
CHAPTER 11 – CARDIOVASCULAR SYSTEM

First Nations and Inuit Health Branch (FNIHB) Pediatric Clinical Practice Guidelines for Nurses in Primary Care.
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Table of Contents

INTRODUCTION	11-1
ASSESSMENT OF THE CARDIOVASCULAR SYSTEM	11-1
In Infants	11-1
In Children.....	11-2
Medical History (Specific to Cardiovascular System)	11-2
Physical Findings	11-2
COMMON PROBLEMS OF THE CARDIOVASCULAR SYSTEM.....	11-3
Heart Murmurs	11-3
Innocent Heart Murmur	11-4
EMERGENCY PROBLEMS OF THE CARDIOVASCULAR SYSTEM	11-5
Cardiac Failure.....	11-5
Cyanosis in the Newborn (Birth to 6 Weeks)	11-6
Rheumatic Fever (Carditis)	11-7
Viral Myocarditis.....	11-9
SOURCES.....	11-12

INTRODUCTION

Cardiovascular disease is uncommon in childhood. The major problems seen include congenital heart disease (usually abnormalities of the great vessels, hypoplastic heart, pulmonary or aortic atresia and tetralogy of Fallot), cardiac failure, rheumatic fever, carditis and myocarditis.

Functional or innocent heart murmurs are common.

Congestive heart failure at birth is rare and usually suggests severe valvular deformities.

Symptoms of ventricular septal defect, including heart failure, usually occur at approximately 6 weeks of age.

For more information on the history and physical examination of the cardiovascular system in older children and adolescents, *see the chapter “Cardiovascular System” in the adult clinical practice guidelines.*

ASSESSMENT OF THE CARDIOVASCULAR SYSTEM

Symptoms of cardiovascular disease vary with the age of the child.

Ask about:

- Rapid or noisy breathing
- Cough
- Cyanosis
- Sleeping patterns
- Exercise tolerance: indicated in a young child by ability to feed and in an older child by ability to keep up with peers during play

IN INFANTS

CYANOSIS

- An abnormality of oxygen transport related to heart, lungs or blood or inadequate oxygenation of blood due to mixing of venous and arterial blood. Transport problems include impairment of the oxygen-carrying capacity of hemoglobin, as for example, in carbon monoxide poisoning, and hypoxemia secondary to ventilation/perfusion mismatches as for example in pneumonia
- Causes bluish discoloration of mucous membranes, nail beds and skin, is a significant clinical finding and is related to inadequate oxygenation of arterial blood
- May be transient (related to increased oxygen demand by tissues, for example, during feeding in infants or during play in toddlers) or permanent from birth

EXERCISE INTOLERANCE

- Eats slowly or poorly
- Tires easily during feeding and with poor weight gain
- Cyanosis appears with feeding (exertional)
- Often described by parents or caregiver as a “good baby”: always quiet, sleeps a lot, parents may find baby less energetic compared to siblings at same age

DIFFICULTY BREATHING

- Tachypnea
- Chest retractions
- Nasal flaring
- Anxious appearance
- Grunting

EXCESSIVE PERSPIRATION

- Infant’s head described as “always wet”
- Infant perspires freely and easily, especially with excretion and feeding

SLOW GROWTH

- Child usually exhibits slow weight gain, relative to height gain; difficulty in feeding may contribute to this problem
- Metabolic demands increased

RESPIRATORY INFECTIONS

- More common with congestive heart failure
- More severe with increased pulmonary flow

IN CHILDREN

- Slow growth
- Respiratory infections
- Chest pain
- Palpitations
- Dizzy spells or blackouts
- Exercise intolerance
- Squatting with cyanotic episodes (“tetralogy spells”)

MEDICAL HISTORY (SPECIFIC TO CARDIOVASCULAR SYSTEM)

- Prematurity (associated with a higher prevalence of congenital cardiac malformation)
- History of illnesses related to heart disease (for example, strep throat)
- “Flu-like” illness
- Joint pains or swelling
- Down syndrome (associated with a higher prevalence of congenital heart disease)

PHYSICAL FINDINGS

An examination of the cardiovascular system involves more than just examining the heart. The examination generally covers two systems: the central cardiovascular system (head, neck and precordium [anterior chest]) and the peripheral vascular system (extremities). Examination of the cardiovascular system must also include a full assessment of the lungs and neurological status (for signs of confusion, irritability or stupor).

