

Chest Pain

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Chest pain is a very common presenting symptom. Many patients are well aware that it is a warning of potential life-threatening disorders and seek evaluation for minimal symptoms. Other patients, including many with serious disease, minimize or ignore its warnings. Pain perception (both character and severity) varies greatly between individuals as well as between males and females. However described, chest pain should never be dismissed without an explanation of its cause.

Pathophysiology of Chest Pain

The heart, lungs, esophagus, and great vessels provide afferent visceral input through the same thoracic autonomic ganglia. A painful stimulus in these organs is typically perceived as originating in the chest, but because afferent nerve fibers overlap in the dorsal ganglia, thoracic pain may be felt (as referred pain) anywhere between the umbilicus and the ear, including the upper extremities.

Painful stimuli from thoracic organs can cause discomfort described as pressure, tearing, gas with the urge to eructate, indigestion, burning or aching. Uncommonly, other descriptions of chest pain are given such as stabbing or sharp needle-like pain. When the sensation is visceral in origin, many patients deny they are having pain and insist it is merely “discomfort.”

Etiology of Chest Pain

Many disorders cause chest pain or discomfort. These disorders may involve the cardiovascular, gastrointestinal, pulmonary, neurologic, or musculoskeletal systems (see table [Some Causes of Chest Pain](#)).

Some disorders are **immediately life threatening**:

- [Acute coronary syndromes](#) (acute myocardial infarction/unstable angina)
- Thoracic [aortic dissection](#)
- [Tension pneumothorax](#)
- [Esophageal rupture](#)
- [Pulmonary embolism](#) (PE)

Other causes range from serious, potential threats to life to causes that are simply uncomfortable.

Overall, the **most common causes** are

- Chest wall disorders (ie, those involving muscle, rib, or cartilage)
- Pleural disorders
- Gastrointestinal disorders (eg, [gastroesophageal reflux disease](#), [esophageal spasm](#), [ulcer disease](#), [cholelithiasis](#))
- [Acute coronary syndromes](#) and stable [angina](#)

In some cases, no cause can be confirmed even after a full evaluation.

TABLE

Some Causes of Chest Pain

Cause*	Suggestive Findings	Diagnostic Approach†
Cardiovascular		
1 Myocardial ischemia (acute myocardial infarction/unstable angina/ angina)	<p>Acute, crushing pain radiating to the jaw or arm</p> <p>Exertional pain relieved by rest (angina pectoris)</p> <p>S4 gallop</p> <p>Sometimes systolic murmurs of mitral regurgitation</p> <p>Often red flag findings‡</p>	<p>Serial ECGs and cardiac biomarkers</p> <p>Sometimes echocardiogram (traditional, POCUS, or both)</p> <p>Stress imaging test or CT angiography considered in patients with negative or unchanged ECG findings and no cardiac biomarker elevation on serial testing</p> <p>Often heart catheterization and coronary angiography if findings are positive</p>
1 Thoracic aortic dissection	<p>Sudden, tearing pain radiating to the back</p> <p>Some patients have syncope, stroke, or leg ischemia</p> <p>Pulse or blood pressure that may be unequal in extremities</p> <p>Age > 55 years</p> <p>Hypertension</p> <p>Red flag findings‡</p>	<p>D-dimer in patients who are at low risk</p> <p>Chest radiograph, which may reveal widening of the mediastinum</p> <p>In patients who are hemodynamically stable: CT angiogram, possibly subsequent MR angiography or TEE</p> <p>In patients who are hemodynamically unstable: bedside TEE</p>
2 Myocarditis	<p>Fever, dyspnea, fatigue, chest pain (if myopericarditis), recent viral or other infection</p> <p>Sometimes findings of heart</p>	<p>ECG</p> <p>Serum cardiac biomarkers</p> <p>ESR</p> <p>C-reactive protein</p>

