Myocarditis: A shock to the heart

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Myocarditis is an inflammation or infection of the middle layer of the heart muscle called the myocardium. This inflammatory or infectious process can result in myocyte death and lead to arrhythmia, low cardiac output, organ failure, and death.

Myocarditis is very rare in young children; however, if it occurs in children younger than age 2, it can be more dangerous because their immune system isn't fully developed.

The heart's layers three

The heart has three layers of muscle tissue: the endocardium (inner layer), the pericardium (outer layer), and the myocardium (middle layer). The specialized muscle cells of the myocardium contract in synchrony during systole and diastole, effecting a coordinated pumping of the upper and lower chambers of the heart. This synchronous contraction occurs by specialized electrical conduction pathways that carry electrical signals from the upper to the lower chambers. The heart's rhythm, rate, and outflow of blood result from electrical stimulation of the myocardium.

In myocarditis, an autoimmune-mediated inflammatory response causes a catecholamine reaction to occur as the body attempts to fight the offending viral, bacterial, or fungal organism (see *Picturing myocarditis*). During this autoimmune response, T cells and cytokines target the myocardium. This can damage the myocardium and cause myocyte death. When the patient has idiopathic giant-cell myocarditis (IGCM), there's also the presence of a mixed inflammatory infiltrate containing lymphocytes, plasma cells, macrophages, and eosinophils, along with numerous giant cells.

Without prompt recognition and treatment, myocarditis can potentially result in permanent and irreversible damage to the heart, heart failure, or death.

Types of myocarditis

There are two type of myocarditis: generalized myocarditis and IGCM.

Generalized myocarditis may have no symptoms or subtle symptoms that are often referred to as "flu like." It can cause tissue damage within the muscle cells of the myocardium or the specialized electrical conduction pathways of the heart. This can lead to an irregular cardiac rhythm, very fast or slow heart rates, palpitations, or loss of consciousness.

Although most commonly caused by a viral pathogen, generalized myocarditis may also be caused by bacterial, fungal, and parasitic pathogens. It can occur in any age group; many cases of acute generalized myocarditis occur without any symptoms and are only diagnosed by an ECG or blood tests that can detect heart injury. Some patients with generalized myocarditis may have symptoms that mimic myocardial infarction or they may go into shock; however, they rarely succumb to sudden death.

ICGM typically results in rapid cardiovascular collapse and death. Most cases of ICGM aren't diagnosed until after death or after a heart transplant has been completed due to lack of awareness of the disease. ICGM can be mildly responsive to immunosuppressive drugs such as steroids for up to 1 year; however, it's typically only treated long term with a heart transplant.

ICGM typically presents with sustained ventricular tachycardia in rapidly progressive heart failure. IGCM is so rare that it's infrequently considered as a possible diagnosis in patients who present with new-onset heart failure.

Causes to consider

There are many causes of myocarditis. The most common is the inflammatory reaction to infection. Other causes include chemical exposure, radiation

exposure, spider bites, allergies, medication reaction, or trauma. Autoimmune diseases such as systemic lupus erythematosus and rheumatoid arthritis have also been linked to myocarditis.

The most common cause—infection—may be viral, bacterial, or fungal in nature. Below are examples of common conditions associated with myocarditis.

Viral infections:
- coxsackie virus
- Epstein-Barr virus
- cytomegalovirus
- hepatitis C
- herpes
- HIV
- parvovirus
- influenza
- adenovirus.

Bacterial infections:
- chlamydia
- mycoplasma
- streptococcus
- treponema bacteria
- staphylococcus
- borrelia bacteria.

Fungal infections:
- aspergillus
- candida
- coccidioides
- cryptococcus.

Know the signs and symptoms

The most common signs and symptoms in children are failure to thrive or listlessness, feeding difficulties, and pale or cool extremities.