VITAL SIGNS

- Heart rate
- Respiratory rate
- Blood pressure (in both an upper and a lower limb, if possible)
- Temperature (may be elevated with myocarditis or acute rheumatic fever)
- Cardiovascular problems may present as failure to thrive (weight and height below specified percentiles for age) or as a sharp decline in the growth curve across a major percentile line, therefore always document height and weight for all well baby and child examinations

INSPECTION

- Respiratory distress
- Cyanosis: central and peripheral
- Hands and feet: cyanosis, clubbing
- Precordium: visible pulsations
- Edema (hands, feet, sacrum)

PALPATION

- Apical beat is located at fourth intercostal space, lateral to the mid-clavicular line in infants, and at fifth intercostal space, lateral to the mid-clavicular line in older children
- Brief, localized apical tap is normal
- Apical beat may be laterally displaced, which indicates cardiomegaly
- Thrills or heaves may be palpable through chest wall; check supraclavicular area for thrills (in children with a thin chest wall, normal heart movements can be easily palpated and should not be confused with true thrills and heaves)
- Hepatomegaly
- Check for presence, rate, rhythm, amplitude and equivalence of peripheral pulses, especially femoral pulses (which are bounding in patent ductus arteriosus, absent in coarctation of aorta)
- Check for synchrony of radial and femoral pulses
- Capillary refill (normal < 3 seconds)
- Edema: pitting (rated 0 to 4) and level (how far up the feet and legs the edema extends); sacral edema
- Skin: temperature, turgor

AUSCULTATION

- S₁ and S₂ heart sounds
- Physiologic splitting of S₂ heart sound
- Added heart sounds (S₃ and S₄): determine their location and relation to respiration
- Murmurs: determine location (where murmurs are best heard), radiation, their timing in cardiac cycle, intensity, grade (*see Table 1, “Characteristics of Heart Murmurs of Various Grades”*) and quality
- Bruits: may occur in carotid arteries, abdominal aorta, renal arteries, iliac arteries, femoral arteries
- Crackles in lungs: may indicate heart failure (in infants and children, this usually occurs as a late sign)

Table 1 – Characteristics of Heart Murmurs of Various Grades

Grade	Characteristics
I	Very quiet, barely audible
II	Quiet but audible
III	Easily heard
IV	Thrill can be felt, murmur is easily heard
V	Thrill can be felt and loud murmur can be heard with stethoscope placed lightly on chest
VI	Thrill can be felt and very loud murmur can be heard with stethoscope held off the chest wall

COMMON PROBLEMS OF THE CARDIOVASCULAR SYSTEM

HEART MURMURS

Most murmurs are innocent flow murmurs, which are present in up to 50% of children; see “*Innocent Heart Murmur*.”

A heart murmur may signify congenital anatomic, infectious or inflammatory damage to valves and outlets of the four chambers of the heart.

PHYSICAL FINDINGS: AUSCULTATION

Auscultation helps to distinguish significant murmurs from innocent murmurs.

Murmurs must be recognized in relation to other physiologic and pathologic sounds of the cardiac cycle.

- The S₁ sound is caused by the closure of the mitral and tricuspid valves, which usually occurs simultaneously. The S₁ sound is best heard at the cardiac apex
- The S₂ sound occurs with the closure of the aortic and pulmonary valves. Because the closure of these two valves is somewhat asynchronous, what is known as the S₂ sound actually consists of two sounds. The separation of the two component sounds is often difficult to detect in young children, although it is more pronounced during inspiration. Wide separation of the S₂ sound is often a significant pathologic finding. The S₂ sound is best heard in the second and third left intercostal spaces

- An S₃ sound may occur after the second heart sound. This may be found in healthy children. It is a sign of heart failure in a symptomatic child. The S₃ sound is best heard when listening at the apex of the heart (in the fourth and fifth intercostal spaces); a left side-lying position may accentuate the sound. Use the bell part of the stethoscope
- Ejection “clicks” may be present in certain conditions; they are always abnormal

If a murmur is present, several characteristics should be determined.

