Endocarditis, Bacterial

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SYNONYMS AND RELATED KEYWORDS: bacterial endocarditis, infective endocarditis, acute bacterial endocarditis, subacute bacterial endocarditis, fulminant endocarditis

INTRODUCTION

BACKGROUND: Bacterial endocarditis is a microbial infection of the endothelial surface of the heart. Signs and symptoms of bacterial endocarditis are diverse; therefore, the practitioner must have a high degree of suspicion to make an early diagnosis. In addition, classification that implicates the temporal aspect, etiology, anatomic site of infection, and relevant pathogenic risk factors is essential in therapeutic and prognostic considerations.

PATHOPHYSIOLOGY: A high-velocity flow through a stenotic or incompetent valve or an abnormal communication between systemic and pulmonary circulations causes turbulence downstream from the opening. This turbulence damages or denudes the
endothelium, to which platelets and fibrin adhere, and a small, sterile thrombus forms. In addition, indwelling intravascular catheters in the right heart may directly traumatize the endocardium or valvular endothelium. Circulating bacteria and inflammatory cells adhere to and grow in these thrombi, forming an infected vegetation. Infection may occur (1) on the wall, where the turbulent jet strikes, or (2) downstream, near the orifice, where the flow eddies. Once vegetation forms, the constant blood flow may result in embolization to virtually any organ in the body. A brisk immunologic response is produced.

**Frequency:**

- **In the US:** The incidence of endocarditis is approximately 1 case per 1000 pediatric hospital admissions. This incidence has remained essentially unchanged over the past 40 years; however, the distribution of etiologies has shifted. Rheumatic heart disease, which was once common, is now a rare cause of endocarditis. In contrast, the advent of sophisticated cardiac procedures and early intervention has led to an increase in the incidence of endocarditis in children with congenital heart disease. Preexisting cardiac abnormalities are found in approximately 75% of children with bacterial endocarditis.

**Mortality/Morbidity:** The overall mortality rate for endocarditis in pediatric patients is approximately 16-25%. Improved general health care, improved dental care, early treatment, and antibiotic prophylaxis have decreased the mortality rate. Mortality is mostly due to secondary congestive heart failure (CHF).

Factors that increased the risk of complications include prosthetic valve endocarditis, left-sided endocarditis, infection with *Staphylococcus aureus* or fungi, previous endocarditis, cyanotic congenital heart disease, systemic-to-pulmonary shunts, and a poor response to antibiotic therapy.

**Race:** No racial predilection exists.

**Sex:** No predilection exists for either sex.

**Age:** Bacterial endocarditis is most frequently observed in adults, but the incidence in children with congenital heart disease or central indwelling venous catheters continues to rise.

**History:** Features of bacterial endocarditis are due to bacteremia, local cardiac invasion by organisms, peripheral embolization, and the formation of immune complexes.

- Patients with bacterial endocarditis may present with many nonspecific symptoms; however, 85-99% of patients are febrile. Patients with congenital heart disease and fever require special consideration.
- Other historical features include fatigue, chills, sweats, anorexia, malaise, a cough, a headache, myalgia and/or arthralgia, and confusion.
- Patients with acute bacterial endocarditis present with an acute, toxic, febrile illness and symptoms that have lasted less than 2 weeks. A history of intravenous (IV) drug use may be elicited. *S aureus* is the most common cause of acute bacterial endocarditis.
- Patients with subacute bacterial endocarditis present with a more nonspecific flu-like illness and symptoms that have lasted more than 2 weeks. Subacute bacterial endocarditis is more common in patients with an underlying congenital heart defect.

**Physical:** Physical findings are nonspecific and varied. Factors such as the duration of illness, microbiologic etiology, and patient's age may vary.

- Fever is present in 85-99% of patients with endocarditis. Fever is usually low grade with a temperature rarely exceeding 39°C, remittent, and typically not associated
• A new or changing heart murmur is noted in 20-80% of patients. These murmurs may be difficult to identify in patients with subacute endocarditis or in infants and young children who may already have a clinically significant murmur secondary to congenital heart disease.

• Neurologic abnormalities occur in approximately 30-40% of patients and are most frequent in endocarditis caused by *S aureus*. Symptoms include stroke, intracerebral hemorrhage, and subarachnoid hemorrhage.

