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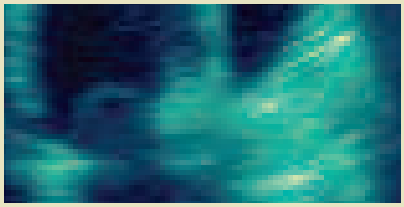

Pericardial inflammation is a familiar but uncommon cause of chest pain. The classic triad of retrosternal chest pain, pericardial friction rub, and serial ECG changes facilitates diagnosis of pericarditis, the etiology most often being idiopathic in nature. Because older adults more frequently contend with multiple conditions that may require cardiovascular surgical intervention, receive numerous medications, or result in an immunocompromised state, other important causes of pericarditis need to be considered. This article considers pericarditis in the older population and emphasizes diagnosis and management of this condition. Situations common to this age group that require special attention to the appropriate treatment are also discussed.

Key words: *pericarditis, pericardium, heart, inflammation, tamponade*

Diagnosis and Treatment of Pericarditis in the Aged

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Introduction

Pericarditis, or inflammation of the pericardium, may be acute or chronic. Acute pericarditis, generally a self-limiting disorder that rarely has adverse long-term sequelae, is an uncommon condition that should be considered when evaluating patients with chest pain. Complications such as cardiac tamponade, constrictive pericarditis, or recurrent pericarditis may arise; thus, prompt identification of the condition can be life saving. Approximately 90% of cases of pericarditis are reportedly idiopathic, though a significant proportion of these are likely viral.[1] There are, however, many other identifiable etiologies of pericardial inflammation significant to an older patient population that often has multiple comorbid conditions such as a history of prior surgery, inappropriate medication use, debilitation, or compromised immunity—factors that may predispose to pericarditis. Pericarditis at different pathogenic stages may be associated with effusion, fibrosis, and calcification (Figures 1 and 2). It is often associated with an increase in tissue vascularity, edema, inflammatory cell infiltrate, and fibrin deposition (Figure 3).[2] Pericarditis is often accompanied by myocarditis, creating a truly mixed picture of myopericarditis.

The incidence of pericarditis at necropsy ranges from 1–6%, and approximately 5% of patients with chest pain presenting to the emergency room have pericarditis as the underlying disease.[3] Common and uncommon causes of pericarditis such as uremic, infectious, postoperative, or postradiation therapy pericarditis will be discussed in this article (Table 1). Rare causes of pericarditis linked with herbal medicines,[4] inherited predisposition,[5] and associated with pregnancy[6,7] have also been described; however, these will not be discussed herein. In this review, we summarize the pertinent clinical and morphological features of pericardial inflammation along with an approach to its diagnosis and management. We will also address some of the more important complications where they may present first to the clinician.

Anatomy and Physiology

The pericardium is a double-layered sac that encases the heart, helps maintain its position in the mediastinum, and prevents over-distension by sudden volume overload. The pericardium is compliant up to volumes corresponding to the normal limits of ventricular distention, at which point the pericardial sac becomes stiff and resistant to further acute stretch. Its blood supply is derived primarily from the internal thoracic arteries and the pericardiophrenic vessels traveling with

Table 1: Selected Etiologies of Pericarditis

Common	Uncommon
Idiopathic (possibly viral)	Postprocedural
Viral (+/- myocarditis)	Trauma
Infectious (e.g., bacteria or mycobacteria)	Infectious (e.g., fungi)
Uremia	Connective tissue disorders
Postmyocardial infarction	
Postoperative	
Neoplasia	
Medications	

the phrenic nerves. Venous drainage is variable through the azygous system. Lymphatic drainage of the parietal layer is through the anterior and posterior mediastinal nodes and the visceral layer through the tracheal and bronchial mediastinal nodes, facts that are important to keep in mind because malignant obstruction of lymphatic channels may secondarily lead to pericardial effusions that can be confused with acute pericarditis. Microorganisms may also seed the pericardium through these lymphatics. The two layers of mesothelium are normally separated by up to 50cc of a straw-coloured fluid that serves to lubricate the two layers of pericardium. It is believed that pericardial fluid originates from the visceral pericardial layer under both physiological and pathological circumstances.[8]