Timing within Cardiac Cycle

- Systolic ejection murmurs occur after the first sound. They are caused by turbulence in the blood as it leaves the heart
- Pansystolic murmurs begin with the first heart sound and end with the second. They most often occur in association with ventricular septal defects
- Diastolic murmurs begin with the second heart sound. They are always abnormal

Shape or Contour

- Qualifies the intensity over time: murmurs can be crescendo, decrescendo, or crescendo-decrescendo

Location on the Thorax

There are four general auscultatory areas:

- *Aortic*: left ventricular outflow murmur (usually ejection)
- *Pulmonary*: right ventricular outflow murmur, patent ductus arteriosus
- *Tricuspid*: tricuspid murmurs increase on inspiration; ventricular septal defects are heard best in this area
- *Mitral*: murmur at the cardiac apex

Radiation

Radiation of the murmur to the back, sides and neck should be carefully auscultated. Radiation of the murmur may give important diagnostic clues (for example, aortic stenosis radiates to the neck).

Intensity of Murmur

- Intensity expressed as a fraction of VI (for example, I/VI, II/VI), where a very loud murmur = V/VI or VI/VI, a loud murmur = III/VI or IV/VI, and a soft murmur = I/VI or II/VI (*see Table 1, “Characteristics of Heart Murmurs of Various Grades”*)
- Intensity (loudness) does not necessarily correlate with the severity of the condition. Soft murmurs may be dangerous, whereas loud murmurs are not necessarily so. A murmur associated with a thrill has an intensity of at least IV/VI
- Intensity may also increase with increased blood flow, as with exercise

Pitch

- Can be low, medium or high and is determined by whether it can be auscultated best with the bell or the diaphragm of a stethoscope

Quality

- Blowing
- Harsh
- Musical
- Rumbling
- Clanging

INNOCENT HEART MURMUR

Heart murmur that occurs in the absence of anatomic or physiologic abnormalities of the heart and therefore has no clinical significance. Such murmurs occur in 50–80% of children.

TYPES OF INNOCENT HEART MURMURS

Still’s murmur – vibratory, systolic ejection murmur (SEM), lower left sternal border (LLSB) or apex; ages 3 to 6 years.

Venous hum – infraclavicular hum, continuous, heard on right side more than left side; ages 3 to 6 years.

Peripheral pulmonic stenosis – pulmonic area, systolic, low pitched, radiates to axilla and back, seen in neonates; disappears usually by 3 to 6 months of age.

Pulmonary ejection – soft, blowing, upper left sternal border, systolic ejection murmur (SEM).

PATHOPHYSIOLOGY

Most innocent heart murmurs are produced by the forward flow of blood, which creates turbulence in the chambers of the heart or the great vessels. These murmurs are often more pronounced in high-output states, such as during a fever. Because the intensity of the murmur parallels the ejection velocity of blood from the ventricles, innocent murmurs usually occur during early to mid-systole, are short in duration, have a crescendo-decrescendo contour (especially an ejection murmur), are less than 3/6 in intensity and are never diastolic.

CLINICAL FEATURES

Innocent heart murmurs are asymptomatic and are usually found on routine physical examination.

DIAGNOSTIC TESTS

- Electrocardiogram (ECG)
- Echocardiography (only as ordered by a physician)

MANAGEMENT

Reassure the parents or caregiver that no immediate treatment is necessary.

Referral

Refer the asymptomatic child electively to a physician for assessment when a murmur is found.

EMERGENCY PROBLEMS OF THE CARDIOVASCULAR SYSTEM

CARDIAC FAILURE

The inability of the heart to pump blood commensurate with the body's needs. The symptoms and signs correlate with the degree of failure.

CAUSES

- Congenital abnormality of cardiac structures
- Inflammatory (for example, rheumatic fever)
- Infectious (for example, viral cardiomyopathy, subacute bacterial endocarditis)
- Severe anemia (that is, hemoglobin < 40 g/L)
- Other high-output states (for example, thyrotoxicosis, arteriovenous malformation)
- Extracardiac disease (for example, chronic pulmonary disease, pulmonary hypertension)

HISTORY

The history varies according to the child's age.