• Peripheral symptoms may be observed.
  
  o Extracardiac manifestations of endocarditis are less common in children than in adults. Petechiae are the most common of these symptoms (20-40%). They are found on the palpebral conjunctiva, the buccal or palatal mucosa, and the extremities. However, petechiae are not specific for endocarditis.

  o Splinter and subungual hemorrhages are dark red, linear streaks in the nail beds of the fingers and toes.

  o Osler nodes are small, tender, subcutaneous nodules that develop in the pulp of the digits.

• Acute heart failure may be due to valve destruction or distortion and/or rupture of the chordae tendineae. Chronic heart failure may be due to progressive valvular insufficiency with worsening ventricular function. Heart failure with aortic insufficiency is associated with high mortality rates.

• Hepatosplenomegaly is noted in approximately 15-20% of patients.

• Renal insufficiency, as a result of immune complex–mediated glomerulonephritis, occurs in less than 15% of patients with endocarditis and may cause hematuria but rarely azotemia.

• In neonates, endocarditis commonly produces septic embolic phenomena, such as osteomyelitis, meningitis, and pneumonia. Neonates with endocarditis may also have feeding problems, respiratory distress, tachycardia, or neurologic symptoms.

• The diagnosis of endocarditis with the modified Duke criteria is based on pathologic or clinical findings. Pathologic criteria for definite infectious endocarditis include microorganisms on cultures or histology in a vegetation or histologic confirmation of active disease in a vegetation or intracardiac abscess. Clinical criteria for definite infectious endocarditis includes 2 major, 1 major and 3 minor, or 5 minor criteria, as follows:

  o Major criteria
  
  ■ Positive blood cultures (2 separate cultures for a typical endocarditis microorganism, such as *Streptococcus viridans* or HACEK organism [Haemophilus parainfluenzae, Haemophilus aphrophilus, Haemophilus paraphrophilus, Actinobacillus actinomyctemcomitans, Cardiobacterium hominis, Eikenella corrodens, or *Kingella* species], persistently positive blood cultures, or evidence of infection with a *Coxiella* organism and/or Q fever)

  ■ Positive echocardiographic findings (eg, oscillating mass and/or vegetation, paravalvular abscess, or dehiscence of a prosthetic valve)

  ■ New valvular regurgitation

  o Minor criteria

  ■ Predisposition (history of IV drug use or congenital heart disease)
- Fever with a temperature >38°C
- Vascular phenomena (arterial emboli, septic pulmonary infarcts, intracranial hemorrhage, conjunctival hemorrhage, Janeway lesions [painless, hemorrhagic lesions on palms and soles])
- Immunologic phenomena (glomerulonephritis, Osler nodes, Roth spots, positive result for rheumatoid factor)
- Positive blood cultures without meeting the criteria above or serologic evidence of active infection consistent with endocarditis

**Causes:** Risk factors for bacterial endocarditis may be divided into those associated with high-risk conditions and those from high-risk procedures.

- High-risk conditions
  - Congenital heart disease (septal defects, valve disease, cyanotic heart disease)
  - Acquired valve disease
  - Prosthetic valve
  - IV drug use
  - Previous episode of bacterial endocarditis
  - Surgical systemic to pulmonary shunts and conduits
  - Central venous catheters
- High-risk procedures (procedures that are likely to produce bacteremia involving typical microorganisms in susceptible patients)
  - Dental procedures (extractions, implants, root canals)
  - Respiratory procedures (tonsillectomy and adenoidectomy, surgical operations, bronchoscopy)
  - GI procedures (sclerotherapy, biliary tract surgery, endoscopic retrograde cholangiopancreatography [ERCP])
  - Genitourinary tract (prostatic surgery, cystoscopy, urethral dilation)
- Microbiology
  - A select group of organisms causes most cases of endocarditis. Gram-positive organisms, particularly alpha-hemolytic streptococci (*S. viridans*), *S. aureus*, and coagulase-negative staphylococci, are the most common offenders.
  - Enterococci are rare but dangerous causative organisms because they often are highly resistant to antibiotic treatment.
  - *Haemophilus, Actinobacillus, Cardiobacterium, Eikenella*, and *Kingella* species (HACEK organisms) are particularly common in neonates and immunocompromised children.
  - Fungal endocarditis is a severe disease with poor prognosis. Complications are common.
- Culture-negative endocarditis occurs when a patient has typical clinical or echocardiographic findings of endocarditis, with persistently negative blood cultures. Common causes include recent antibiotic therapy or infection caused by a
fastidious organism that grows poorly in vitro.

