Chapter 1
Chest Pain

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Abbreviations

ACS	Acute coronary syndrome
ASCVD	Atherosclerotic cardiovascular disease
CAD	Coronary artery disease
CP	Chest pain
DVT	Deep vein thrombosis
ECG	Electrocardiogram
GERD	Gastroesophageal reflux disease
H&P	History and physical
HCM	Hypertrophic cardiomyopathy
MI	Myocardial infarction
PCP	Primary care physician

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PE	Pulmonary embolism
PMH	Past medical history

Introduction

- The differential diagnosis of chest pain (CP) is broad, with etiologies ranging from life-threatening to those with low morbidity and mortality.
- CP is one of the most common complaints in the outpatient setting with a prevalence ranging from 20% to 40% depending on criteria, location, and practice [1].
- The primary care physician (PCP) is often the main point of entry to the healthcare system.
- Cardiovascular disease, the most life-threatening etiology, must be ruled out in the initial evaluation.
- Musculoskeletal or "chest wall syndrome" is the most common cause in the primary care setting [2], accounting for 20.4–50% of cases [1–3], followed by gastroesophageal reflux disease (GERD).
- The prevalence of CP due to coronary artery disease (CAD) ranges from 1.5% to 15% [3, 4].
- A detailed history and physical (H&P) of the patient's CP can limit unnecessary testing.

Initial Evaluation

- The "OPQRST" mnemonic provides a helpful framework to approach the history of present illness and narrow the differential diagnosis [5]:
  - Onset of pain
  - Provocation/palliation
  - Quality
  - Radiation
  - Site of pain
  - Timing
- The pain characteristics (3 P's) that decrease the likelihood of acute coronary syndrome (ACS) [6] are:
  - **P**leuritic pain worsened with inspiration

  - **P**ositional pain worsened with lying down
  - Pain reproduced by **p**alpation
- The approach to a differential diagnosis of chest pain can be divided into cardiac versus non-cardiac etiologies [7].

Clinical Pearl 1
A negative ECG and troponin do not rule out ACS.

Cardiac Etiologies of Chest Pain

- Ischemic Heart Disease
  - Ischemic heart disease is an umbrella term that includes stable angina and ACS.
  - Stable angina presents with the following characteristics:

    Substernal location
    Onset with exertion
    Improvement with rest or nitroglycerin [8]

  - If a patient presents with only two out of three characteristics, the chest pain is considered atypical. If a patient has one out of three characteristics, it is considered non-anginal chest pain. The presentation predicts the likelihood that the chest pain is due to CAD (Table 1.1).
  - ACS encompasses unstable angina (UA) and myocardial infarction (MI) [9] and presents with:

    New onset angina at rest
    Angina with minimal exertion
    Crescendo angina

  - Additional symptoms of ACS can include radiation to the arms/shoulder/jaw/neck, shortness of breath, pain similar to prior ACS (if applicable), nausea, and diaphoresis [7, 10].
  - Exam can include Levine's sign (clenching fist on chest), rales on lung exam, and hypotension [7, 11]. The

Table 1.1 Pre-test probability that CP is associated with CAD-based CP characteristic

Population	Non-anginal	Atypical	Typical
Older male (>50)	20%	65%	93%
Older female (>60)	14%	51%	86%

presence of chest wall tenderness significantly decreases the likelihood of ACS [12, 13].
- ECG and troponin (if available and risk factors present) can be used for further workup. A normal ECG does not rule out ACS.
- Risk factors include older age, hypertension, diabetes, hyperlipidemia, and tobacco use [14, 15]. However, up to 12% of patients with acute MI have no risk factors [16].
- Atherosclerotic cardiovascular disease (ASCVD) risk score can be helpful to determine one's overall risk of CAD [17, 18].

- Aortic Dissection
  - Classically presents with abrupt onset sharp/tearing/ripping chest or back pain, though presentation can be subtle [19, 20].
  - Physical exam findings include soft, high-pitched, early diastolic decrescendo murmur heard best at the third intercostal space on the left (consistent with aortic regurgitation) and pulse deficit (blood pressure difference between both arms).
  - Aortic dissection is rare [21–23], but should always be considered given its high mortality [19].

- Pericarditis
  - Classically described as acute onset of sharp, pleuritic (worse with inspiration) chest pain that is positional (worse with laying down, improved with sitting up and leaning forward).
  - May occur in the setting of flu-like symptoms or associated with a history of autoimmune disease.

- On physical exam, auscultation over the left sternal border reveals a pericardial friction rub that is best heard during expiration with the patient leaning forward [24].
- Dullness with bronchial breath sounds suggests pericardial effusion (Ewart sign).
- Assess for cardiac tamponade through inspection of jugular venous pulsations and pulsus paradoxus (decrease in systolic blood pressure greater than 10 mmHg with inspiration) [25].