- Difficulty with feeding
- Shortness of breath
- Excessive sweating
- Poor weight gain
- Anxious appearance

PHYSICAL FINDINGS

- Tachycardia
- Tachypnea
- Blood pressure (assessed in both arms) usually normal but may be reduced (if so, this is cause for concern, as it may indicate cardiogenic shock)
- Temperature: if higher than normal, consider inflammatory or infectious cause
- Irritable
- Anxious
- Fontanel full
- Nostrils flared
- Cyanosis
- Peripheral swelling (in older children)
- Increased jugular venous distention
- Displaced, diffuse apical impulse (cardiomegaly)
- Heave or thrill
- Gallop rhythm (with extra S₃ heart sound)
- Increased murmurs

- Crackles in lung fields
- Hepatomegaly
- Diminished peripheral pulses

DIFFERENTIAL DIAGNOSIS

- Respiratory disease (for example, bronchiolitis or pneumonia)
- Metabolic abnormality (for example, hypoglycemia; poisoning, as with salicylates) also consider hyperglycemia with ketosis, head injuries
- Sepsis including meningitis

COMPLICATIONS

- Decreased cardiac output (shock)
- Death

DIAGNOSTIC TESTS

- Pulse oximetry

MANAGEMENT

Goals of Treatment

- Improve hemodynamic function
- Prevent complications

Appropriate Consultation

Consult with a physician regarding emergency treatment.

Nonpharmacologic Interventions

- Nurse the child in head-elevated position (do not allow neck to become kinked)
- Restrict oral fluids to no more than the quantity required to maintain hydration (*see chapter "Fluid Management"*)

Adjuvant Therapy

- Start IV therapy with normal saline to keep vein open (unless this would stress the child too much)
- Give oxygen 6–10 L/min or more by non-rebreather mask.¹ Titrate to keep oxygen saturations > 97%.²

Pharmacologic Interventions

Drugs used to treat heart failure in children are to be ordered by a physician.

- Diuretics to decrease volume:
 - furosemide (Lasix), 1 mg/kg IV stat (may be given PO if IV access not available)
- ACE inhibitors may be prescribed by a physician for afterload reduction
- Digoxin may be used in some cases to increase contractility

Monitoring and Follow-Up

Acute Phase

Monitor ABCs (airway, breathing and circulation), vital signs, pulse oximetry (if available), heart and lung sounds, intake and output until child is transferred to hospital.

Over the Long Term

Children with cardiac illness should be monitored regularly within the community to ensure normal growth and development and to watch for complications. Frequency of follow-up depends on the severity of the condition.

Referral

Medevac immediately.

CYANOSIS IN THE NEWBORN (BIRTH TO 6 WEEKS)

Bluish discoloration of the skin and mucous membranes secondary to hypoxia.

CAUSES

Congenital Heart Disease

Cardiac cyanosis is due to left-to-right shunting, so that systemic venous blood bypasses the pulmonary circulation and enters the arterial systemic circulation.

Findings of increased risk for congenital heart disease:

- Genetic syndromes (for example, Down syndrome)
- Certain extracardiac anomalies (for example, omphalocele)
- Maternal diabetes that is poorly controlled in the first trimester
- Exposure to a cardiac teratogen (for example, lithium, isotretinoin [Accutane], alcohol)
- Family history of significant congenital heart disease

Non-cardiac Causes

- Pulmonary infection (for example, group B streptococcal infection)
- Intrauterine infection or systemic viral infection (for example, Rubella or Coxsackie B5)
- Aspiration of meconium
- Pulmonary hypoplasia
- Respiratory distress syndrome (for example, in premature infants)
- Hypoventilation (for example, neurologic depression)
- Persistent fetal circulation: seen in post-term infants with perinatal distress or pulmonary disease

Clinical Features of Infants with Cyanotic Heart Disease

The clinical features usually present in the first week of life but may present later:

- Difficulty feeding; infant appears to tire easily
- Lethargy
- Cyanosis when feeding or active (for example, while crying)
- Perspiration on face or forehead, especially when feeding or active
- Rapid, noisy breathing

PHYSICAL FINDINGS

- Lethargy
- Cyanosis, initially of the oral mucosa; in severe cases, the cyanosis becomes generalized
- Reduced oxygen saturation
- Tachypnea
- Poor perfusion (for example, pallor or gray, ashen appearance; extremities cool; capillary refill diminished; peripheral pulses diminished)
- In coarctation of aorta, pulse quality and blood pressure may differ in different extremities
- Heart sounds may be loud
- Precordium may appear hyperdynamic (heaves or thrills may be present)
- Heart murmur may be present
- Hepatomegaly (if infant is in heart failure)

DIFFERENTIAL DIAGNOSIS

- Pulmonary causes as listed above
- Sepsis

COMPLICATIONS

- Cardiac failure (*see* “*Cardiac Failure*”)
- Failure to thrive (*see* “*Failure to Thrive*” in the pediatric chapter “*Hematology, Endocrinology, Metabolism and Immunology*”)
- Death

DIAGNOSTIC TESTS

- Pulse oximetry

MANAGEMENT**Appropriate Consultation**

Consult a physician immediately and prepare to medevac.