**Differentials**

- Acute Lymphoblastic Leukemia
- Acute Myelocytic Leukemia
- Arthritis, Septic
- Endocarditis, Fungal
- Fever in the Toddler
- Fever in the Young Infant
- Heart Failure, Congestive
- Kawasaki Disease
- Meningitis, Bacterial
- Myocarditis, Nonviral
- Pneumonia
- Rheumatic Fever
- Vasculitis and Thrombophlebitis

**Workup**

**Lab Studies:**

- The most definitive laboratory tests are multiple blood cultures that grow an organism known to cause endocarditis.
  - Blood cultures should be obtained from all patients with fever of unclear etiology and a pathologic heart murmur, a history of heart disease, or previous endocarditis.
  - For microbiologic documentation, obtaining 5-7 mL of blood for children (1-3 mL in infants) in 3 separate samplings within 1-24 hours is recommended, according to the clinical presentation.
  - Venous blood samples should be obtained from different peripheral sites.
  - The microbiology laboratory should be notified of the clinical suspicion for endocarditis. Cultures should be grown aerobically and anaerobically for at least 1 week.
  - If no growth is observed by the second day of incubation, 2 more blood cultures should be obtained.
  - Blood cultures should be repeated during therapy to demonstrate clearance of bacteremia with appropriate antibiotic treatment.

- Other laboratory studies include a CBC, measurement of the erythrocyte sedimentation rate (ESR) and C-reactive protein level, test for rheumatoid factor, and urinalysis.
  - Complete blood count: Anemia is present in 70-90% of patients and is usually normocytic and normochromic. Leukocytosis is noted in 20-30% of patients.
  - ESR and C-reactive protein level: The ESR is elevated in almost all patients except for those with CHF, renal failure, and disseminated intravascular coagulation (DIC). The mean ESR is 55 mm/h. The C-reactive protein, although nonspecific, is elevated in most patients but decreases with successful treatment. Levels of C-reactive protein may be used to monitor response to antibiotic therapy.
  - Rheumatoid factor: A positive rheumatoid factor is observed in 40-50% of patients with endocarditis of more than 6 weeks’ duration. Immune complexes are also observed in patients with prolonged disease.
  - Urinalysis may show proteinuria (50-60%) and/or microscopic hematuria (30-50%).
Imaging Studies:

- Echocardiography is the primary modality for detecting endocarditis in patients in whom the diagnosis is suspected. In fact, echocardiographic features suggestive of infectious endocarditis are considered major criteria for confirming the diagnosis (see the modified Duke criteria above). Typical findings include vegetations, abscesses, and new valvular insufficiency.
  - Transthoracic echocardiography (TTE) has a greater sensitivity in infants and children than in adults. Reported sensitivity is as high as 81%. It is the most common form of imaging used in children, and is usually sufficient in most clinical circumstances.
  - Transesophageal echocardiography (TEE) is occasionally required when transthoracic acoustic windows are inadequate. This is most likely to occur in patients who are obese or very muscular, post cardiac surgery, or have pulmonary hyperinflation. TEE is especially useful in detecting aortic root abscess, involvement of the sinuses of Valsalva, and prosthetic valve dehiscence.

- MRI has identified paravalvular extension of infection, aortic root aneurysms, and fistulas. Its utility relative to echocardiography has not been widely established.

Medical Care: Bacterial endocarditis is a disease in which complete eradication of the organism is required. Bacteria involved in endocarditis are relatively protected from phagocytic activity by the vegetation, which contains high concentrations of bacteria with relatively low metabolic rates. Prolonged parenteral therapy is the only way to achieve bactericidal serum levels for the time needed to kill all the bacteria present in a vegetation of endocarditis. Treatment ranges from 4-8 weeks.

Therapy is tailored according to the etiologic agent. Recommended antibiotic regimens for uncomplicated bacterial endocarditis are listed below. Because of the high risk for morbidity and mortality associated with this disease, individual therapy should be discussed between all consultants with the available antibiotic sensitivity testing.

- Penicillin-susceptible streptococcal endocarditis (PSSE) on native cardiac valves is treated with penicillin G for 4 weeks or penicillin or ceftriaxone combined with gentamicin for 2 weeks. Penicillin-resistant streptococcal endocarditis (PRSE) on native cardiac valves is treated with penicillin, ampicillin, or ceftriaxone for 4 weeks combined with gentamicin for the first 2 weeks.