- Pulmonary Embolism (PE)
  - Seventy-five percent of cases present with chest pain [26], which is generally lateral or substernal.
  - Pain is of sudden onset, sharp, and pleuritic and commonly occurs with unexplained breathlessness, cough, hemoptysis, or syncope.
  - Clinical suspicion is high according to Wells score [27], including findings suggestive of deep vein thrombosis (DVT) such as calf pain or tenderness, immobilization or surgery, hemoptysis, and previous DVT/PE.
  - PMH, family history (FH), and current medications may reveal prothrombotic risk factors.
  - Physical exam may include elevated jugular venous pulsation and loud S2 over the left upper sternal border.
  - One should always consider PE in any patient with CP, tachycardia, and tachypnea/hypoxemia, especially in patients with risk factors. These patients should be sent to the emergency department for further evaluation.

- Valvular Heart Disease
  - Aortic stenosis

    History may include exertional angina, dyspnea, decreased exercise tolerance, syncope, palpitations, or dizziness.

    Auscultation over the right second intercostal space reveals a harsh crescendo and decrescendo systolic murmur that radiates into the carotid arteries.

Palpation of the carotid upstroke during cardiac auscultation may demonstrate a weak pulse that rises slowly to a delayed peak (pulsus parvus et tardus) [28].
When grading aortic stenosis, the absence of S2 is specific for stenosis in the severe range.

- Mitral valve prolapse

  Most patients are asymptomatic, though some may experience vague chest discomfort.
  Some cases present with significant mitral regurgitation, leading to fatigue, exertional dyspnea, orthopnea, or palpitations.
  Auscultation over the apex reveals a late or mid-systolic click with a holosystolic murmur or high-pitched mid-late systolic murmur [29] that radiates to the axilla.
  The murmur is louder and occurs earlier with a Valsalva maneuver, but is softer and delayed with squatting.

- Hypertrophic Cardiomyopathy (HCM)
  - HCM with obstruction occurs due to a hypertrophied septum bulging into the left ventricular outflow tract.
  - May present with exercise intolerance, angina, or syncope.
  - HCM has an autosomal dominant pattern of inheritance with 60–70% of HCM patients having an affected family member [30].
  - Auscultation at the left sternal border reveals a systolic murmur that increases with Valsalva and with standing. The murmur decreases with passive leg raising and handgrip maneuvers.
  - To differentiate the murmur of aortic stenosis and HCM:

    Auscultate the carotid pulse and note murmur severity in response to the Valsalva and handgrip maneuvers.

Valsalva maneuver → murmur louder with HCM
Handgrip maneuver → murmur softer with HCM

- A summary of risk factors, history, and physical exam findings associated with cardiac etiologies can be found in Table 1.2.

Clinical Pearl 2
Most chest pain in primary care is non-cardiac with most common etiologies including chest wall syndrome and GERD.

Non-cardiac Etiologies of Chest Pain

- Chest Wall Syndrome
  - Chest wall pain due to costochondritis or intercostal muscle spasms are the most frequent causes of CP [31].
  - History and pain to chest wall palpation are clues to the diagnosis.
  - Pain is generally moderate, well localized, continuous or intermittent, and sometimes described as "stinging."
  - Pain is generally retrosternal and/or on the left side [31] and exacerbated by position and movement.
  - May coexist with CAD [32]. Careful assessment of risk factors and further testing may be needed to rule out cardiac etiology.
- Gastroesophageal Disorders
  - Amongst the most frequent causes of non-cardiac chest pain [33] are GERD and non-GERD esophageal disorders [34] .
  - GERD

    A common diagnosis in patients with CP [35, 36]. Typically presents with burning retrosternal chest pain, acid regurgitation, and sour/bitter taste in the mouth [37].

Table 1.2 Risk factors, history, and physical exam for cardiac etiologies of CP

Diagnosis	Risk factors	Characteristics of pain	Physical exam findings
Coronary artery disease	Older age Hypertension Diabetes mellitus Hyperlipidemia Tobacco use	Substernal Improves with rest (if stable) Does not improve with rest (if unstable and MI) Radiation to right shoulder or both arms/ shoulder/ jaw/ neck Associated with nausea Diaphoresis	Levine's sign May have rales Hypotension No chest wall tenderness
Aortic dissection	Age (>65) [19, 21] Male [21] Hypertension (most important) [19, 51] Smoking [22] Aortic aneurysm [52] Bicuspid aortic valve [53, 54]	Abrupt onset Sharp/tearing/ ripping chest or back	Blood pressure difference between both arms Murmur consistent with aortic regurgitation
Pericarditis	Autoimmune disease Immunocompromised	Fairly acute onset Pleuritic Anterior Sharp Radiates to trapezius Associated with flu-like symptoms	Pericardial friction rub Dullness with bronchial breath sounds

Table 1.2 (continued)

Diagnosis	Risk factors	Characteristics of pain	Physical exam findings
Pulmonary embolism	Hypercoagulable state Immobility/recent surgery Family history	Acute onset Lateral or substernal Sharp, pleuritic Dyspnea Associated with cough, hemoptysis, syncope	Tachycardia Tachypnea Hypoxemia Neck vein distension Loud P2

Usually occurs postprandially, particularly after large fatty meals or spicy foods, and tends to worsen in supine position [38].
Risk factors include older age, obesity, and tobacco use [39].
An empiric trial of PPI can be used for diagnostic purposes [40, 41].

