The Cardiovascular Exam
Sources: UST-FMS Med1 Lecture (October 8, 2014), Mosby’s, KaiMM notes, Netter’s Anatomy, Berne and Levy Physiology

MOSBY’S NOTES
Heart: ANATOMY AND PHYSIOLOGY
- Cone-shaped
- 12 cm long, 8 cm wide, 6 cm AP diameter
- Broader upper portion: BASE
- Narrower lower tip: APEX
- Area overlying the heart: PRECORDIUM
- Lies in the mediastinum, to the left of midline, just above the diaphragm, and is cradled between the medial and lower borders of the lungs
- Positioned behind the sternum and the contiguous parts of the 3rd to 6th costal cartilages
- In a tall person: heart tends to hang vertically and positioned more centrally
- In a stocky or short person: heart tends to be more left and horizontally
- Dextrocardia: heart on the right
- Situs Inversus: heart and stomach on the right, liver on the left

Structure
- Four chambers: two atria and two ventricles
- Pericardium: tough, double-walled, fibrous sac encasing the heart; has 2 layers with fluid inside providing for easy, low friction movement
- Epicardium – thin outermost muscle layer
- Myocardium – thick muscular layer
- Endocardium – innermost layer, lines the chambers and valves
- Cardiac Septum – divides the heart into left and right
- Atrium – small, thin-walled
- Ventricle – large, thick-walled
- Primary muscle mass of the heart: ventricles

Surface Anatomy
- Anterior: RV
- Left: LV
- Right: RA
- Posterior: LA

Valves
- AV Valves: Mitral and Tricuspid
  - Mitral (left): 2 cusps
  - Tricuspid (right): 3 cusps
- Semilunar Valves: Aortic and Pulmonary (both have 3 cusps)
  - Aortic: between Left ventricle and Aorta
  - Pulmonary: between right ventricle and pulmonary artery
Ask patient to lie down and remove his/her T-shirt. Introduce yourself to the patient. We should always do CV exam with the patient lying. We stay on the right side of the patient.

**WE DO IT IN THIS SEQUENCE:**

1. General Survey
2. Vital signs
3. JVP
4. Carotid pulse
5. Peripheral pulse
6. Precordial Exam

Just for this afternoon, we’ll start with precordial exam. We expose only the area we want to examine. The heart is in the middle, pointing to the left.

- R cardiac border: RA
- Most anterior portion: RV
- L cardiac border: LV
- Most posterior chamber: LA (when it enlarges, it will push anterior structures forward)

**The Flow of Blood**

1. SVC and IVC
2. RA
3. Tricuspid valve
4. RV
5. Pulmonic valve
6. Pulmonary artery
7. Lungs (to be oxygenated)
8. Pulmonary veins
9. LA
10. Mitral valve
11. LV
12. Aortic valve
13. Aorta

In essence, there are 2 simultaneous circulation: (1) pulmonary and (2) systemic. Our heart as a pump has to be depolarized. There is electrical and mechanical event.

**MOSBY’S NOTES**

**ECG**

- The heart is autonomous
- An intrinsic electrical conduction system enables it to contract within itself
- *Electrocardiogram*: graphic recording of the electrical activity of the heart; depolarization and repolarization
- *P wave* – the spread of stimulus through the atria (atrial depolarization)
- *PR interval* – the time from initial stimulation of the atria to initial stimulation of the ventricles, usually 0.12 to 0.20 s
- *QRS complex* – the spread of stimulus to the ventricles (ventricular depolarization), usually less than 0.10 s
- *ST segment and T wave* – the return of stimulated ventricular muscle to a resting state (ventricular repolarization)
- *U wave* – a small deflection sometimes seen just after the T wave
- *QT interval* – the time elapsed from the onset of ventricular depolarization until the completion of ventricular repolarization. Interval varies with cardiac rate

**Conduction of Impulse**

- SA node (pacemaker): located in the wall of RA
- AV node: located at the atrial septum
- Bundle of His
- Purkinje fibers: in the ventricular myocardium
- Ventricular contraction starts at the apex to the base
**Precordial Examination**

**Inspection**

Look at the chest and check for any deformity:

- *Pectus excavatum* – Sternum naka-uka papaloob
- *Pectus carinatum* – sternum protruding out
- These deformities may be associated with heart problems

Check the back, there is usually slight thoracic *Kyphosis*

- If there’s no kyphosis → *Straight back syndrome* (associated with heart problems)

Check the precordium for visible pulsations.