Presentation and Diagnosis

Although variation exists, the classic diagnostic features of pericarditis are primarily clinical, namely retrosternal chest pain, pericardial friction rub, and serial ECG changes (Table 2). Chest pain is usually abrupt in onset and sharp in quality, although it may be dull, aching, or pressure-like. The pain is often pleuritic, exacerbated by recumbency, deep inspiration, and coughing, and may radiate to the shoulders, neck, jaw, arms, and ridge of trapezius muscles. Sitting up and leaning forward may partially relieve symptoms. A prodrome of low-grade fever, malaise, myalgias, and possibly a cough may precede the onset of chest pain. High fevers in the setting of the aforementioned symptomatology should immediately elicit a consideration of purulent pericarditis. Other causes of "chest" pain such as acute coronary syndromes, pneumonia, chest wall pain, pulmonary embolism, cholecystitis, and aortic dissection with rupture into the pericardium must be considered and excluded.

The hallmark of pericarditis is the triphasic friction rub, which has a scratchy character, best heard at end-expiration between the cardiac apex and lower left sternal border with the patient sitting forward. Although three components of the rub are often described—ventricular systole, atrial systole, and occasionally ventricular diastole—a biphasic rub is the most common finding. It is important that the rub be heard in the absence of breathing to help differentiate it from a pleural rub. Unfortunately, an associated pleuritis may accompany the pericarditis, especially in cases of connective tissue disease or Dressler's Syndrome. Rubs may be intermittent and transitory and may require repeated examinations to detect.

Electrocardiographic abnormalities accompany acute pericarditis in up to 90% of cases and may change depending on when they are taken (Figure 4).[8] The two classic evolutionary changes are PR-segment depression followed by ST-segment elevations.[3] PR-segment depression is reported to occur 80% of the time very early in the course of acute pericarditis, usually within the first few hours, and often precedes ST changes.[9] Diffuse ST-segment elevation (except in leads aVR and V1) is often concave up, unlike classic infarction-related changes, and may be differentiated from an ischemic pattern by the lack of reciprocal ST depression. Finally, as the ST segments gradually return to baseline there may be accompanying variable T-wave abnormalities, such as flattening or inversion, which may persist for up to two weeks.[8] It is important to note, however, that none of these ECG abnormalities may occur or may be confounded by other electrophysiologic aberrations secondary to conduction disturbances or a recent transmural infarct. Sinus tachycardia resulting from pain or fever is common during acute pericarditis; however, conduction abnormalities and ventricular tachycardia are more suggestive of primary myocardial disease.

Documentation of prior viral infection does not alter management of acute pericarditis; nonetheless, a detailed history is important, especially in the aging population where other comorbid conditions and/or polypharmacy may predispose to pericardial inflammation.

Investigations

Routine laboratory investigations are of little use for most causes of pericarditis, and a diagnosis should be based on clinical suspicion (Table 3). A mild leukocytosis and elevations in erythrocyte sedimentation rate or C-reactive protein are commonly associated with any inflammation. Cardiac enzymes are usually negative, though a small elevation in troponin I may be associated with acute pericarditis, especially when myopericarditis is suspected.[2] Blood tests are tailored to etiology and may include viral serology (usually not necessary), blood cultures, fungal serology, HIV testing, Mantoux testing, and serum urea con-

Table 2: Clinical Presentation of Acute Pericarditis

a.	**Classic Diagnostic Features of Pericardial Inflammation**
1.	Retrosternal chest pain
2.	Pericardial friction rub
3.	Serial ECG changes
b.	**Important Differential Diagnoses to Consider**
1.	Acute coronary syndrome
2.	Myocarditis
3.	Aortic dissection
4.	Pulmonary embolism
5.	Pneumonia
6.	Empyema
7.	Gastroesophageal reflux
8.	Esophageal spasm
9.	Peptic ulcer
10.	Anxiety

centration; levels of thyroid-stimulating hormone (TSH), thyroxine (T4), antinuclear antibody (ANA), and rheumatoid factor (RF) tests may also be considered. The diagnostic yield of pericardial fluid analysis following a pericardiocentesis is generally low, yet may have a better positive predictive value in severe patients who have failed prior conservative treatments[10] or with repeated sampling. Pericardial fluid may be assessed for cell count, biochemistry, cytology, cultures and special stains for bacteria, fungi, or mycobacteria.