In adults, signs and symptoms typically include:
- ECG changes such as ST-segment and T wave abnormalities
- very low or increased heart rate
- abnormal heart rhythm
- low BP
- heart failure or congestive heart failure
- chest pain
- shortness of breath
- nocturnal dyspnea
- fatigue
- dizziness
- fever
- jugular vein distension
- decreased urine output (less than 30 mL/hour x 4 hours)
- extremity edema.

The first sign or symptom noted is usually shortness of breath that occurs within 7 to 14 days of viral myocarditis. In rare cases, sudden death may, unfortunately, be the first sign of this disease.

key points

Treatment options

- Antibiotics, antifungals, or antivirals to fight infection
- Steroids or IVIG to control inflammation
- Medications to treat the symptoms of heart failure
- Medications to treat abnormal heart rhythms
- Mechanical support, such as an intra-aortic balloon pump, to help the heart function (in extreme cases)

Let's diagnose!

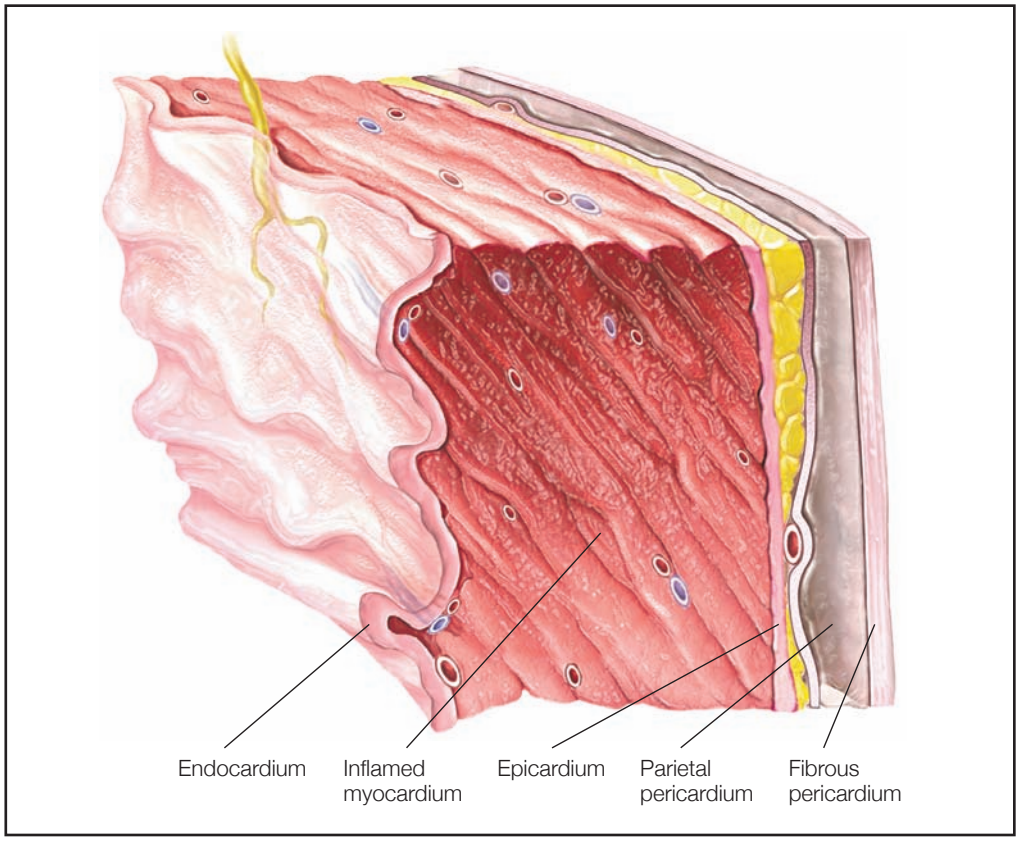
Diagnosis is often made following the appearance of symptoms such as chest pain, fainting, hypotension, tachycardia, edema, T wave abnormality seen on ECG, and chest X-rays revealing cardiac enlargement. An ECG will often show decreased left ventricular function, septal wall thickness, and decreased ventricular dilatation and cardiac output.

