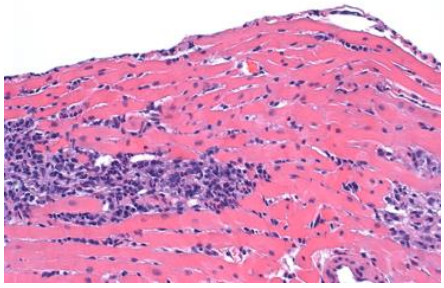
The information below has been obtained with the assistance of:

Dr. Jack Price, Associate Professor of Pediatrics, Baylor College of Medicine; Pediatric Cardiologist at Texas Children's Hospital; and a member of the Myocarditis Foundation Board of Directors.

Dr. Leslie Cooper, Chair of the Mayo Clinic Enterprise Dept. of Cardiovascular Medicine; founder and former president of the Myocarditis Foundation who continues to serve on our Board of Directors.

What is Myocarditis?



The term myocarditis was first designated in Germany in 1837. Not much was spoken again about this for the next 100+ years. Over the past 25 years, there has been an interest and increase in myocarditis research and thus more has been learned about this rare disease that seems to be not as rare as once thought.

Myocarditis is the inflammation of the heart muscle causing myocardial injury. In the developed world, the most common causes of myocarditis are viral infections. Enteroviruses, most frequently Coxsackievirus B, are historically implicated as a common cause of the disease. Mild cases of myocarditis may go unnoticed; but severe cases can cause heart failure and cardiac rhythm disturbances.

Documented myocarditis cases globally, in 2017, were 3.1 million.

Myocarditis is often challenging to diagnose and is often misdiagnosed. It can cause symptoms similar to a heart attack, such as chest pain and shortness of breath; stomach issues, such as vomiting and diarrhea; and weakness, lethargy, fever, among other common symptoms. In children it is even harder to diagnose because they cannot explain their symptoms easily.

Many infants and children with myocarditis present with rapid and labored breathing, wheezing and grunting, often mimicking more common childhood illnesses such as asthma, bronchiolitis and gastroenteritis.

Older children and young adults may complain of fatigue, fever, vomiting and muscle aches a few days before developing more severe symptoms such as shortness of breath and exercise intolerance. Often flu, gastroenteritis and asthma are the diagnoses given. More advanced symptoms include rapid heart rate, erratic and weakened pulse, pallor, diaphoresis and dizziness.

The high-risk age group for developing myocarditis is from puberty through one's 20s and is twice as frequent in males than females.

Often a patient is examined two or more times before being correctly diagnosed with Myocarditis. The earlier a diagnosis is made, the better the outcome and it improves the chances for full recovery. There is no cure. Treatment is symptomatic.

Including Myocarditis as a possibility of non-specific symptoms can be lifesaving. Most with Myocarditis recover with treatment, but a substantial percentage of people may progress to progressive heart failure leading to cardiac transplantation or death.

Myocarditis is the 20th leading cause of death worldwide.

Myocarditis accounts for 45% of Heart Transplants in the U.S.

It is recommended that patients diagnosed with myocarditis be restricted from competitive sports and exertional activities for 6 months. Persistent inflammation of the heart muscle may lead to lethal cardiac arrythmias and sudden death.

Myocarditis is the 3rd leading cause of Sudden Cardiac Death in children and young adults.

Many times, a patient is examined two or more times before being correctly diagnosed with Myocarditis. The earlier a diagnosis is made, the better the outcome and improves the chances for full recovery.

There is no cure. Treatment is Symptomatic.

How Do You Make the Diagnosis of Myocarditis?

It is important to keep acute myocarditis in the differential diagnosis of a patient who presents with new signs or symptoms of acute heart failure, which can initially look like a viral syndrome with vomiting, diarrhea, fever, cough, shortness of breath, fatigue, especially in children and young adults.

It is extremely important that when evaluating children who present with viral syndromes, that you screen carefully in your physical exam and medical history for the potential of early myocarditis. Do they have a gallop heart rhythm? Is there any JVD? Is there any hepatomegaly? Has everyone else in their family or friends recovered from whatever "virus" went through their family/friends/school, but this person is still sick?