Adjuvant Therapy

- Give oxygen 6–10 L/min (or more, if necessary) by non-rebreather mask. Titrate to keep oxygen saturations > 97%²
- Consider intravenous (IV) therapy with normal saline if infant is feeding poorly or is in significant clinical distress

Nonpharmacologic Interventions

- Nurse in an upright position
- Feed small amounts frequently

Monitoring and Follow-Up

- Monitor level of consciousness, vital signs, heart and lung sounds, perfusion, pulse oximetry
- Hydration status (intake and output) (*see* “*Clinical Features of Dehydration*” in the chapter “*Fluid Management*”)
- Watch for signs of cardiac failure (*see* “*Cardiac Failure*”)

Referral

- Medevac as soon as possible

RHEUMATIC FEVER (CARDITIS)

A diffuse inflammatory disease of the connective tissues, which involves the heart, joints, skin, central nervous system and subcutaneous tissue. It tends to recur. The disease arises from immune complications of group A β -hemolytic streptococcal infection.

Rheumatic fever is much more common in Aboriginal children and in those living in lower socioeconomic circumstances. It may occur at any age but is most common in school-aged children. The risk is higher in families in which there is a history of the disease.

CAUSES

- Precedent group A streptococcal infection (pharyngitis, cellulitis) and subsequent immune response

HISTORY

The disease is nearly always preceded by streptococcal pharyngitis (occurring 2–5 weeks earlier)

The presenting symptoms are variable, but may include the following:

- Fever
- Joint pain, redness and swelling (a constellation of symptoms known as migratory arthritis, typically involving the large joints)
- Emotional lability
- Involuntary, purposeless muscular movements (known as Sydenham’s chorea)
- Shortness of breath, edema, cough, fatigue (representing heart failure)
- Rash (erythema marginatum)
- Subcutaneous nodules along tendon sheaths

PHYSICAL FINDINGS

The physical findings are variable and depend on the degree of involvement of various parts and systems of the body.

- Low-grade fever
- Tachycardia (increase in resting heart rate)
- Tachypnea

Cardiovascular Signs

- Dyspnea, cyanosis, edema and hepatomegaly if the child is in heart failure
- Thrill or heave may be present
- New heart murmurs, often pansystolic
- Rubs may be audible with inspiration and expiration if disease is associated with pericarditis
- Decrease in intensity of heart sounds

Musculoskeletal Signs

- Joints hot, tender and swollen at several sites

Skin

- Rash (erythema marginatum: nonpruritic, commonly affecting trunk, proximal extremities and sparing the face)
- Nodules may be palpated in subcutaneous tissue, usually on extensor surfaces of limbs

Other Symptoms

- Emotional lability
- Involuntary, purposeless muscular movements (Sydenham’s chorea)

DIFFERENTIAL DIAGNOSIS

- Congenital heart disease (previously undiagnosed)
- Viral carditis
- Rheumatoid arthritis
- Tics (which may mimic chorea)

The diagnosis is based on a complicated collection of signs known as Jones’ criteria (*see Table 2, “Jones’ Criteria for Diagnosis of Rheumatic Fever”*).

Table 2 – Jones’ Criteria for Diagnosis of Rheumatic Fever*

Major Criteria	Minor Criteria
Carditis	Fever
Polyarteritis	Arthralgia
Sydenham’s chorea	Previous rheumatic fever
Erythema marginatum	Laboratory findings: elevated ESR, WBC, C-reactive protein; decreased hemoglobin; prolonged PR or QT intervals on electrocardiogram

Subcutaneous nodules

ESR = erythrocyte sedimentation rate;

WBC = white blood count

*Any combination of two major criteria or one major and two minor criteria is indicative of the diagnosis, in addition to evidence of recent streptococcal infection.

COMPLICATIONS

- Carditis
- Congestive heart failure
- Rheumatic heart disease (valvular damage, usually to the mitral valve)

DIAGNOSTIC TESTS

- None

MANAGEMENT

The diagnosis and treatment of rheumatic fever require evacuation to hospital. Emergency treatment of congestive heart failure may be necessary; *see “Cardiac Failure”*.