- **Adynamic**: no visible pulsations
- **Dynamic**: 1 visible pulse
- **Hyperdynamic**: 2 or more visible pulse

Check visible pulsations at eye level or use white light (flash it tangentially)

- Apex
- L. lower parasternum and Epigastrium
- Midprecordium
- 2nd ICS, left parasternum
- 2nd ICS, right parasternum

**Landmarks**

- Midsternum
- Parasternum
- Midclavicular line (do not use the nipple)
- Anterior axillary line
- Midaxillary line
- Posterior axillary line
- Angle of Louis (palpate from suprasternal notch, slide your finger down): 2nd rib is attached

**Palpation**

**MOSBY’S NOTES**

**Palpation**

*Suggested sequence*: apex → left sternal border → base → down to the right sterna border → epigastrium or axilla (depending on circumstances)

*Apical Impulse*: no more than 1cm, gentle and brief, not lasting as long as systole

**Thrills**

For thrills, sensation is like the ball of your hand. Thrill is a palpable murmur (at least grade 4) → turbulent flow

**MOSBY’S NOTES**

**Thrill**

- fine, palpable, rushing vibration, a palpable murmur; usually over the base or right or left 2nd ICS; locate in terms of ICS, relationship to midsternal, midclavicular, or axillary lines
- While palpating precordium, use the other hand to palpate the carotid artery just medial or below the angle of the jaw.
- The carotid pulse and S1 are practically synchronous.
The murmur of grade IV level or more can be felt. The sensation is called the **thrill**, it can be appreciated in systole or diastole. The following are common:

<table>
<thead>
<tr>
<th>Timing</th>
<th>Location</th>
<th>Probable Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systole</td>
<td>Suprasternal notch and/or 2nd and 3rd right ICS</td>
<td>Aortic stenosis</td>
</tr>
<tr>
<td></td>
<td>Suprasternal notch and/or 2nd and 3rd left ICS</td>
<td>Pulmonic stenosis</td>
</tr>
<tr>
<td></td>
<td>4th left ICS</td>
<td>VSD</td>
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<tr>
<td></td>
<td>Apex left lower sternal border</td>
<td>Mitral regurgitation</td>
</tr>
<tr>
<td></td>
<td>Left upper sternal border, often with extensive radiation</td>
<td>Tetralogy of Fallot</td>
</tr>
<tr>
<td>Diastole</td>
<td>Right sternal border</td>
<td>Aortic regurgitation</td>
</tr>
<tr>
<td></td>
<td>Apex</td>
<td>Aneurysm of ascending aorta</td>
</tr>
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</table>

### Apex beat

When the heart contracts, it will rotate counterclockwise, hitting the chest to produce the apex beat.

For apex beat, do not use PMI. It's not always LV that produces the PMI.

### Apex beat

- Most lateral palpable ventricular impulse
- Patient should be sitting
- Mid left thorax (10 cm from MSL)
- Level of 4th to 5th ICS, LMCL
- Only feel it within one ICS (< 2.0 cm); if more than 1, the apex beat is **diffuse**
- Not more than 1 ½ fingertips wide
- Small and feels like a gentle tap
- Only feel it transiently

Characterize the apex beat: location, amplitude, diameter, duration

- Ask the patient to exhale, then hold his/her breath; so that the lungs won’t cover the apex beat
- Or put the patient on left lateral decubitus

How to report Apex beat:

*“The apex beat is palpable over the 5th ICS MCL, 8.5 cm from MSL. Found on only 1 ICS, approx. 1 cm in diameter. Amplitude is very small.”*

If you can feel the apex beat during the whole systole, that is a **sustained** apex beat. This means that LV is **hypertrophied**. If LV is **dilated**, the apex beat will go to left and down.

