Case 1: A young man who was stabbed in the chest is rushed to a hospital. The stab wound is found to be in the 3rd left intercostal space, just lateral to the sternum. The emergency physician notes that the veins of his face and neck are engorged. What is the diagnosis?

Case 2: During the physical examination of a 15-year-old girl for summer camp, a "machinelike" murmur was heard during auscultation in the 2nd intercostal space near the left sternal edge. On palpation, the physician felt a continuous thrill (vibration) at the same location. Other physical findings were normal. The young woman said she had always been well, although she feels that she gets "out of breath" faster than other girls. Following consultation with her parents and a cardiologist, the family physician decided to conduct further investigations. He ordered PA and lateral chest radiographs and angiocardiography. The radiographs of the chest reveal slight left ventricular enlargement and slight prominence of the pulmonary artery and aortic knob. The ECG indicates a moderate degree of left ventricular hypertrophy. Angiocardiography was then performed. The catheter was passed to the heart through the femoral vein and IVC into her right atrium, right ventricle, and pulmonary trunk. A small injection of contrast showed the tip of the catheter to be in the thoracic aorta. The catheter was drawn back to the right atrium and a right angiocardiogram was performed that showed an essentially normal right heart. Another catheter was passed via the femoral artery to the ascending aorta and contrast medium injected into it (aortography). The ascending aorta and aortic arch appear normal, but the left and right pulmonary arteries as well as the thoracic aorta, are opacified. What is the likely diagnosis?

Case 3: While having a heated discussion with a client, a 48-year-old businessman experiences a sudden, crushing substernal pain in his chest that radiates along the medial aspect of his left arm. The client helps him to the couch and calls an ambulance. The ambulance attendants administer oxygen and rush him to the hospital, where he is placed in intensive care. He is placed under observation with ECG monitoring for detection of potential fatal arrhythmias. On questioning, the resident learns that the patient has had previous attacks of substernal discomfort during stress that he is reluctant to describe as pain. He said that this discomfort always passed when he rested. When asked to describe his current chest pain, he says it is the worst pain he has ever felt and that when it first struck, he had a feeling of weakness and nausea. On auscultation, the resident detects an occasional arrhythmia. The ECG is also abnormal. What is the likely diagnosis?

The answers to the cases begin on the next page.
Clinical Case Answers

Case 1: A young man who was stabbed in the chest is rushed to a hospital. The stab wound is found to be in the 3rd left intercostal space, just lateral to the sternum. The emergency physician notes that the veins of his face and neck are engorged. What is the diagnosis?

Answer: Hemopericardium and cardiac tamponade

Explanation: The knife would puncture the pericardial sac and the right ventricle of the heart. Stab wounds that pierce the heart cause blood to enter the pericardial cavity producing hemopericardium and cardiac tamponade. As blood accumulates in the pericardial sac, the heart's ability to expand and fill with blood following each contraction becomes increasingly compromised and circulation is impaired. The veins of the face become engorged because of the compression of and accumulation (backup) of blood in the superior vena cava, which, in turn, impedes the return of blood from the head and neck. Pericardiocentesis was likely performed to remove blood from the pericardial cavity and relieve the cardiac tamponade, allowing the heart to expand more fully to receive blood. A wide-bore needle was probably inserted through the left 5th or 6th intercostal space to the left of the sternum to aspirate the blood.


Case 2: During the physical examination of a 15-year-old girl for summer camp, a "machinelike" murmur was heard during auscultation in the 2nd intercostal space near the left sternal edge. On palpation, the physician felt a continuous thrill (vibration) at the same location. Other physical findings were normal. The young woman said she had always been well, although she feels that she gets "out of breath" faster than other girls. Following consultation with her parents and a cardiologist, the family physician decided to conduct further investigations. He ordered PA and lateral chest radiographs and angiocardiography. The radiographs of the chest reveal slight left ventricular enlargement and slight prominence of the pulmonary artery and aortic knob. The ECG indicates a moderate degree of left ventricular hypertrophy. Angiocardiography was then performed. The catheter was passed to the heart through the femoral vein and IVC into her right atrium, right ventricle, and pulmonary trunk. A small injection of contrast showed the tip of the catheter to be in the thoracic aorta. The catheter was drawn back to the right atrium and a right angiocardiogram was performed that showed an essentially normal right heart. Another catheter was passed via the femoral artery to the ascending aorta and contrast medium injected into it (aortography). The ascending aorta and aortic arch appear normal, but the left and right pulmonary arteries as well as the thoracic aorta, are opacified. What is the likely diagnosis?

Answer: Patent Ductus Arteriosus

Explanation: The ductus arteriosus is a fetal vessel that connects the left pulmonary artery to the aortic arch, just distal to the origin of the left subclavian artery. At birth the ductus arteriosus may be equal to or larger in diameter than either the pulmonary artery or the aorta. The prenatal function of the ductus arteriosus is to allow most of the blood in the left pulmonary artery to bypass the uninflated lungs. Because of the relatively high pulmonary vascular resistance to bloodflow through the uninflated lungs, and the relatively low resistance in the embryonic thoracic and abdominal aorta and umbilical arteries, blood easily flows from the pulmonary artery into the aortic arch and thoracic
aorta. The shunting of blood in this way provides a more direct route for fetal blood to pass through the umbilical arteries to the placenta, where it becomes oxygenated.