A chest x-ray is recommended in all cases, as is echocardiography.[3] The chest radiograph is usually normal in uncomplicated acute pericarditis, yet one may detect cardiomegaly (>250cc of effusion), pneumopericardium (fistulization), an adjacent pneumatic infectious or inflammatory process, or possibly neoplasia. Although echocardiography is the most sensitive test to demonstrate signs of tamponade or pericardial effusion, it cannot confirm the clinical diagnosis of acute pericarditis. Pericardial thickening and calcification related to recurrent pericarditis or scarring from prior surgery may also be detected with echocardiography. Computed tomography (CT) or magnetic resonance imaging (MRI) are better imaging modalities for this physical finding.[11] Of note, Doppler echocardiography has become a very useful noninvasive test to help differentiate between restrictive cardiomyopathy and constrictive pericarditis. Cardiac catheterization has a limited role in the diagnosis of pericarditis; it is mainly used to confirm the clinical suspicion of pericardial disease, uncover occult constriction/effusive-constrictive hemodynamic features, and identify associated coronary disease. We will address this issue more fully with the discussion of complicated pericarditis below.

Management

Management of acute pericarditis is principally directed towards alleviating symptoms, such as fever and pain, defining the etiology if possible, as well as identifying or preventing cardiac tamponade. Identifying the exact cause of pericarditis may help target therapy. Hospitalization is generally not required for uncomplicated pericarditis; however, the potential for significant pericardial effusion causing hemodynamic compromise is the principal consideration regarding need for admission. Good response to nonsteroidal anti-inflammatory drugs (NSAIDs) such as acetylsalicylic acid (ASA) (325–650mg/day divided q.i.d.), indomethacin (75–225mg/day divided b.i.d. to t.i.d.), or ibuprofen (600–800 mg/day divided q.i.d) for one week is well documented. Symptoms persisting for more than two weeks while on NSAIDs may necessitate substitution with oral prednisone (60–80 mg/day) for five to seven days followed by a week-long taper. The addition of colchicine (1mg/day divided) is controversial and may best be considered for prophylaxis against recurrent pericarditis or possibly as a substitute for steroids in conjunction with NSAID therapy. Recurrent attacks occur in 20% of cases and frequently do respond to repeated conservative management.[8]

A few notes on therapy for complicated pericarditis deserve mention. Antibiotics are not indicated unless an infectious etiology is alleged, with pharmacotherapy tailored to those microorganisms responsible. Anticoagulation should be avoided during

