Your learning objectives for mastering the cardiovascular system examination are: to assess the jugular venous pressure and pulsation and the carotid upstroke; to palpate any heaves, lifts, and thrills; to determine the point of maximal impulse (PMI); to auscultate heart sounds and murmurs in six positions on the chest wall using the diaphragm and bell of the stethoscope; to identify $S_1$ from $S_2$ and distinguish systole from diastole; to identify extra sounds such as $S_3$ and $S_4$; and to correctly identify valvular murmurs such as mitral regurgitation and aortic insufficiency.

For a skilled clinical assessment, you must place your examination of the heart and great vessels in the context of the patient’s health history. You must also understand the anatomy of the heart and vascular structures of the neck and chest.

Finally, you must be able to accurately describe your findings.

Health History

Utilizing clinical reasoning, where you move from general observations to more specific conclusions, will lead you to skilled and comprehensive assessment of the patient.

For instance, the general appearance of the patient provides many clues to cardiac illness. Note the patient’s color, respiratory rate, and level of anxiety. These preliminary observations can be helpful as you begin taking the health history.

When talking with the patient, keep in mind the three goals of every health history: to establish a trusting and supportive relationship, to gather information, and to offer information.

When assessing new patients, you will gather information that will form the basis for a comprehensive written health history. For patients seeking care for a specific complaint, you may prepare a more focused, problem-oriented history. In either case you will record the patient’s chief complaint along with common or concerning symptoms.

So, tell me your special concerns today.

Common or concerning symptoms relating to neck vessels and the heart include: chest pain; palpitations; and shortness of breath, orthopnea, or paroxysmal nocturnal dyspnea.

Eliciting the patient’s concerns before the examination prepares you for an examination that is focused, efficient, and productive.
What I’d like you to do now is to put on this gown so it opens to the back, and then I’ll be back shortly.

Think about the possible meanings of your individual observations, fit them together in a logical pattern, and correlate your cardiac findings with the patient’s blood pressure, arterial pulses, venous pulsations, jugular venous pressure, the remainder of your physical examination, and the patient’s history.

**Anatomy Review—Vascular Structures of the Neck**

Let’s review the three key vascular structures in the neck: the carotid artery, the internal jugular vein, and the external jugular vein.

The carotid artery is deep to the sternomastoid muscle. The internal jugular vein lies beneath the sternomastoid muscle, adjacent to the carotid artery. (The internal jugular vein is not normally visible.) The external jugular vein runs at an angle along the sternomastoid muscle toward the clavicle.

After comprehensive hand hygiene, you are ready for the physical examination.

**Estimating Jugular Venous Pressure (JVP)**

Jugular venous pressure, or JVP, is a measurement of the highest oscillation point (or meniscus) of the jugular venous pulsations.

This measurement reflects pressure in the right atrium (that is, central venous pressure).

The JVP also provides valuable information about the patient’s volume status and cardiac function.

Estimating the patient’s JVP is one of the most important and frequently used skills of physical examination—and, often, the first step in your cardiovascular assessment.

The JVP is best assessed from pulsations in the right internal jugular vein.

Adjust the head of the examining table to 30 degrees. With the patient supine, place the patient’s head on a pillow just to the top of the shoulders to relax the sternomastoid muscles. Then adjust the patient’s gown and drape as necessary.

Examine both sides of the neck. Then turn the patient’s head slightly to the left, since the physical examination is conducted from the patient’s right side. Focusing on the right side, identify the external jugular vein. Then find the internal jugular venous pulsations. If necessary, raise or lower the head of the bed until you can see the oscillation point of the internal jugular venous pulsations in the lower half of the neck.
Look for the oscillation point along the sternomastoid muscle between the clavicle and the angle of the jaw, or just posterior to the sternomastoid.

Internal jugular pulsations have a soft, undulating quality, usually with three elevations per heart beat, two of which are visible, and two troughs. Whereas the carotid pulse has a more vigorous thrust with a single outward component.

Internal jugular pulsations are rarely palpable, whereas the carotid pulse is almost always palpable.

Internal jugular pulsations are eliminated by light pressure on the vein just above the clavicle... whereas the carotid pulse is not eliminated by the pressure.

The level of internal jugular pulsations changes with position. In a euvolemic patient the level in the neck drops as the patient becomes more upright... whereas the carotid pulse is unchanged by position.

Finally, the level of internal jugular pulsations usually falls with inspiration... whereas the carotid pulse is not affected by inspiration.

Measure the oscillation point of pulsation in the right internal jugular vein using the following technique.

Extend an elongated rectangular object, such as a 3 x 5 card, from the meniscus point of pulsation, while extending a centimeter ruler vertically from the sternal angle, making a right angle.

To establishing the true vertical and horizontal lines, place your ruler on the sternal angle and line it up with a vertical line in the room. Then place your card or other rectangular object at an exact right angle to the ruler. This constitutes your horizontal line.