Goals of Treatment

- Identify the disease early
- Prevent complications

Primary Prevention

- Aggressive treatment of group A streptococcal throat infections with a complete course of antibiotic medications

ACUTE PHASE**Appropriate Consultation**

Consult a physician immediately and prepare to medevac.

Nonpharmacologic Interventions

- Bed rest

Pharmacologic Interventions³

Medications should not be started until the diagnosis has been clearly established. Medications are prescribed only by a physician.

Treatment of acute rheumatic fever involves antibiotic therapy to eliminate carriage group A streptococci, anti-inflammatory therapy and if needed, therapy for heart failure.

Anti-inflammatory therapy:

acetylsalicylic acid (ASA), 80 to 100 mg/kg/day divided q6-8h in children

Antibiotic therapy to eliminate carriage of group A streptococci:

Children ≤ 27 kg

penicillin VK (Pen Vee K), 250 mg PO bid or tid for 10 days

OR

amoxicillin 40 mg/kg/day PO divided bid-tid for 10 days

OR

cephalexin 25–50 mg/kg/day PO divided bid for 10 days

If allergic to penicillin:

azithromycin 12 mg/kg PO once daily for 5 days

Erythromycin is also a suitable alternative in penicillin-allergic patients

Adolescents > 27 kg

penicillin VK (Pen Vee K), 500 mg PO bid or tid for 10 days

OR

amoxicillin 500 mg PO tid for 10 days

OR

cephalexin 500 mg PO bid for 10 days

If allergic to penicillin:

azithromycin 500 mg PO on day one, then 250 mg on days 2–5

Erythromycin is also a suitable alternative in penicillin-allergic patients.

Monitoring and Follow-Up

Monitor for signs of cardiac failure. If child is in cardiac failure, see “*Cardiac Failure*”.

Referral

Medevac.

POST-ACUTE PHASE

Pharmacologic Interventions for Prophylaxis⁴

Because of the risk of recurrence, continual antibiotic prophylaxis must be maintained. The risk of recurrence is greatest in the first 5 years after the initial bout. Prophylaxis is initiated immediately after completion of a full therapeutic course of antibiotics as described above. A physician would initially prescribe prophylaxis, usually with penicillin, sulfadiazine or a macrolide antibiotic such as azithromycin.

Prophylaxis for children without carditis should be maintained for at least 5 years and preferably throughout childhood.

If valvular disease results, lifetime prophylaxis is recommended or at least to 21 years of age.

A physician should also determine any discontinuation of prophylaxis.

VIRAL MYOCARDITIS

Myocarditis is an inflammatory disorder of the myocardium with necrosis of the myocytes and associated inflammatory infiltrate.

PATHOPHYSIOLOGY

Myocarditis generally results in a decrease in myocardial function, with concomitant enlargement of the heart and an increase in the end-diastolic volume caused by increased preload. Progressive increase in left ventricular end-diastolic volume increases left atrial, pulmonary venous and arterial pressures, resulting in increasing hydrostatic forces. These increased forces lead to both pulmonary edema and congestive heart failure.

CAUSES

It is usually caused by a viral infection. Parvovirus B19 and human herpesvirus-6 are the most frequent pathogens in patients with acute myocarditis. Infecting organisms may include the following:

- Parvovirus B19
- Herpesvirus
- Coxsackievirus types A and B (especially type B)
- Adenovirus (most commonly types 2 and 5)
- Cytomegalovirus
- Echovirus
- Epstein-Barr virus
- Hepatitis C virus
- Human immunodeficiency virus
- Influenza and parainfluenza
- Measles
- Mumps, associated with endocardial fibroelastosis (EFE)
- Poliomyelitis virus
- Rubella
- Varicella

Risk Factors

Younger patients, especially newborns and infants and immunocompromised individuals may have increased susceptibility to myocarditis.

HISTORY

Clinical presentation varies widely. In mild forms, few or no symptoms are noted. In severe cases, patients may present with acute cardiac decompensation and progress to death.