It is extremely important that you "think outside the box" and potentially rule out this disease early. <u>The prognosis is usually good when early supportive care is provided. Most can recover from it and live healthy lives.</u>

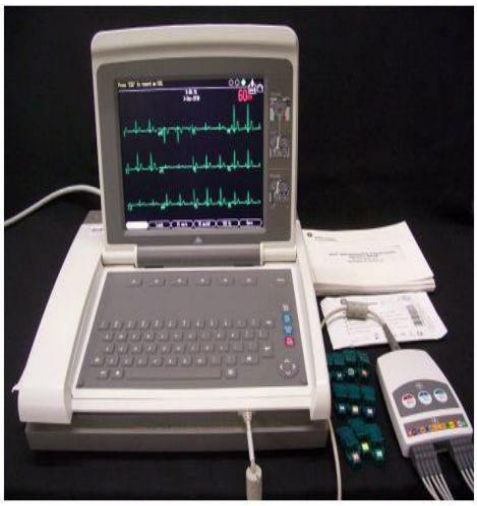
Findings on physical exam may include:

- Hepatomegaly
- Abnormal heart sounds (murmur of mitral regurgitation, gallop rhythm)
- Delayed capillary refill
- Jugular venous distention
- Rales on auscultation of lung fields
- Wheezing, grunting, tachypnea

Tests to consider that may help with diagnosis:

If you have any doubt that this is not “just a simple virus”, please do further diagnostic testing. While there is not a single biomarker that can definitively diagnose myocarditis, there are ways to utilize existing blood tests to help raise “red-flags” that may point to the possibility of myocarditis as a diagnosis.

- B-type Natriuretic peptide (BNP) is a simple blood test that if elevated can be a sign of early heart failure and possibly myocarditis.
- Troponin may or may not be elevated, especially in children. If elevated it signifies damage to the heart muscle.
- Myoglobin is released during cardiac injury and increases with the severity of myocarditis.



Other tests:

- Chest x-ray (cardiomegaly, pulmonary vascular congestion, pleural effusion)
- EKG (PR depression, decreased voltages, irregular rhythm, heart block, ST segment changes)
- Echocardiogram (depressed left ventricular systolic function, mitral regurgitation, dilated left ventricle, decreased ejection fraction)
- Cardiac MRI (can reveal myocardial edema and ischemia that often occurs in myocarditis, though specificity is lacking)

Viral serologies and peripheral blood and tissue cultures are frequently negative and not helpful in making an early diagnosis.

An endomyocardial biopsy has been considered the “gold standard” for confirming a diagnosis of acute myocarditis. However, because of the patchy distribution of inflammation in the myocardium, the cardiac biopsy is fraught with a high false negative rate. However, if looking for Giant Cell Myocarditis, this is the standard.

Treatment and Outcome:

If acute myocarditis is suspected, referral to a cardiologist for confirmation is suggested. Clinical deterioration may occur rapidly, especially in small children.

Treatment of acutely ill patients with myocarditis is focused on correcting hemodynamic derangements, optimizing cardiac output, and providing symptomatic relief. In those with shock or impending shock, temporary mechanical circulatory support, such as ECMO, can maintain circulation and end-organ perfusion, allowing some patients to recover.

Most people with myocarditis will recover with supportive care, but a substantial percentage may develop progressive heart failure leading to death or need for cardiac transplantation.

FULMINANT MYOCARDITIS:

Fulminant myocarditis develops quickly and can prove fatal without early recognition and advanced medical therapy. A recent scientific statement (January 6, 2020) from the American Heart Association and endorsed by the Myocarditis Foundation and the Heart Failure Society of America, details the resources needed to diagnose and treat fulminant myocarditis successfully.

The statement was posted in the cardiovascular journal, Circulation, on January 6, 2020. *You can google Fulminant Myocarditis in Circulation Journal and it will come up for you to read the complete statement.*

This is extremely important information,

especially for Emergency Room Physicians

Updated July, 2020