	failure, pericarditis, or both	Usually echocardiography or cardiac MRI
2 <u>Pericarditis</u>	<p>Constant or intermittent sharp pain often aggravated by breathing, swallowing food, or supine position and relieved by sitting or leaning forward</p> <p>Pericardial friction rub</p> <p>Jugular venous distention (if constrictive pericarditis or large or rapidly accumulating pericardial effusion)</p>	<p>ECG</p> <p>Serum cardiac biomarkers (sometimes showing minimal elevation of troponin and CK-MB levels if associated myocarditis present)</p> <p>Transthoracic echocardiogram to evaluate for pericardial effusion</p>
Gastrointestinal		
1 <u>Esophageal rupture</u>	<p>Sudden, severe pain following vomiting or instrumentation (eg, esophagogastroscope or transesophageal echocardiography)</p> <p>Subcutaneous crepitus detected during auscultation</p> <p>Red flag findings†</p>	<p>Chest radiography</p> <p>Esophagography with water-soluble contrast for confirmation</p>
2 <u>Pancreatitis</u>	<p>Pain in the epigastrium or lower chest that is often worse when lying flat and is relieved by leaning forward</p> <p>Vomiting</p> <p>Upper abdominal tenderness</p> <p>Shock</p> <p>Fever</p> <p>Often history of alcohol use disorder or biliary tract disease</p>	<p>Serum lipase (> 3 times upper limit of normal)</p> <p>Abdominal CT</p>
3 <u>Biliary tract disease</u>	<p>Recurrent right upper quadrant or epigastric discomfort following meals</p>	<p>Ultrasonography of gallbladder</p> <p>Sometimes <u>cholescintigraphy</u> (hepatic</p>

	(but not exertion)	iminodiacetic acid [HIDA] scan)
3 Esophageal motility disorders	Long-standing pain of insidious onset that may or may not accompany swallowing Usually also difficulty swallowing	Barium swallow Esophageal manometry
3 Esophageal reflux (GERD)	Recurrent burning pain radiating from epigastrium to throat that is exacerbated by bending down or lying down and relieved by antacids	Clinical evaluation Sometimes endoscopy Sometimes motility studies
3 Peptic ulcer	Recurrent, vague epigastric discomfort, particularly in a patient who smokes or uses alcohol excessively, that is relieved by food, antacids, or both No red flag findings (unless perforated or bleeding)‡	Clinical evaluation Sometimes endoscopy Sometimes testing for <i>Helicobacter pylori</i>
Pulmonary		
1 Pulmonary embolism	Often pleuritic pain, dyspnea, tachycardia Sometimes mild fever, hemoptysis, shock More likely when risk factors are present	Risk stratification (Wells Criteria, Pulmonary Embolism Rule-out Criteria [PERC rule], Revised Geneva Scoring System) ECG, chest radiography, BNP, troponin (evaluate alternative diagnosis, and provide prognostic information) Sometimes POCUS (right ventricular size and function, interventricular septum, inferior vena cava) Sometimes D-dimer Sometimes CT pulmonary angiography

1 <u>Tension pneumothorax</u>	Significant dyspnea, hypotension, neck vein distention, unilateral diminished breath sounds and hyperresonance to percussion Sometimes subcutaneous air	Usually clinical evaluation Obvious on chest radiograph Sometimes immediate POCUS
2 <u>Pneumonia</u>	Fever, chills, cough, and sometimes purulent sputum Often dyspnea, tachycardia, signs of consolidation	Chest radiography
2 <u>Pneumothorax</u>	Sometimes, pleuritic chest pain, unilateral diminished breath sounds, and/or subcutaneous air	Chest radiography Sometimes POCUS or chest CT
3 Pleuritis	May have preceding pneumonia, pulmonary embolism, or viral respiratory infection Pain with breathing, cough Sometimes a pleural rub, but otherwise examination unremarkable	Usually clinical evaluation Sometimes chest radiography
Other		
2 Various thoracic cancers	Variable but sometimes pleuritic pain Sometimes chronic cough, smoking history, signs of chronic illness (weight loss, fever), cervical lymphadenopathy	Chest radiography Chest CT if plain radiograph findings are compatible with cancer Bone scan considered for persistent, focal rib pain
3 Musculoskeletal chest wall pain (eg, due to trauma, overuse, or costochondritis)	Often suggested by history Pain typically persistent (typically days or longer), worsened with passive and active motion Diffuse or focal tenderness	Clinical evaluation

3 <u>Fibromyalgia</u>	<p>Nearly constant pain, affecting multiple areas of the body as well as the chest</p> <p>Typically, fatigue and poor sleep</p> <p>Multiple trigger points</p>	Clinical evaluation
3 <u>Herpes zoster</u> infection	<p>Sharp, band-like pain in the thorax unilaterally</p> <p>Classic dermatomal, unilateral, vesicular rash</p> <p>Pain may precede rash by several days</p>	Clinical evaluation
3 Idiopathic	<p>Various features</p> <p>No red flag findings‡</p>	Diagnosis of exclusion
<p>* Seriousness of causes varies as indicated:</p> <p>¹ Immediate life threats.</p> <p>² Potential life threats.</p> <p>³ Uncomfortable but usually not dangerous.</p>		
<p>† Most patients with chest pain should have pulse oximetry, ECG, and chest radiography (basic tests). If there is suspicion of coronary ischemia, serum cardiac biomarkers (troponin, CK-MB) should also be checked.</p>		
<p>‡ Red flag findings include abnormal vital signs (tachycardia, bradycardia, tachypnea, hypotension), signs of hypoperfusion (eg, confusion, ashen color, diaphoresis), shortness of breath, asymmetric breath sounds or pulses, new heart murmurs, or pulsus paradoxus > 10 mm Hg.</p>		
<p>BNP = brain (B-type) natriuretic peptide; CK-MB = creatine kinase, MB fraction; ESR = erythrocyte sedimentation rate; POCUS = point-of-care ultrasound; S4 = fourth heart sound; TEE = transesophageal echocardiogram.</p>		