Patency of the ductus arteriosus after the perinatal period is a relatively common congenital abnormality, occurring approximately once in every 3000 births and more often in females than in males. PDA is the most common malformation associated with maternal rubella infection during early pregnancy. Although this malformation occurs more frequently as an isolated abnormality, it may coexist with other malformations.

The typical continuous, loud "machinelike" murmur results from turbulent flow of blood from a high-pressure vessel (aorta) to a low-pressure vessel (pulmonary artery) via the ductus arteriosus. Because the pressure gradient exists during both systole and diastole, the murmur is continuous. The left-to-right shunt increases the workload of the left ventricle; as a result, it enlarged and its walls thicken. The left atrium may also enlarge in response to the increased volume of blood returning from the lungs.

PDA may result in cardiac failure and pulmonary edema in the premature infant, but its presence is compatible with survival until adult life in most cases. However, because the leading cause of death in adults with this malformation is cardiac failure and/or bacterial endocarditis (inflammation of the endocardium of the heart, its valves, and great vessels), ligation of the ductus arteriosus is commonly performed.

Pulmonary vascular disease (arteriosclerosis) may develop in a patient with a PDA, in which case the high pulmonary vascular resistance results in an increase in pressure in the right ventricle and pulmonary artery. This pressure causes a reversal of bloodflow through the ductus arteriosus (i.e., right to left). Consequently, poorly oxygenated blood is shunted from the left pulmonary artery into the aortic arch and thoracic aorta. As the ductus arteriosus enters the arch of the aorta distal to the origin of the left subclavian artery, the toes (but not the fingers) become cyanotic (bluish, owing to oxygen deficiency) and clubbed (broadened and thickened). The finding of cyanosis in the toes, but not in the fingers, is referred to as differential cyanosis.


**Case 3:** While having a heated discussion with a client, a 48-year-old businessman experiences a sudden, crushing substernal pain in his chest that radiates along the medial aspect of his left arm. The client helps him to the couch and calls an ambulance. The ambulance attendants administer oxygen and rush him to the hospital, where he is placed in intensive care. He is placed under observation with ECG monitoring for detection of potential fatal arrhythmias. On questioning, the resident learns that the patient has had previous attacks of substernal discomfort during stress that he is reluctant to describe as pain. He said that this discomfort always passed when he rested. When asked to describe his current chest pain, he says it is the worst pain he has ever felt and that when it first struck, he had a feeling of weakness and nausea. On auscultation, the resident detects an occasional arrhythmia. The ECG is also abnormal. What is the likely diagnosis?
Answer: Acute myocardial infarct

Explanation Acute myocardial infarct (MI) is a disease of the myocardium, characterized by necrosis of ventricular muscle that results from sudden occlusion of a part of the coronary circulation. Blockage of a coronary artery results in dysfunction of the heart as a pump. If a large branch of a coronary artery is involved, the infarcted area may be so extensive that cardiac function is severely disrupted and death occurs. MI may also result from excessive exertion (e.g., running to catch a bus) by a person with stenotic coronary arteries. An atheroma (or atheromatous plaque) is a lipid deposit that produces a swelling on the endothelial surface of the blood vessel. Ulceration of the atheroma results in the release of atheromatous debris that is carried along the coronary artery until it reaches the stenotic part. Because it blocks the vessel, no blood can pass to the myocardium, and MI occurs unless a good collateral circulation has developed previously.

Anastomoses exist between the terminations of the right and left coronary arteries in the coronary groove and between the interventricular branches around the apex in approximately 10% of apparently normal hearts. The potential for the development of this collateral circulation probably exists in most if not all hearts. In slow occlusion of a coronary artery, the collateral circulation has time to increase so that adequate perfusion of the myocardium can occur when a potentially ischemic event occurs. Consequently, infarction may not result. On sudden blockage of a large coronary branch, some infarction is probably inevitable, but the extent of the area damaged depends on the degree of development of collateral anastomotic channels.

If large branches of both coronary arteries are partially obstructed, an extracardiac collateral circulation may be utilized to supply blood to the heart. These collaterals connect the coronary arteries with the vasa vasorum in the tunica adventitia of the aorta and pulmonary arteries and with branches of the internal thoracic, bronchial, and phrenic arteries. Reversal of flow in the anterior and smallest cardiac veins (venae cordis minimae) may bring luminal blood to the capillary beds of the myocardium in some regions, providing some additional collateral circulation. However, unless these collaterals have dilated in response to preexisting ischemic heart disease, they are unlikely to be able to supply sufficient blood to the heart during an acute event and prevent MI.

The dominant symptom of MI is deep visceral pain. Afferent pain fibers from the heart run centrally through the middle and interior cervical branches and the upper thoracic branches of the sympathetic trunks of the neck and thorax. Central processes (axons) of primary sensory neurons enter spinal cord segments T1 through T4 or T5 on the left side. Pain of cardiac origin is often referred to the left side of the chest and along the medial aspect of the arm and upper forearm. These are the areas of the body that send sensory impulses to the same spinal ganglia and segments of the spinal cord that receive cardiac sensation. Visceral referred pain is the perception of visceral pain as occurring in remote cutaneous areas.