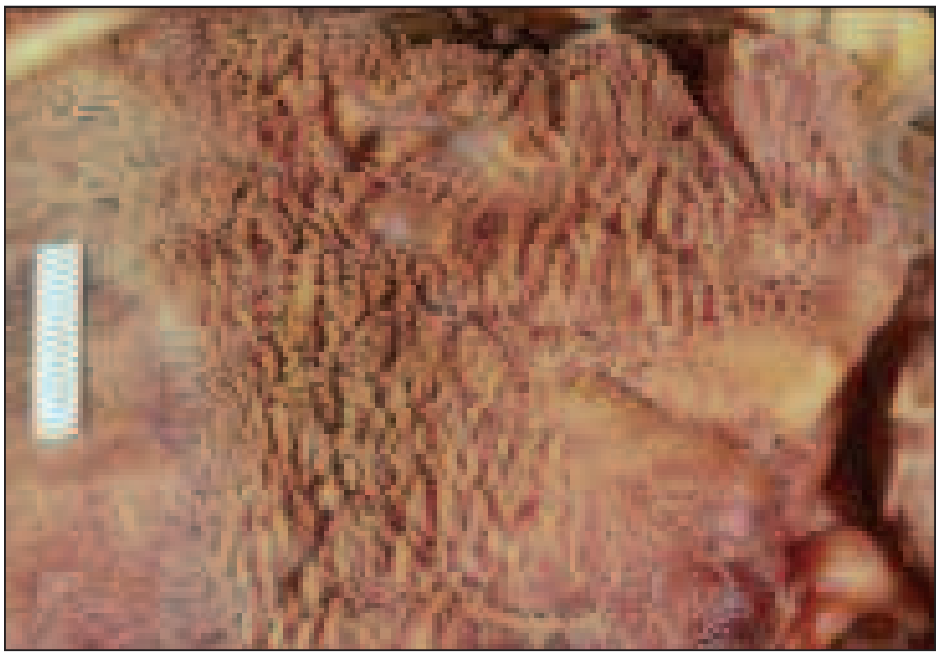

Figure 1: Acute Pericardial Inflammation This photograph demonstrates the classic "bread and butter" appearance of acute pericardial inflammation. This appearance is largely due to the fibrinous exudate.

Table 3: Summary of Clinical Features and Investigations for Common Forms of Pericarditis

Type of Pericarditis	Clinical Features	Diagnostic Techniques and Findings
Acute Pericarditis	A sharp, pleuritic chest pain is experienced that is worse when lying supine or coughing.	**ECG:** A widespread concave upward ST-segment elevation and occasionally PR-segment depression is seen. **Laboratory tests:** Plasma troponin levels are elevated in 35 to 50% of patients with acute pericarditis.
Postpericardiotomy Syndrome	Friction rubs are almost universal after cardiac surgery, and usually found one week to two months postoperatively. Cardiac tamponade may also occur.	**ECG:** Changes of acute pericarditis may be present, along with an enlarged cardiac silhouette and echocardiographic findings of tamponade.
Acute Postmyocardial Infarction Pericarditis	This occurs during the first few days to approximately one week after a myocardial infarction.	**ECG:** Elevation of the ST segment in the infracted area may be present, along with T wave changes.
Dressler's Syndrome	Pleuropericarditis with chest pain that occurs weeks to months after an acute myocardial infarction is seen; it is usually self-limiting, but hospital observation is recommended.	**ECG:** Changes of acute pericarditis may be present. **Chest radiograph:** A pleural effusion may be observed.
Constrictive Pericarditis	An elevated jugular venous pressure with sharp y descent is seen, as well as Kussmaul's Sign, peripheral edema, abdominal distension, dyspnea, and pericardial knock.	**Cardiac Catheterization:** Hemodynamic changes are seen; echocardiography or CT scan may show pericardial thickening. **ECG:** Low voltage of the QRS complex and diffuse flattening or inversion of the T waves is observed.
Cardiac Tamponade	Pulsus paradox, tachycardia, and tachypnea may also be observed. Diminished heart sounds and a pericardial friction rub are sometimes present.	**Chest radiograph:** A radiograph may demonstrate an enlarged cardiac silhouette if 200–250ml of fluid has accumulated. **Echocardiography:** This is recommended only if hemodynamically stable.
Tuberculous Pericarditis	Fever, night sweats, dyspnea, and abdominal discomfort are experienced or, if in chronic stage, constrictive pericarditis. Patient has a history of tuberculosis infection.	**Tuberculin skin test:** A positive pericardiocentesis is seen (possible role for adenosine deaminase?).
Bacterial Pericarditis	Commonly, a high-grade fever with chills, dyspnea, and chest pain is seen. Pericardial friction rub may be present. Cardiac tamponade could be confused with septic shock.	**ECG:** ST segment and T wave changes of acute pericarditis are seen. **Echocardiography:** Pericardial effusion is observed.
Uremic Pericarditis	Generally asymptomatic, it may present with features similar to acute pericarditis. Alternatively, it may present with large pericardial effusion, cardiac tamponade, or hemorrhage with constrictive pericarditis.	**Laboratory Investigations:** Serum blood urea, nitrogen, and creatinine are examined.
HIV-related Pericarditis	Always consider secondary infectious etiology.	**Laboratory Investigations:** A serologic test for HIV is performed.
Neoplastic Pericarditis	Primary tumours are rare. Pericardial effusion and cardiac tamponade may be observed.	**MRI/CT scan:** Assess for metastatic disease.
Radiation Pericarditis	Symptoms are similar to acute pericarditis (or to constrictive pericarditis months to years later).	**MRI/CT scan and Laboratory Investigation:** Both are used to rule out recurrent malignancy or hypothyroidism.
Pericarditis in Autoimmune Disease	Symptoms are similar to acute pericarditis, asymptomatic pericardial effusion, or cardiac tamponade. Constrictive pericarditis can occur as a result of long-standing pericardial inflammation.	**ECG:** Typical findings of acute pericarditis are often seen. **Chest radiograph:** There is visible enlargement of the cardiac silhouette. **Laboratory Investigations:** RF, complement levels, and ANA are measured.