In newborns and infants, symptoms may sometimes appear suddenly and may include:

- Irritability
- Failure to thrive
- Feeding difficulties
- Fever and other symptoms of infection
- Lethargy
- Low urine output (a sign of decreasing kidney function)
- Pale hands and feet (a sign of poor circulation)
- Rapid breathing
- Rapid heart rate

Symptoms in children over age 2 may also include:

- Belly area pain and nausea
- Cough
- Fatigue
- Swelling (edema) in the legs, feet and face
- Recent, nonspecific, flu-like illness
- Older children present with similar symptoms as above and may experience lack of energy and general malaise
- Chest pain: Although rare in young children, this may be the initial presentation for older children and adolescents and should be considered a serious symptom accordingly

PHYSICAL FINDINGS

Neonates/Infants

- Hypothermia or hyperthermia
- Tachypnea
- Tachycardia
- Cyanosis
- Cool extremities
- Decreased capillary refill
- Pale or mottled skin may be present
- Wheezing, and diaphoresis with feeding
- Irritability
- Somnolence
- Hypotonia
- Seizures
- Oliguria
- End-organ damage (for example, renal failure may develop because of direct viral infestation or because of low cardiac output)

Older Children

- Low grade fever
- Tachycardia, weak pulse
- Jugular venous distention and edema of the lower extremities may be present
- Heart sounds may be muffled, especially in the presence of pericarditis
- An S3 may be present
- Heart murmur caused by atrioventricular valve regurgitation may be heard
- Crackles may be heard in older children
- Hepatomegaly may be present in younger children
- Cool extremities
- Decreased capillary refill
- Pale or mottled skin may be present

Adolescents

Presentation in adolescents is similar to that of children between 6 and 12 years old. However, the following symptoms may be more prominent:

- Decreased exercise tolerance
- Lack of energy, malaise
- Chest pain
- Low-grade fever
- Arrhythmia
- Cough
- Low cardiac output

DIFFERENTIAL DIAGNOSIS

- Myocarditis, nonviral
- Pericarditis, viral
- Aortic stenosis, valvular
- Enteroviral infections
- Cardiomyopathy, dilated
- Glycogen-storage disease type I or type II
- Coarctation of the aorta
- Coronary artery anomalies

DIAGNOSTIC TESTS

Chest x-ray may show cardiomegaly and cardiac failure.

Electrocardiography (ECG)

In some patients with mild cardiac involvement, ECG changes may be the only abnormal findings suggestive of myocarditis.

- Low-voltage QRS (< 5 mm throughout the limb leads) is the classic pattern
- Pseudoinfarction patterns with pathologic Q waves and poor progression of R waves in the precordial leads may also be present
- T-wave flattening or inversion is a common finding associated with small or absent Q waves in V5 and V6
- Left ventricular hypertrophy with strain may be present
- Other nonspecific findings include a prolonged PR segment and prolonged QT interval
- Sinus tachycardia is the most common finding
- Premature ventricular contractions and atrial tachycardia have been reported
- Junctional tachycardia is common and may worsen congestive heart failure
- Occasional second-degree and third-degree atrioventricular block may be present
- Ventricular tachycardia is commonly associated and may be the initial presentation

COMPLICATIONS

- Arrhythmia
- Cardiac failure (*see “Cardiac Failure”*)
- Thromboembolism
- Decrease in ventricular function
- Dilated cardiomyopathy

MANAGEMENT

Goals of Treatment

- Stabilize cardiovascular function
- Prevent complications

Appropriate Consultation

Consult a physician urgently if you suspect this condition.

Adjuvant Therapy

- Give supplemental oxygen as necessary via non-rebreather mask. Titrate to keep oxygen saturations > 97%
- Start an intravenous line with normal saline. Run at a rate sufficient to maintain hydration depending on oral intake of child. Do not overhydrate. Keep line open until consultation with an emergency physician. Always weigh infant before starting any intravenous fluids as a measure of hydration

Nonpharmacologic Interventions

- Bed rest is necessary during the acute phase of the illness
- Nurse in an upright position

Pharmacologic Interventions

Consult a physician for medication orders. Medications may include the following, when indicated: *see “Cardiac Failure”*.

- Diuretics to decrease volume:
 - furosemide (Lasix), 1 mg/kg IV stat (may be given PO if IV access not available)
- ACE inhibitors may be prescribed by a physician for afterload reduction
- Digoxin may be used in some cases to increase contractility
- Antiarrhythmics
- Anticoagulants

Monitoring and Follow-Up

Acute Phase

Monitor ABCs (airway, breathing and circulation), vital signs, pulse oximetry, heart and lung sounds, neuromental status, intake and output and medication response and adverse effects closely until child is transferred to hospital.

Over the Long Term

Children with cardiac illness should be monitored regularly within the community to ensure normal growth and development and to watch for complications. Frequency of follow-up depends on the severity of the condition.

Referral

Medevac to a facility with intensive and cardiology care.

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