Make sure one edge of the card is at the point of oscillation of the jugular venous pulsations, making sure to keep the card horizontal. Read the vertical distance where the card crosses the ruler.

This measurement identifies the jugular venous pressure, or JVP,—the vertical distance in centimeters above the sternal angle where your card crosses the ruler.

Round your measurement off to the nearest centimeter. In this patient, the JVP is about 2 centimeters above the sternal angle.

Venous pressure is elevated above normal when it measures at greater than 3 to 4 centimeters above the sternal angle with the bed elevated to 30 degrees, or more than 7 to 8 centimeters in total distance above the right atrium.

These steps allow you to make an accurate measurement of the JVP that is important for assessing the intravascular volume status in euvolemic, hypervolemic, or hypovolemic patients.
In hypovolemic patients, the JVP can be as high at the angle of the jaw. In hypovolemic patients, the JVP may be below the sternal angle.

**Assessing the Carotid Pulse**

Next, assess the carotid pulse. The carotid pulse provides valuable information about valvular heart disease and is especially useful for detecting aortic stenosis or aortic insufficiency. Your assessment will include both palpation (to assess the amplitude and contour of the carotid upstroke), and auscultation for the presence or absence of bruits from turbulent blood flow.

Inspect and palpate both the right and left carotid arteries, then compare. However, do not press on both carotid arteries at once since syncope may ensue.

Place your index and middle fingers, or your thumb, on the right carotid artery in the lower third of the neck.

Press just inside the medial border of a well-relaxed sternomastoid muscle, roughly at the level of the cricoid cartilage.

Slowly increase pressure until you feel a maximal pulsation.

Then slowly decrease pressure until you best sense the arterial pressure wave and contour.

Try to assess the amplitude of the pulse. This correlates reasonably well with the pulse pressure.

This illustration represents the contour of the pulse wave, that is, the speed of the upstroke, the duration of its summit, and the speed of the downstroke.

The normal upstroke is brisk, smooth, and rapid, and follows $S_1$ almost immediately. The summit is smooth, rounded, and roughly midsystolic.

The downstroke is less abrupt than the upstroke.

The more familiar you are with normal readings, the easier it will be to detect abnormalities, such as a pulse that has a bounding upstroke (aortic insufficiency)

These and other abnormalities of arterial pulse and pressure waves are important indicators of abnormalities of the aortic valve and cardiac function.

Okay, just turn your head a little bit and hold your breath...

After palpating the carotid arteries, listen carefully over both arteries with the diaphragm of your stethoscope. Some examiners use the bell. Ask the patient to hold breathing for a moment so that breath sounds do not obscure the sound of turbulent flow. Listen for a bruit, which is a whooshing, murmur-like sound often from atherosclerotic narrowing of the carotid artery. A bruit sounds like this:
You should listen for bruits over the carotid arteries in middle-aged or older adults, or if you suspect cerebrovascular disease.

**Anatomy Review—Heart**

Now turn to the cardiac examination and review the important features of cardiac anatomy.

The right atrium forms the right border of the heart. The left atrium is mostly posterior. Neither the right nor the left atrium can be examined directly.

Above the heart lie the great vessels. The pulmonary artery arises from the right ventricle and quickly bifurcates into its left and right branches. The aorta arises from the left ventricle.

Most of the anterior surface of the heart is made up of the right ventricle.

The left ventricle lies to the left of and behind the right ventricle. It forms the left border of the heart and produces the apical impulse.

During systole the left ventricular apex typically generates a brief tapping apical impulse usually found in the left 5th interspace about 7 to 9 centimeters from the midsternal line.

The impulse measures about the size of a quarter, roughly 1-to-2.5 centimeters in diameter.

**Examining the Heart**

Your examination of the heart consists of inspection, palpation, and auscultation. Let’s begin with inspection and palpation.

Stand at the patient’s right side. Have the patient remain supine with the upper body raised to 30 degrees. First, inspect the anterior chest, noting any heaves or lifts. None are observed here.

Careful inspection may also reveal the location of the apical impulse. Later in the examination you will palpate to more clearly identify the apical impulse.

Now proceed with palpating the chest wall.

First palpate for heaves or thrills using your fingerpads. Hold them flat or obliquely on the body surface as you palpate in the right and left 2nd interspaces, along the left sternal border and in the apical area.

Ventricular impulses may heave, or lift your fingers, suggesting ventricular dilatation. None is seen here.

Then check for thrills by pressing the ball of your hand firmly on the chest in these same locations. If subsequent auscultation reveals a loud murmur, go back and check for thrills over
that area again. Thrills suggest underlying turbulent blood flow and change how you will grade related heart murmurs.