Evaluation of Chest Pain

History

History of present illness should note the location, duration, character, and quality of the pain. The patient should be asked about any precipitating events (eg, straining or overuse of chest muscles), as well as any triggering and relieving factors. Specific factors to note include whether pain is present during exertion or at rest, presence of psychologic stress, whether pain occurs during respiration or coughing, difficulty swallowing, relationship to meals, and positions that relieve or exacerbate pain (eg, lying flat, leaning forward). Previous similar episodes and their circumstances should be noted with attention to the similarity or lack thereof and whether the episodes are increasing in frequency and/or duration. Important associated symptoms to seek include [dyspnea](#), [palpitations](#), [syncope](#), diaphoresis, nausea or vomiting, cough, fever, and chills.

Review of systems should seek symptoms of possible causes, including leg pain, swelling, or both ([deep venous thrombosis](#) [DVT] and therefore possible [pulmonary embolism](#)) and chronic weakness, malaise, and weight loss (cancer).

Past medical history should document known causes, particularly cardiovascular and gastrointestinal (GI) disorders, and any cardiac investigations or procedures (eg, stress testing, catheterization). [Risk factors for coronary artery disease](#) (CAD—eg, hypertension, dyslipidemia, diabetes, cerebrovascular disease, tobacco use) or [pulmonary embolism](#) (eg, lower extremity injury, recent surgery, immobilization, known cancer, pregnancy) should also be noted.

Drug history should note use of drugs that can trigger coronary artery spasm (eg, cocaine, triptans) or GI disease (particularly alcohol, nonsteroidal anti-inflammatory drugs).

Family history should note history of [myocardial infarction](#) (particularly among first-degree relatives at an early age, ie, < 55 years in males and < 60 years in females) and dyslipidemia.

Physical examination

The extent of physical examination is guided by clinical suspicion. Vital signs and weight are measured, and body mass index (BMI) can be calculated. Pulses are palpated in both arms and both legs, blood pressure is measured in both arms.

General appearance is noted (eg, pallor, diaphoresis, cyanosis, anxiety).

The neck is inspected for venous distention and hepatjugular reflux. The neck is palpated for carotid pulses, lymphadenopathy, or thyroid abnormality. The carotid arteries are auscultated for bruit.

Lungs are percussed and auscultated for presence and symmetry of [breath sounds](#), signs of congestion (dry or wet crackles, rhonchi), consolidation (pectoriloquy), pleural friction rubs, and effusion (decreased breath sounds, dullness to percussion).

The cardiac examination notes the intensity and timing of the first heart sound (S1) and second heart sound (S2), the respiratory movement of the pulmonic component of S2, pericardial friction rubs, murmurs, and gallops. When murmurs are detected, the timing, duration, pitch, shape, and intensity and the response to changes of position, handgrip, and the Valsalva maneuver should be noted. When gallops are detected, differentiation should be made between the fourth heart sound (S4), which is

often present with diastolic dysfunction or myocardial ischemia, and the third heart sound (S3), which is present with systolic dysfunction.

The chest is inspected for skin lesions due to trauma or herpes zoster infection and palpated for crepitance (suggesting subcutaneous air) and tenderness. The abdomen is palpated for tenderness, organomegaly, and masses or tenderness, particularly in the epigastric and right upper quadrant regions.

The legs are examined for arterial pulses, adequacy of perfusion, edema, varicose veins, and signs of DVT (eg, swelling, erythema, tenderness).

Pulsus paradoxus may be measured if there is clinical concern for pericardial tamponade (distant heart sounds, jugular venous distension, unexplained dyspnea, tachycardia, or hypotension).