### Lifts

- LA lift (at the 3rd ICS L parasternum): dilated LA
- PA lift (at the 2nd ICS L parasternum): dilated PA
- Dilated aorta (2nd ICS, R parasternum)

### Heaves

- RV heave (left lower parasternum or over epigastrum): dilated/hypertrophied RV
- LV heave (apical area, very strong): dilated RV
AUSCULTATION

Auscultatory Areas

1. Mitral Valve: Apex, 5th ICS MCL
2. Tricuspid Valve: Left lower parasternum, 4th ICS
3. Pulmonic Valve: Left parasternum, 2nd ICS
4. 2nd Pulmonic Valve: Left sternal border, 3rd ICS
5. Aortic Valve: Right parasternum, 2nd ICS

Ideal Stethoscope

- Largest ear tips possible
- Adjustable head pieces
- Vinyl tubing
- Not more than 25 cms
- 3/16 internal diameter
- Shallow large diameter bell
- Smooth stiff, thin diaphragm

The Cardiac Cycle

1. **Isovolumetric contraction**
   a. Because systemic pressure is always HIGHER than ventricular pressure, ventricles build pressure by contracting
   b. No movement of blood
   c. Contraction against closed valve = builds up pressure

2. **Rapid ejection**
   a. Rapid movement of blood upon opening of aortic valve
   b. LV pressure drops -> aortic & pulmonic valve will close (S2)

3. **Isovolumetric relaxation**
   a. Atria cannot build up pressures as high as ventricles \(\rightarrow\) Not pressure builders
   b. They need the ventricles to actively relax
   c. When ventricular pressure drops and becomes less than atrial pressure, mitral & tricuspid valves open

4. **Rapid filling phase**
   a. During ventricular systole, large amounts of blood accumulate in the right and left atria because of the closed A-V valves.
   b. Therefore, as soon as systole is over and the ventricular pressures fall again to their low diastolic values, the moderately increased pressures that have developed in the atria immediately push the A-V valves open and allow blood to flow rapidly into the ventricles.

5. **Slow filling phase**
   a. When pressures between atria and ventricles equilibrate

6. **Atrial depolarization**
   a. Cause atrial contraction and eject any residual blood

- Systole: ventricles contract, ejecting blood from the LV into the aorta and from the RV into the pulmonary artery
- Diastole: the ventricles dilate, an energy-requiring effort that draws blood into the
Heart Sounds
- **S1**, “lubb”: closure of AV valves
- **S2**, “dubb”: closure of semilunar valves, has 2 components; A2(aortic valve closure) and P2 (pulmonary valve closure)
- **S3**: ventricular filling/ diastole
- **S4**: atrial contraction

Generalities
- Pressures in the RV, RA and PA are LOWER than the left side of the heart
- The events occur slightly LATER on the right side than on the left side; thus heart sounds sometimes have two components E.g. A2 and P2: “split S2” (physiologic)
- The simultaneous muscular tension and flow of blood give “body” to the sounds
- The sounds are best heard in the direction of blood flow

**S1 (1st Heart Sound)**
- **Etiology**
  - Closure of mitral valve
  - Closure of tricuspid valve
  - Ejection into the aortic root
- **Quality (apex)**
  - Loud
  - High pitch
- **Timing**
  - Coincides with the apex beat
- **How to Identify S1 from S2**
  - S1 Coincides with apex upstroke
  - S1 is heard immediately before carotid upstroke
  - S1 with shorter interval from S2
  - Apex - S1 louder than S2
  - Base - S2 louder than S1, S2 splits on inspiration
- **Factors affecting the loudness of S1**
  - Rate of rise of LV pressure
  - Timing of MV closure in relation to onset of ventricular contraction
  - Position of the MV at the beginning of ventricular contraction
  - The more open the mitral valve is at the end of diastole, the louder the S1(parang pinto. Kapag binuksan mo ng malaki, malakas ang kalabog pag padabog mong sinara)
  - The stronger the LV contracts, the louder the S1
- **Splitting of S1**: usually over tricuspid area