Next, identify the apical impulse. The apical impulse represents the brief pulsation of the left ventricle as it moves anteriorly during contraction and touches the chest wall. Note that in most examinations the apical impulse is the point of maximal impulse, or PMI. However, some pathologic conditions—an enlarged right ventricle, for example—may produce a pulsation that is more prominent than the apical impulse.

Using the palmar surfaces of several fingers—then, for finer assessments, your fingertips followed by one finger alone—palpate to confirm the characteristics of the apical impulse. You will note its location, diameter, and amplitude.

Identify the location of the apical impulse by the interspaces in which you feel it and by its distance in centimeters from the mid-sternal line.

If you experience difficulty locating the apical impulse, ask the patient to tip or partially roll onto his left lateral side, that is, into the left lateral decubitus position. Palpate again using the palmar surfaces of several fingers.

Measure the diameter of the impulse in centimeters.

Feel for the amplitude of the apical impulse. It is usually small and feels like a gentle tap. A diffuse apical impulse suggests left ventricular dilatation often found in congestive heart failure. A sustained tapping impulse that lifts your finger off the chest wall suggests left ventricular hypertrophy found in hypertension and aortic stenosis.

With experience you will learn to feel the apical impulse in a high percentage of patients.

Next, feel for a right ventricular impulse at the lower left sternal border.

While keeping one finger in the 3rd interspace, place additional fingertips in the 4th and 5th interspaces. Then feel for the right ventricular impulse in the epigastric, or subxiphoid, area.

I’d like you to take a breath in.

If the patient’s chest has an increased anteroposterior diameter, palpate for the right ventricular impulse high in the epigastric area where it may be easier to feel.

This can be seen in COPD due to increased right ventricular pressure and hypertrophy from pulmonary hypertension.

**Heart Sounds**

Auscultation of heart sounds is an important skill that leads directly to important clinical diagnoses. Before auscultating the heart, let’s review normal heart sounds.
Closure of the heart valves creates a pair of audible heart sounds. The first sound, $S_1$, arises from closure of the mitral valve.

[S1 SOUNDS OF CLOSURE OF MITRAL VALVE]

Tricuspid valve closure may also contribute to $S_1$.

The second sound, $S_2$, arises from closure of the aortic valve.

[S2 SOUNDS OVER AORTIC VALVE]

Pulmonic valve closure may also contribute to $S_2$.

This graphic represents the ventricular systole that occurs between $S_1$ and $S_2$.

Ventricular diastole occurs between $S_2$ and the next $S_1$.

The fact that diastole usually lasts longer than systole is helpful in distinguishing the two sounds.

**Auscultation of Heart Sounds**

When auscultating, it’s important to know your stethoscope.

The diaphragm is better for detecting higher pitched sounds such as $S_1$ or $S_2$, the murmurs of aortic and mitral regurgitation, and pericardial friction rubs.

The bell is more sensitive to low-pitched sounds such as $S_3$ or $S_4$ and the murmur of mitral stenosis.

When auscultating the heart, remember to correlate your findings with the patient’s jugular venous pressure and carotid pulse.

For example, if there is a diffuse PMI and an $S_3$ suggesting congestive heart failure, look for an elevated JVP.

You will listen for $S_1$ and $S_2$ in each of the six listening areas: in the aortic area in the right 2nd interspace close to the sternum, in the pulmonic area in the left 2nd interspace close to the sternum, in the left 3rd interspace, in the tricuspid area in the left 4th and left 5th interspaces, and in the mitral area at the apex.

I’m going to listen to your heart over various areas of your chest.

To begin the auscultation sequence, adjust your stethoscope so that you listen through the diaphragm.

Begin listening in the aortic area, at the right 2nd interspace close to the sternum. Starting in the right 2nd interspace helps orient you to the cardiac cycle.
Note the cardiac rate and rhythm. Normally the rate is 60–100 beats per minute, and the rhythm is regular.

Identify $S_1$ and $S_2$, in the aortic area, $S_2$ is usually louder than $S_1$.

[$S_2$ SOUNDS IN AORTIC AREA]

$S_2$ is also usually louder than $S_1$ in the pulmonic area.

[$S_2$ SOUNDS IN PULMONIC AREA]

Okay now, just take a breath in and out.

Still listening in the pulmonic area, try to identify the inspiratory splitting of $S_2$ into its two components. Its first component, $A_2$, is from aortic valve closure. Its second component, $P_2$, comes from pulmonic valve closure.

[INSPIRATORY SPLITTING OF $S_2$]

This “physiologic split” of $S_2A$ and $S_2P$ normally occurs during inspiration. During expiration, however, these two components are fused into a single sound, $S_2$. Listen again...

[INSPIRATORY SPLITTING OF $S_2$]

$S_2$ usually diminishes in intensity while $S_1$ becomes louder as you proceed down through the 3rd interspace and into the tricuspid and mitral areas.