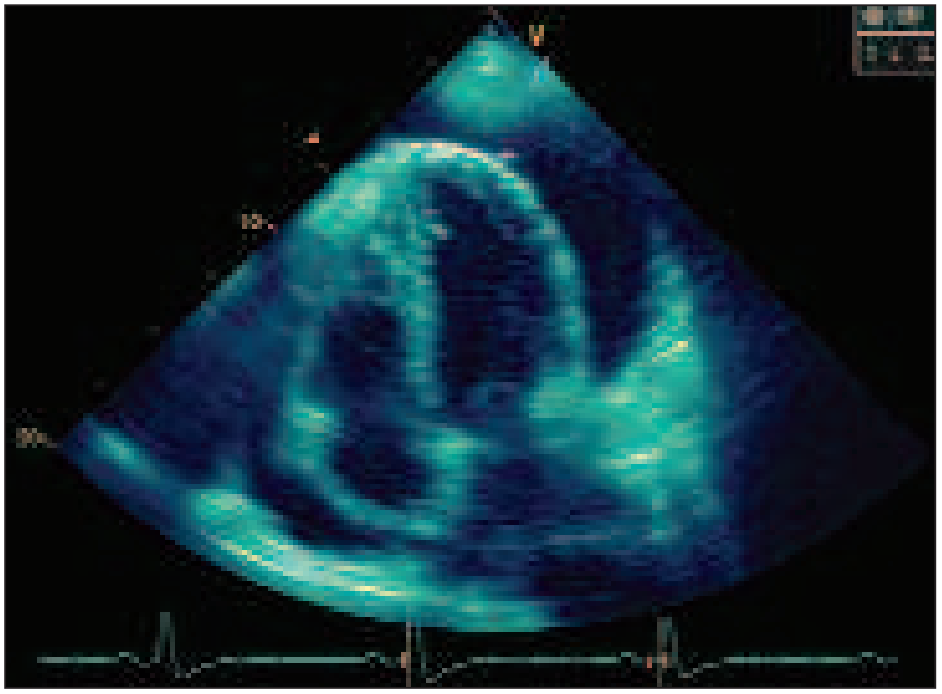

Figure 2: Pericardial Effusion An echocardiogram showing pericardial effusion typically seen in association with pericarditis.

the acute phase of inflammation to avoid hemorrhagic complications unless a very clear indication precludes withholding therapy (such as unstable angina, recent myocardial infarction, or prosthetic heart valves). Under such circumstances the patient may best be served by hospital admission for intravenous heparin therapy and cessation of oral anticoagulation with close monitoring for hemodynamic compromise until the inflammation has subsided. Acetylsalicylic acid has been recommended in place of other NSAIDs in the setting of recent myocardial infarction given the propensity of the latter to interfere with scar formation.[12] Indomethacin may interfere with coronary blood flow in patients with severe coronary artery disease[13] and should generally be avoided.