- PSSE on prosthetic valve or other prosthetic material should be treated with penicillin, ampicillin, or ceftriaxone for 6 weeks combined with gentamicin for the first 2 weeks. PRSE on prosthetic valve or other prosthetic material is treated with penicillin, ampicillin, or ceftriaxone for 6 weeks combined with gentamicin.

- Susceptible enterococcal infection on native valves is treated with penicillin or ampicillin combined with gentamicin for 4-6 weeks. Infection on prosthetic material should be for at least 6 weeks.

- Methicillin-susceptible *S. aureus* (MSSA) infection on native valves is treated with nafcillin or oxacillin for at least 6 weeks. The addition of gentamicin for 3-5 days is optional. Methicillin-resistant *S. aureus* (MRSA) infection on native valves is treated with vancomycin for at least 6 weeks, with or without 3-5 days of gentamicin.

- MSSA infection on prosthetic tissue is treated with nafcillin or oxacillin plus rifampin for at least 6 weeks, in combination with gentamicin for 2 weeks. MRSA infection on prosthetic tissue is treated with vancomycin plus rifampin for at least 6 weeks, in combination with gentamicin for 2 weeks.

- Gram negative endocarditis caused by HACEK organisms is treated with ceftriaxone or ampicillin plus gentamicin for 4 weeks.

Surgical Care: Absolute indications for surgery include progressive cardiac failure, valve obstruction, definitive perivalvular abscess, noncandidal fungal infection, and pseudomonal infection. Relative indications include persistent bacteremia despite appropriate antibiotic therapy, candidal endocarditis, and very large vegetations >10 mm.

Surgery should be performed without delay in patients with severe CHF secondary to valvular regurgitation.
Surgery for patients who have had a recent neurologic injury should be evaluated and possibly delayed to make modifications to avoid intracranial hemorrhage.

**Consultations:** Initial consultants for the patient suspected to have bacterial endocarditis should include an infectious disease specialist, a cardiologist, and a cardiac surgeon.

**Diet:** No specific dietary restrictions are recommended in the literature for the patient with bacterial endocarditis.

**Activity:** Patients may be as active as they can tolerate. Patients may be ill and should remain hospitalized until they are hemodynamically stable, afebrile, with negative blood cultures, and not at high risk for complications.

**Drug Category:** *Antimicrobial agents* -- Treatment with antibiotics is specific to the etiologic agent and its characteristics. Therapy for PSSE, PRSE, enterococcal endocarditis, MSSA, MRSA, endocarditis caused by HACEK organisms, and fungal endocarditis are aimed at total eradication of the organism. After antibiotic treatment, antibiotic prophylaxis is required before procedures that may cause bacteremia are performed. For more information, see Antibiotic Prophylactic Regimens for Endocarditis.

### Drug Name: Penicillin G (Pfizerpen)

**Adult Dose:** 10-20 million U/d IV divided q4-6h for 4 wk

**Pediatric Dose:** 200,000-400,000 U/kg/d IV divided q4-6h for 4 wk

**Contraindications:** Documented hypersensitivity

**Interactions:** Probenecid may increase effectiveness by decreasing clearance; tetracyclines are bacteriostatic, decreasing effectiveness of concurrent penicillins

**Pregnancy:** B - Usually safe but benefits must outweigh the risks.

**Precautions:** Caution in impaired renal function (adjust dose)

### Drug Name: Ceftriaxone (Rocephin)

**Adult Dose:** PSSE or HACEK: 2 g/d IV/IM for 4 wk

**Pediatric Dose:** PSSE or HACEK: <45 kg: 50 mg/kg/d IV/IM divided q12h for 4 wk; not to exceed 2 g/d; >45 kg: Administer as in adults

**Contraindications:** Documented hypersensitivity

**Interactions:** Probenecid may increase levels; coadministration with ethacrynic acid, furosemide, and aminoglycosides may increase nephrotoxicity

**Pregnancy:** B - Usually safe but benefits must outweigh the risks.

**Precautions:** Decrease dose in combined hepatic and renal impairment; caution in breastfeeding women and penicillin allergy

### Drug Name: Gentamicin (Garamycin)

**Adult Dose:** Aminoglycoside antibiotic for gram-negative coverage. Not drug of choice (DOC). Consider if penicillins or other, less toxic drugs contraindicated; if clinically indicated; or if mixed infections are caused by susceptible staphylococci and gram-negative organisms. Dosing regimens are numerous; adjust dose on basis of CrCl and changes in volume of distribution. Follow up each regimen by
measuring trough level drawn 30 min before the third or fourth dose. Peak levels may be drawn 30 min after 30-min infusion.