- Non-GERD esophageal disorders

  Present with similar symptoms as GERD, including dysphagia and globus sensation [34, 42].
  Include nutcracker esophagus (more common) and diffuse esophageal spasm [43].
  It is important to consider these disorders (and referral to GI) if patient is having symptoms despite trial of PPI.

- Pneumothorax
  - Potentially life-threatening but rare cause of CP in primary care [44].
  - Presents with sudden-onset pleuritic chest pain and dyspnea.
  - May be tachycardic, tachypneic, and hypoxic [45] on exam.

  - Lung exam may demonstrate focal decreased breath sounds with hyperresonance on percussion.
  - Chest x-ray is the initial diagnostic study and can show air in the pleural space.

- Psychosocial
  - Anxiety and depression are associated with an increased risk of reporting chest pain [46].
  - Seen as a diagnosis of exclusion and can be discerned through screening questions for anxiety and panic disorders such as the GAD-7 questionnaire [47].
  - Patients report "tightness" sensation of the chest and shortness of breath.
  - Physical exam reveals tachycardia but is otherwise normal.
  - Social history may include drugs of abuse such as cocaine and methamphetamine, which may precipitate cardiac ischemia or vasospasm.
  - Substance abuse may also present with diaphoresis and pupillary dilation.
  - If thought to be the etiology, a urine drug screen should be obtained.

- Pneumonia
  - Clinical history of fever, productive cough, pleuritic CP, shortness of breath, gastrointestinal symptoms (nausea, vomiting, diarrhea), or history of recent illness.
  - Pertinent exam findings can include decreased and/or bronchial breath sounds, coarse crackles, dullness to percussion, increased tactile fremitus, and egophony.
  - Bronchial breath sounds and dullness to percussion are highly specific findings [48].

- Herpes Zoster
  - Pain is generally described as "burning," "throbbing," or "stabbing" [49] and may develop prior to appearance of rash [50].

  - Exam findings typically include erythematous vesicular rash in a unilateral dermatomal distribution.
  - Thoracic and lumbar dermatomes are the most common sites leading to CP.

- A summary of risk factors, history, and physical exam findings associated with non-cardiac etiologies can be found in Table 1.3.

Clinical Pearl 3
Pleuritic CP differential includes the 5 Ps: pneumonia, pneumothorax, pericarditis, pulmonary embolism, and pleuritis.

Key Learning Points
- The best approach to chest pain is a thorough history and physical.
- The 3 P's pain characteristics that decrease the likelihood of ACS include pleuritic, positional, and reproduced by palpation.
- Patients without risk factors for CAD can still have ACS.
- ASCVD score and Wells score can be helpful to assess risk of cardiac or thrombotic etiology, respectively.

Table 1.3 Risk factors, history, and physical for non-cardiac etiologies of CP

Diagnosis	Risk factors	Characteristics of pain	Physical exam findings
Chest wall syndrome	Female gender [55] History of autoimmune or chronic pain syndrome (fibromyalgia, arthritis)	Insidious and persistent Positional and exacerbated by movement but not exertion	Reproducible pain by palpation Localized muscle tension
GERD	Older age Obesity Tobacco use	Retrosternal Acid regurgitation Sour/bitter taste in mouth Postprandial Worsens in supine position	Epigastric tenderness to palpitation
Non-GERD esophageal disorders (nutcracker esophagus and diffuse esophageal spasm)	Consider if patient is having GERD-like symptoms despite trial of PPI	Similar to GERD Also includes dysphagia and globus sensation	

Pneumothorax		Sudden onset Pleuritic Dyspnea at rest	Tachycardia Tachypnea Hypoxia Decreased breath sounds Hyperresonance on percussion
Panic attack/anxiety	Family or personal history of anxiety, depression Childhood adversity Substance use	Exacerbated by emotional stress Chest "tightness"	Tachycardia Tachypnea Otherwise normal
Pneumonia	Seasonal Prolonged hospital stay	Pleuritic with inspiration Associated with productive cough and fever	Shallow breathing Cachexia Course crackles Decreased or bronchial breath sounds Dullness to percussion
Herpes zoster	Immune status- transplant, autoimmune disease [56] Female Family history HIV [50] Age ≥60 [50]	Burning, stabbing, pin point pain Associated with erythematous vesicular rash	Unilateral dermatomal distribution of pain and rash

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