Other patient populations may also require special consideration when tailoring management. HIV itself may cause fulminant bacterial pericarditis, but one should always consider a concomitant infectious etiology in these patients (particularly from atypical organisms such as mycobacteria). Essentially the same may be said for any immunocompromised host. Dialysis is often necessary in conjunction with pain control for patients with uremic pericarditis. Pericardial inflammation caused by adverse drug reactions to medications such as procainamide or hydralazine may require a trial of cessation or substitution with another agent.[14,15] Connective tissue syndromes such as systemic lupus erythematosus may necessitate hospitalization given the increased potential for tamponade,[8] while acute pericarditis associated with flares of rheumatoid arthritis may require immunosuppressive agents; thus, exclusion of an infectious etiology is of considerable importance. Finally, pericarditis associated with radiotherapy for thoracic neoplasms should also prompt an evaluation of coronary artery disease and radiation-induced valvular damage.

Complications

Three significant life-threatening complications of acute (or recurrent) pericarditis are pericardial effusion, cardiac tamponade, and constrictive pericarditis.

Small, clinically insignificant effusions are commonly associated with acute pericarditis; however, larger effusions may occur as gradual accumulations that may be tolerated to levels of 1,000cc or more. These are best diagnosed when clinical findings suggestive of tamponade are present and confirmed with adjunctive echocardiography. With very large effusions, elec-

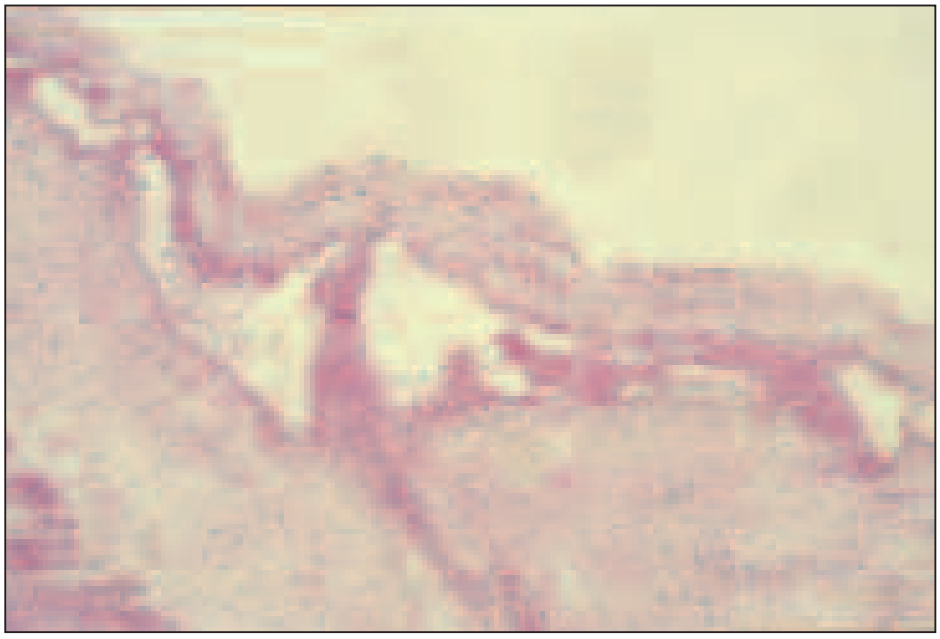

Figure 3: Histopathology of Acute Pericardial Inflammation This image shows the histopathology of acute pericardial inflammation, demonstrating acute inflammation, edema, and fibrin deposition within the pericardium.

trical alternans may occasionally be seen on ECG. Large effusions lasting months need not be drained if the patient is clinically well, yet consideration for cardiac function, immunocompetency status, as well as risk for hemorrhagic complications should dictate further management. Hemodynamic compromise or infected fluid collections should prompt immediate surgical consultation.