Red flags

Certain findings raise suspicion of a more serious etiology of chest pain:

- Abnormal vital signs (tachycardia, bradycardia, tachypnea, hypotension)
- Signs of hypoperfusion (eg, confusion, ashen color, diaphoresis)
- Shortness of breath
- Hypoxemia on pulse oximetry
- Asymmetric breath sounds or pulses
- New heart murmurs
- Pulsus paradoxus > 10 mm Hg

Interpretation of findings

Symptoms and signs of thoracic disorders vary greatly, and those of serious and nonserious conditions often overlap. Although red flag findings indicate a high likelihood of serious disease, and many disorders have “classic” manifestations (see table Some Causes of Chest Pain), many patients who have serious illness do not present with these classic symptoms and signs. For example, patients with myocardial ischemia may say only that they have indigestion or have a very tender chest wall on palpation. A high index of suspicion is important when evaluating patients with chest pain. Nonetheless, some distinctions and generalizations are possible.

Duration of pain can provide clues to the severity of the disorder. Long-standing pain (ie, for weeks or months) is not a manifestation of a disorder that is immediately life threatening. Such pain is often musculoskeletal in origin, although gastrointestinal origin or a cancer should be considered, particularly in patients who are older. Similarly, brief (< 5 seconds), sharp, intermittent pains rarely result from serious disorders. Serious disorders typically manifest pain lasting minutes to hours, although episodes may be recurrent (eg, unstable angina may cause several bouts of pain over 1 or more days).

Patient age is helpful in evaluating chest pain. Chest pain in children and young adults (< 30 years) is less likely to result from myocardial ischemia, although myocardial infarction can occur in people in

their 20s. Musculoskeletal and pulmonary disorders are more common causes in children and young adults.

Exacerbation and relief of symptoms also are helpful in evaluating chest pain. Although angina can be felt anywhere between the ear and the umbilicus, it is typically consistently related to physical or emotional stress, ie, patients do not experience angina from climbing 1 flight of stairs one day and tolerate 3 flights the next day. Nocturnal angina is characteristic of [acute coronary syndromes](#), [heart failure](#), or coronary artery spasm.

Pain from many disorders, both serious and minor, can be exacerbated by respiration, movement, or palpation of the chest. These findings are not specific for origin in the chest wall.

Nitroglycerin may relieve pain of both myocardial ischemia and noncardiac smooth muscle spasm (eg, esophageal or biliary disorders); its efficacy or lack thereof should not be used for diagnosis.

Associated findings may also suggest a cause. Fever is nonspecific but, if accompanied by cough, suggests a pulmonary cause. Patients with [Raynaud syndrome](#) or [migraine](#) sometimes have coronary spasm.

The presence or absence of [risk factors for CAD](#) (eg, [hypertension](#), [hypercholesterolemia](#), smoking, [obesity](#), [diabetes](#), positive family history) alters the probability of underlying CAD but does not help diagnose the cause of a given episode of acute chest pain. Patients with those factors may well have another cause of chest pain, and patients without them may have an [acute coronary syndrome](#). However, known CAD in a patient with chest pain raises the likelihood of that diagnosis as the cause (particularly if the patient describes the symptoms as “like my angina” or “like my last heart attack”). A history of [peripheral vascular disease](#) also raises the likelihood that [angina](#) is the cause of chest pain.

Testing

Testing can involve ECG, cardiac biomarkers, and imaging tests (1). For adults with acute chest pain, immediate life threats must be ruled out. Most patients should initially have pulse oximetry, [ECG](#), and chest radiographs. Sometimes, particularly in patients with hemodynamic instability, either a point-of-care ultrasound (POCUS) or a complete echocardiogram can also be useful in further evaluating potential life-threatening causes (2). Echocardiography can be particularly useful in identifying left ventricular or right ventricular dysfunction, evidence of right ventricular pressure overload, valvular pathology, pericardial effusions, and signs of pericardial tamponade.

If symptoms suggest an [acute coronary syndrome](#) or if no other cause is clear (particularly in patients who are at risk), [troponin levels](#) are measured. Expeditious evaluation is essential because if myocardial infarction or other acute coronary syndrome is present, the patient should be considered for urgent heart catheterization (when available). Immediate catheterization is indicated in patients with ST-elevation on ECG or in patients with non-ST-segment elevation myocardial infarction (NSTEMI) plus high-risk features (eg, hypotension, ventricular arrhythmias, persistent chest pain despite optimal medical management), or high risk score (GRACE risk score [3]). In these patients, catheterization within 90 minutes of arrival is considered standard of care. For patients at low risk and possible NSTEMI, non-urgent catheterization along with expeditious non-invasive medical management can be pursued.