**S2 (2nd Heart sound)**
- **Etiology**
  - Initiation of diastole
  - Sudden deceleration of forward flow during aortic and pulmonary valve closure
  - Best heard at the base of the heart
  - Normally widens on inspiration
- **Physiologic Splitting**
  - When a person inhales, the intrathoracic pressure becomes more NEGATIVE increases the blood returning to the right side of the heart. Therefore in SYSTOLE, more blood is present in the right atrium LONGER time is needed for blood to empty from the right atrium to the right ventricle
  - Component delayed is the pulmonic component

![Diagram](attachment:image1.png)
S3 (3rd Heart sound)

- Rapid filling sound
- Early filling gallop sound
- Occurs at the end of the rapid expansion phase of the ventricle
- Heard best at or near the apex
- Heart best with bell applied with light pressure
- **Physiologic S3**: due to increase in velocity of ventricular expansion (tachycardia, nervousness)
- **Pathologic S3**: loss of compliance/distensibility (heart failure)

S4 (4th Heart Sound)

- Atrial gallop, presystolic gallop, S4 gallop
- rarely physiological
- commonly pathological - decreased distensibility or compliance of the LV
  - During atrial Contraction
- best heard with the use of bell at the apex with the patient on left lateral decubitus

Murmurs

- Abnormal sounds
- Pericardial friction rub
- Prosthetic Valve sounds
- Pacemaker sounds

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**JUGULAR VENOUS PULSE**

Use internal jugular vein which is behind SCM (external jugular vein may also be used)

- Look for maximal movement of that column of blood
- In getting JVP, use the RIGHT jugular vein because it reflects right atrial pressure

**REMEMBERS IN TAKING THE JVP:**

1. Patient must be seated at 30-45°
2. Measure the highest angulation
3. Put ruler horizontally
4. Put ruler vertically at angle of Louis
5. Height will be your JVP
6. Use cm mark
7. Use white light
JVP Waveforms

1. **a wave** - reflects the slight rise in atrial pressure that accompanies atrial contraction.
   a. It occurs just before the first heart sound and before the carotid pulse.
2. **x descent** - starts with atrial relaxation. It continues as the right ventricle, contracting during systole, pulls the floor of the atrium downward.
3. **v wave** - second elevation
   a. The tricuspid valve is closed, the chamber begins to fill, and right atrial pressure begins to rise again.
4. **y descent** - second trough
   a. When the tricuspid valve opens early in diastole, blood in the right atrium flows passively into the right ventricle and right atrial pressure falls again.

Low JVP → Dehydration, Diarrhea, Blood loss

**High JVP**
- Volume overload
- Increased RV pressure
- Increased vascular resistance
- Obstruction to outflow
- Pulmonary hypertension
- Any increase in pulmonary pressure
- Tricuspid stenosis
- Increased pressure in RA which reflects RV pressure
- Right heart failure

**OPENING SNAP**
- Occurs in mitral stenosis
- Occurs earlier than S3
- 1st heart sound accentuated
- To distinguish if S3 or OS
- Soft S1 - S3
- Loud S1 – OS

Murmurs

- **Murmurs**
  - Distinguishable from heart sounds by their longer duration.
  - Attributed to turbulent blood flow and may be "innocent, as with flow murmurs of young adults, or diagnostic of valvular heart disease.
  - High frequency
  - Low frequency
  - Mixture
  - Grade 1 - very faint, often missed
  - Grade 2 - faint but easily heard
  - Grade 3 - moderately loud
  - Grade 4 - loud murmur with thrill
  - Grade 5 - heard with stethoscope partly off the chest
  - Grade 6 - stethoscope entirely off the chest

**CAUSES:**
- Flow into a dilated chamber
- Backward flow across an incompetent valve
- Shunting out of a high pressure chamber through and abnormal passage
- Flow across a partial obstruction
  - Ex. Aortic stenosis
- Flow across valvular irregularity without obstruction
  - Ex. Bicuspid, aortic valve
- Increased flow through normal structures