Cardiac tamponade can result from accumulated effusion, blood, clot, pus, gas, or any combination of the above. It is the rate of pericardial space filling that differentiates between a clinically benign effusion and tamponade. Tamponade may be associated with tachycardia, hypotension, oliguria, anxiety, dyspnea, jugular venous distension, muffled or distant heart sounds to auscultation, and pulsus paradoxus (a decrease in systemic arterial pressure of >10mm with inspiration). Echocardiography again can facilitate diagnosis; however, clinical impression should dictate pace of management, requiring pericardiocentesis or surgical decompression of the heart.

Constrictive pericarditis is a chronic process that may occur secondary to recurrent episodes of acute pericarditis or subclinically, as a low-grade inflammatory process causing pericardial scar formation following a single episode of acute pericardial or even myocardial inflammation.[11,16] Pericardial constriction causes decreased ventricular filling and may lead to right heart failure. Signs consistent with right-sided failure, such as elevated venous pressure with prominent y descent, Kussmaul's sign, ascites, edema, and hepatomegaly may be observed. A pericardial knock heard in diastole coincident with the timing of a third heart sound may be evident, as well as symptomatology such as dyspnea and fatigue. Computed tomography and magnetic resonance are the imaging modalities of choice to diagnose the condition, which may demonstrate pericardial thickening and calcification. However, pericardial thickening need not be present to have constrictive pericarditis.[17] Thus, doppler echocardiography flow profiles and cardiac catheterization are also useful techniques to functionally demonstrate constrictive physiology and aid in differentiating from the clinically similar restrictive cardiomyopathy. In cases where differentiation is equivocal, endomyocardial biopsies may be of benefit to exclude endocardial fibrosis as a cause of heart failure. Definitive management is surgical, whether it be a pericardial window for more of an effusive-constrictive presentation, pericardial stripping, or possibly even transplantation (albeit a rare option).[18]

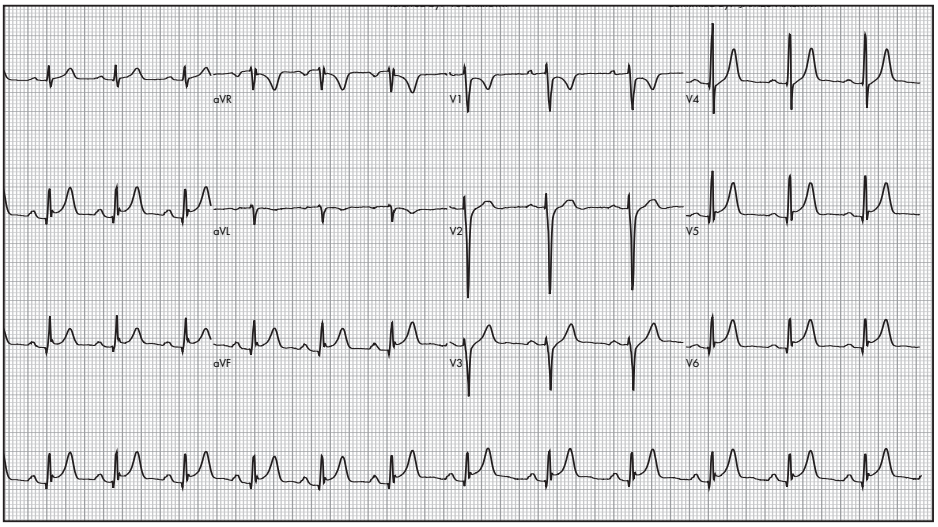

Figure 4: Electrocardiographic changes typical of acute pericarditis.

Concluding Thoughts

Acute pericarditis as a cause of chest pain should be considered and may have relatively nonspecific clinical findings; however, the triad of chest pain, pericardial rub, and abnormal ECG findings strongly suggest pericardial inflammation. Although uncommon, pericarditis can have significant hemodynamic consequences secondary to cardiac tamponade or longer-term complications such as constrictive pericarditis and heart failure. Pericarditis is generally idiopathic and easily treated, making it quite gratifying to manage. Identifying important etiologies that are disproportionally represented in older adults, such as postoperative, infectious, uremic, and neoplasia-related pericarditis, can facilitate prompt management and decrease morbidity.

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