Some abnormal findings on these tests confirm a diagnosis (eg, [acute myocardial infarction](#), [pneumothorax](#), [pneumonia](#)). Other abnormalities suggest a diagnosis or at least the need to pursue further investigation (eg, abnormal aortic contour on chest radiograph suggests need for testing for [thoracic aortic dissection](#)). Thus, if these initial test results are normal, thoracic aortic dissection, tension pneumothorax, and esophageal rupture are highly unlikely. However, in acute coronary syndromes, ECG may not change for several hours or sometimes not at all, and in pulmonary embolism, oxygenation may be normal. Thus, other studies may need to be obtained based on findings from the history and physical examination (see table [Some Causes of Chest Pain](#)). Further, ST-segment abnormality on the ECG may be nonspecific or due to antecedent disorders, so comparison with previous ECGs is important.

Because a single normal set of cardiac biomarkers does not rule out a cardiac cause, patients whose symptoms suggest an [acute coronary syndrome](#) should have serial measurement of the cardiac biomarker troponin and serial ECGs. [Medications for suspected acute coronary syndrome](#) are begun while awaiting results of the second troponin level unless there is a clear contraindication. A diagnostic trial of sublingual nitroglycerin or an oral liquid antacid does not adequately differentiate myocardial ischemia from gastroesophageal reflux disease or gastritis. Either medication may relieve symptoms of either disorder.

Troponin will be elevated in acute coronary syndromes except unstable angina, and often in other disorders that damage the myocardium (eg, [myocarditis](#), [pericarditis](#), [aortic dissection](#) involving coronary artery flow, [pulmonary embolism](#), [heart failure](#), [severe sepsis](#)). Creatine kinase (CK) may be elevated due to damage to any muscle tissue, but creatine kinase-MB isoenzyme (CK-MB) elevation is specific to damage to the myocardium. However, troponin is the standard marker of cardiac muscle injury. Advances in high-sensitivity troponin assays allow for more rapid serial evaluation of a possible acute coronary syndrome. With improved negative predictive value, high sensitivity troponin also has the potential to decrease the necessity of further testing in patients with negative biomarkers and has been demonstrated to allow patients to be discharged more quickly ([4](#)). Guidelines recommend using normal troponin levels and negative coronary CT scanning as a reliable strategy to exclude acute coronary syndrome in patients with chest pain and no red flags ([5](#)). Following up negative initial testing (acutely or within several days) with a stress ECG or a stress imaging test is also reasonable, particularly when there is an intermediate to high clinical suspicion for coronary artery disease or elevated risk of major adverse cardiovascular events (HEART score [\[6\]](#)).

If a pulmonary embolism (PE) is considered possible, D-dimer testing is done in patients who are at low or intermediate risk. The likelihood of pulmonary embolism is affected by a number of clinical factors, which can be used to derive an approach to testing. Many of these factors are included in scoring systems that help determine the probability of PE such as the Wells Scoring System, the Revised Geneva Scoring System, and the Pulmonary Embolism Rule Out Criteria (PERC—[7,8,9](#)).

In patients with chronic chest pain, immediate threats to life are unlikely. Most clinicians initially obtain a chest radiograph and do other tests based on symptoms and signs.

CLINICAL CALCULATORS

Pulmonary Embolism Wells Score



Evaluation references

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Treatment of Chest Pain

Specific identified disorders are treated. If etiology is not clearly benign, patients are usually admitted to the hospital or an observation unit for cardiac monitoring and more extensive evaluation. [Pain](#) is treated with acetaminophen or opioids as needed, pending a diagnosis. Pain relief following opioid treatment should not diminish the urgency of ruling out serious and life-threatening disease.

If pulmonary embolism is highly likely, anticoagulants should be given while the diagnosis is pursued; another embolus in a patient who is not receiving anticoagulants may be fatal.

Geriatrics Essentials: Chest Pain

The probability of serious and life-threatening disease increases with age. Many older patients recover more slowly than younger patients but survive for significant time if properly diagnosed and treated. Medication doses are usually lower, and rapidity of dose escalation is slower. Chronic disorders (eg, chronic kidney disease) are often present and may complicate diagnosis and treatment.

Key Points

- Immediate life threats must be ruled out first.
- Some serious disorders, particularly coronary ischemia and pulmonary embolism, often do not have a classic presentation.
- Most patients should have pulse oximetry, ECG, cardiac marker measurement, and chest radiograph.
- Evaluation must be prompt so that patients with ST-elevation myocardial infarction or other criteria for intervention can be in the heart catheterization laboratory (or have thrombolysis) within the 90-minute standard.
- If pulmonary embolism is highly likely, anticoagulants should be given while the diagnosis is pursued; another embolus in a patient who is not receiving anticoagulants may be fatal.



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