[$S_2$ DIMINISHES, $S_1$ BECOMES LOUDER]

Now switch to the bell of the stethoscope.

Listen next along the lower left sternal border in the left 4th and 5th interspaces. Then listen at the apex.

I’d like to listen to your heart in another position. So could you tip over onto your left side, please?

To improve your ability to hear $S_3$, $S_4$, and the murmur of mitral stenosis, place the patient in the left lateral decubitus position. Have the patient roll part way onto his left side. This brings the left ventricle closer to the chest wall and makes low pitched sounds more audible.

Then, recheck the position of the apical impulse and place the bell lightly over that location. If the patient had an audible $S_3$, it would sound like this.

[$S_3$ SOUNDS]

Now, notice how the third heart sound disappears when the bell is placed more firmly on the chest wall.

[$S_3$ SOUNDS DISAPPEAR]
Attributes and Grading of Heart Murmurs

Murmurs are differentiated from heart sounds by their longer duration. If you detect a heart murmur, you must learn to assess its timing, shape, location of maximal intensity, and radiation; grade its intensity; and assess its pitch and quality.

Palpating the carotid pulse as you listen can help you with timing.

First, decide if you are hearing a systolic murmur, falling between S\textsubscript{1} and S\textsubscript{2} and coinciding with the carotid upstroke, or a diastolic murmur, falling between S\textsubscript{2} and S\textsubscript{1}, falling before or after the carotid upstroke. Murmurs are classified according to where they fall in systole and diastole.

Palpating the carotid upstroke as you listen to the murmur is an important tip that helps you decide if the murmur is systolic or diastolic.

Systolic murmurs can be early, mid, or late systolic, or even pansystolic.

For example, a midsystolic murmur, heard in physiologic flow murmurs or the crescendo–decrescendo murmur of aortic stenosis, begins after S\textsubscript{1} and stops before S\textsubscript{2}.

A middiastolic murmur, as in mitral stenosis, starts a short time after S\textsubscript{2} and may follow an opening snap.

The shape of a murmur is determined by its intensity over time.

A crescendo murmur grows louder...

A decrescendo murmur grows softer...
A plateau murmur has the same intensity throughout.

[PLATEAU MURMUR]

The location of maximal intensity is determined by the site where the murmur originates. Find the location by exploring the area where the murmur is loudest.

Describe where you hear it best in terms of the interspace...

...and describe the murmur’s position relative to the sternum, the apex, or the midsternal, midclavicular, or one of the axillary lines.

Radiation, also referred to as transmission from the point of maximal intensity, reflects not only the site of origin, but also the intensity of the murmur and the direction of blood flow. Auscultate the area around a murmur and determine where else you can hear it.

Intensity is usually graded on a 6-point scale and expressed as a ratio. The numerator describes the intensity of the murmur wherever it is loudest, and the denominator, by convention, is 6, indicating the scale you are using.

Using the 6-point scale, grade 1 indicates a murmur that is very faint, and heard only after the listener has “tuned in.” It may not be heard in all positions.

A grade 2 murmur is quiet, but heard immediately after placing the stethoscope on the chest.

A grade 3 murmur is moderately loud...and grades 4, 5 and 6 by definition have an accompanying palpable thrill.

The quality of a murmur is described in terms such as “harsh,” “blowing” (as in aortic regurgitation) “musical” (as in some murmurs of mitral valve prolapse), or “rumbling” (as in mitral stenosis).

To better detect the more subtle diastolic murmurs of aortic regurgitation and mitral stenosis, you should routinely use two maneuvers. The first maneuver is performed with the patient sitting up and leaning forward. This maneuver enhances detection of aortic regurgitation by moving the left ventricle closer to the chest wall.

Ask the patient to exhale completely and hold his breath out.

Take a big breath in. Blow it all out, and stop.

Using the diaphragm of the stethoscope, listen at the left 2nd interspace and down the left sternal border to the apex for the high-pitched, soft blowing, decrescendo diastolic murmur of aortic regurgitation.

If the patient had this murmur, it would sound like this.

[SOFT-BLOWING DIASTOLIC MURMUR OF AORTIC REGURGITATION]
The second maneuver helps you detect the murmur of mitral stenosis. Have the patient change to the left lateral decubitus position. Auscultating in this position enhances detection of the more subtle opening snap and diastolic rumble of mitral stenosis.

**Recording Your Findings**

A clear, well-organized clinical record—employing language that is neutral, professional, and succinct—is one of the most important adjuncts to patient care. For a healthy patient, your write-up might include language such as...

[TYPING] Jugular venous pressure is 3 centimeters above the sternal angle with head of bed elevated to 30 degrees, or 7 centimeters above the right atrium. Carotid upstrokes brisk, without bruits...

After practice and further review of this video, make sure you have mastered the important learning objectives for examining the cardiovascular system.