**Maneuvers**

Some murmurs are affected by maneuvers to change intensity of murmurs. These are the following maneuvers:
1. Respiratory variations
2. Valsalva maneuver
3. Postural changes
4. Exercise
5. Pharmacologic agents
6. Post premature beat
7. Transient arterial occlusion

**Valsalva maneuver** – forceful attempt to exhale a closed glottis after taking a normal breath
- 2 part process: straining and relaxation
- Most murmurs diminish in intensity due to decreased ventricular filling and cardiac output except MVP
Classification of Murmurs

1. Systolic Murmurs

   a. *Systolic Ejection murmurs*
      i. Produced by blood flowing forward through a semilunar valve
      ii. starts with final component of S1
      iii. crescendo - decrescendo
      iv. finishes before S2
      v. PULMONIC & AORTIC STENOSIS

   b. *Systolic Regurgitant Murmurs*
      i. Produced by retrograde flow from a high pressure area through some abnormal opening into an area of lower pressure
      ii. always start with S1 if early
      iii. always go to or beyond S2 if late
      iv. predominantly high pitch and blowing when soft

2. Diastolic Murmurs

   a. *Diastolic Atrioventricular Valve Murmurs*
      i. low pitch
      ii. rumbling
      iii. starts with an opening snap
      iv. after short crescendo, it is decrescendo, followed by crescendo to S1 (presystolic accentuation)

   b. *Diastolic Semilunar Valve Murmurs*
      i. Begins with S2
      ii. decrescendo
      iii. blowing

1. Pulmonary Regurgitation
2. Aortic Regurgitation

   a. Sit the patient up
   b. Lean patient forward
   c. Press hard with diaphragm during held expiration
   d. “Lub kitah”

**PERICARDIAL FRICTION RUB**
- Caused by pericarditis
- usually sound crunching, scraping, creaking, grating, crackling or scratching
- has 3 components:
  - one systolic
  - two diastolic
- heard usually at the left sternal border about the 3rd or 4th ICS

**CAROTID PULSE**

Pulse: Remember RCV (rate, contour, volume)

**Carotid Arterial Pulsations**
- Pulsus parvus et tardus (eg. Severe AS)
- Pulsus Bisferiens (eg. Severe AR, AS w/ AR, HOCM)
- Pulsus Bigeminus (PVC in bigeminy)
- Dicrotic Pulse (HPN w/ low TPR eg. Fever, amyl nitrite)
- Pulsus alternans (severe depression of myocardial function)

**Simultaneous palpation of radial & femoral pulses: delayed pulse is a feature of aortic coarctation**
PERIPHERAL PULSES

ARTERIAL PULSATION

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<tr>
<th></th>
<th>BRACHIAL</th>
<th>RADIAL</th>
<th>FEMORAL</th>
<th>POPLITEAL</th>
<th>DORSALIS PEDIS</th>
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</thead>
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<tr>
<td>RIGHT</td>
<td>++</td>
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REPORTING OF DIAGNOSIS

+++ Hyperactive ++ Normal + Weak 0 Absence

Simultaneous Radial and Femoral (to detect aortic coarctation)

Popliteal: Use two hands

Dorsalis Pedis

Posterior tibialis: encircle you fingers on the medial malleolus

Brachial (do not use thumb!)

Radial

Femoral: press deeply below the inguinal ligament midway between the ASIS and symphysis pubis
The Auscultogram

- Whatever you cannot draw, write (e.g. yung precordium, lagay nyo sa baba)
- At the apex, louder si S1
- At the base, louder si S2
- Between S1 and S2 are systolic events.
- S1 split heard best on tricuspid. Left has higher pressure, so M1 is taller than T1.
- S2 split heard best at pulmonic, heard at inspiration (indicate). Pulmonic softer than aortic.
- For JVP, write the measurement. Normally the a-wave is higher.
- For CAP, normally upstroke is rapid and at S1. Gradually it will decline.