Elevated viral titers and erythrocyte sedimentation rate, as well as increased serum cardiac enzymes, can be useful in the diagnostic process. An elevated white blood cell (WBC) count may also be seen when bacterial myocarditis is present; however, if myocarditis is caused by an acute viral infection in an elderly patient, it may not illicit an elevated WBC count.

One of the dangers of myocarditis is that it can be present and create extensive electroconductivity havoc and myocyte death in the cardiac tissue for some time without any symptoms.

A gadolinium-enhanced magnetic resonance imaging (MRI) scan can also be useful in the diagnosis of myocarditis to assess the extent of the inflammation or tissue injury. A biopsy and culture of the heart tissue may be necessary to identify the presence of a myocardial infection and the specific pathogen, and to develop an appropriate treatment.

Picturing myocarditis



Treatments to the rescue

Treatment is aimed at alleviating the pathogen causing the myocarditis and reducing cardiovascular strain. It initially centers on prevention of cardiac arrhythmia and hemodynamic compromise or collapse.

If myocarditis is caused by an infectious agent, treatment revolves around managing the underlying infectious organism with antibiotics, antifungals, or antiviral medications. Other medications, such as steroids or I.V. immunoglobulin (IVIG), may be necessary to treat or reduce the inflammatory effects of the pathogen on the myocardial tissue. Other medications such as vasodilators (nitroglycerin, sodium nitroprusside), angiotensin-converting enzyme inhibitors (enalapril), or diuretics (furosemide) may be useful in managing myocarditis. Note that the patient may need supplemental oxygen to maintain an oxygen saturation level above 92%.

Because the electrical conduction pathway can be damaged by myocyte death, carefully monitor the patient's heart function and cardiac output by placing him or her on ECG telemetry or consulting with the interdisciplinary team to discuss the need for a pulmonary artery catheter to evaluate the cardiac output of the heart. When the patient is symptomatic and a pulmonary artery catheter is placed, ensure that the catheter selected has the capability to insert temporary pacing leads in the event that the patient continues to decompensate.

In severe circumstances, the patient may exhibit signs of cardiogenic shock and require temporary placement of an intra-aortic balloon pump to assist the weakened heart for short periods of time. Beta-blockers should be avoided in the acute decompensating phase (low BP, elevated heart rate, lowered Svo_2, and/or altered mental status).

In extreme cases, the heart may be profoundly and irreversibly damaged, necessitating a heart transplant. Certain patients may not be suitable candidates for heart transplants if they have multiple comorbidities or if they decline such an aggressive treatment.

Prognosis ahead

Prognosis varies depending on the cause, delay in treatment, response to treatment, duration of illness, and baseline health of the patient. Some patients recover completely, but many have long-term complications such as chronic heart failure, requiring lifelong use of medications to reduce the heart's workload or strengthen the contraction capability of the damaged heart.

The prevalence of myocarditis is actually rare. International occurrence varies widely depending on socioeconomic status, healthcare availability, hygiene, and immunization compliance; biological sex, race, and ethnicity seem to have no influence. Outbreaks of viral infections have been associated with a higher rate of myocarditis. Fatalities are most often associated with the very young and older patients.

Access to healthcare services and emergent treatment are vital to overall survival of patients with myocarditis. A delay in diagnosis or treatment can allow the pathogen to continue myocardial tissue destruction and increase the patient's risk of mortality.

Think critically, save a life!

Myocarditis can be difficult to diagnose because the signs and symptoms may mimic other diseases or illnesses. Utilize your critical thinking skills and proficient clinical assessment skills to discuss myocarditis as a differential diagnosis with your interdisciplinary team. By understanding the clinical pathway of myocarditis, you can identify it quickly and save lives. ■

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