disease, or when a specific congenital anomaly cannot be identified on the physical examination. Echo-cardiography provides a definitive diagnosis and is recommended for evaluation of any potentially pathologic murmurs, and for evaluation of several heart murmurs because these are more likely to be manifestations of structural heart disease. (Ann Fam Med. 2011;8(7):793-798. Copyright © 2011 American Academy of Family Physicians.)

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### Table 1. Historical Findings Suggesting Structural Heart Disease in Children with Heart Murmurs

<table>
<thead>
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<th>Condition</th>
<th>Significance</th>
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<td>Associated with higher morbidity and mortality</td>
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<td>congenital anomalies</td>
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<tr>
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</tr>
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**Source:** Evaluation and Management of Heart Murmurs in Children. Jennifer E. Frank, MD, and Kathryn M. Jacob, MD, University of Wisconsin Fox Valley Family Medicine Residency Program, Appleton, Wisconsin (Downloaded from the American Family Physician Web site at www.aafp.org/afp.)

### Table 2. Symptoms Suggesting Cardiac Disease

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Patent Ductus Arteriosus (PDA)
- In some babies the ductus arteriosus remains patent (connects pulmonary artery and aorta)
- This opening allows oxygen-rich blood from the aorta to mix with oxygen-poor blood from the pulmonary artery.
- This can put strain on the heart and increase blood pressure in the lung arteries.

Mitral valve prolapse
- displacement of an abnormally thickened mitral valve leaflet that gets displaced into the atrium in systole
- Mid-systolic click with late systolic murmur (if present) from mitral insufficiency

When to Refer?
- A murmur of intensity 3 or greater.
- The murmur is best heard at LUSB (2LICS).
- The murmur is of harsh quality.
- The murmur is pansystolic.
- The presence of a systolic click.
- The presence of an abnormal second heart sound (fixed splitting with respiration).
- Diastolic murmur
- Symptoms... poor growth, signs of CHF, chest pain, decreased exercise tolerance, etc...

PDA
- Sounds like continuous machinery murmur throughout systole and diastole

Atrial Septal Defect (ASD)
- Fixed Split S2
- May have a diastolic flow rumble
- May have systolic pulmonic flow murmur

Case 1
- 34 year old male, recent immigrant from Africa. New to your clinic. PE reveals a healthy appearing black male. He has a murmur heard best at the base of the heart. History of Rheumatic Fever as a child. Grade III/VI systolic murmur is heard and there is a systolic click.
A. Pulmonic Stenosis
B. Aortic Stenosis
C. Mitral Stenosis
D. Mitral Insufficiency
Case 2

- 6 month old child who has been growing and developing normally appears in clinic. Auscultation reveals a grade II/VI systolic murmur at LLSB.

A. Pulmonic Stenosis  
B. Aortic Stenosis  
C. VSD  
D. ASD

Case 3

- 74 year old male, murmur heard best at LLSB in diastole. Grade II/VI. Systolic click audible.

A. Mitral Stenosis  
B. Mitral Insufficiency  
C. Aortic Insufficiency  
D. Pulmonic Insufficiency

Case 4

- 29 year old male with known bicuspid Aortic Valve

A. VSD  
B. ASD  
C. Aortic Stenosis and Aortic Insufficiency  
D. Mitral Valve Prolapse