**Adult Dose**
- PSSE: 1 mg/kg IV q8h for 2 wk; use in combination with ceftriaxone
- Enterococcal: 1 mg/kg IV q8h for 4 wk; use in combination with ampicillin
- MSSA: 1 mg/kg IV q8h for 3-5 d; use in combination with nafcillin

**Pediatric Dose**
Administer as in adults

**Contraindications**
Documented hypersensitivity; non–dialysis-dependent renal insufficiency

**Interactions**
Coadministration with other aminoglycosides, cephalosporins, penicillins, and amphotericin B may increase nephrotoxicity risk; may enhance effects of neuromuscular blocking agents, thus prolonged respiratory depression may occur; coadministration with loop diuretics may increase auditory toxicity of aminoglycosides; possible irreversible hearing loss of varying degrees may occur (monitor regularly)

**Pregnancy**
C - Safety for use during pregnancy has not been established.

**Precautions**
Narrow therapeutic index (not intended for long-term therapy); caution in renal failure (patient not receiving dialysis), myasthenia gravis, hypocalcemia, and conditions that depress neuromuscular transmission; adjust dose in renal impairment

**Drug Name**
Vancomycin (Vancocin) -- DOC in patients who cannot receive or whose condition fails to respond to penicillins and cephalosporins or who have infections with resistant staphylococci. Potent antibiotic directed against gram-positive organisms and active against Enterococcus species. To avoid toxicity, current recommendation is to assay trough levels 0.5 h before fourth dose. Adjust dose according to CrCl in renal impairment.

**Adult Dose**
- PRSE or MRSA: 15 mg/kg IV q12h for 4 wk; not to exceed 2 g/d (unless serum levels measured)

**Pediatric Dose**
Administer as in adults

**Contraindications**
Documented hypersensitivity

**Interactions**
Erythema, histaminelike flushing, and anaphylactic reactions may occur when administered with anesthetic agents; taken concurrently with aminoglycosides, risk of nephrotoxicity may increase above that with aminoglycoside monotherapy; effects in neuromuscular blockade may be enhanced when coadministered with nondepolarizing muscle relaxants

**Pregnancy**
C - Safety for use during pregnancy has not been established.

**Precautions**
Caution in renal failure and neutropenia; red man syndrome is caused by too rapid IV infusion (dose given over few min) but rare when dose given over 2 h; red man syndrome is not an allergic reaction

**Drug Name**
Ampicillin (Omnipen, Principen) -- Bactericidal activity against susceptible organisms. Alternative to amoxicillin when patient cannot take PO medication.

**Adult Dose**
- Enterococcal or HACEK: 2 g IV q4h for 4 wk

**Pediatric Dose**
Enterococcal or HACEK: 100-200 mg/kg/d IV divided q4h for 4 wk; not to exceed 12 g/d

**Contraindications**
Documented hypersensitivity
### Interactions

- Probenecid and disulfiram elevate levels; allopurinol decreases effects and has additive effects on ampicillin rash; may decrease effects of PO contraceptives

### Pregnancy

- B - Usually safe but benefits must outweigh the risks.

### Precautions

- Adjust dose in renal failure; evaluate rash and differentiate from hypersensitivity reaction

### Drug Name

**Nafcillin (Unipen, Nafcil)** -- Initial therapy for suspected penicillin G–resistant (methicillin-susceptible) staphylococcal infections. Because of thrombophlebitis, particularly in elderly patients, administer parenterally only for short term (1-2 d); change to PO as clinically indicated.

#### Adult Dose

MSSA: 2 g IV q4h for 4-6 wk

#### Pediatric Dose

MSSA: 100-200 mg/kg/d IV divided q4h for 4-6 wk; not to exceed 12 g/d

### Contraindications

- Documented hypersensitivity

### Interactions

- Associated with warfarin resistance when administered concurrently; effects may decrease with bacteriostatic action of tetracycline derivatives

### Pregnancy

- B - Usually safe but benefits must outweigh the risks.

### Precautions

- To optimize therapy, determine causative organisms and susceptibility; >10 d treatment to eliminate infection and prevent sequelae (eg, endocarditis); obtain cultures after treatment to confirm that infection is eradicated

### Drug Name

**Oxacillin (Bactocill, Prostaphlin)** -- Bactericidal antibiotic that inhibits cell-wall synthesis; used to treat infections caused by penicillinase-producing staphylococci. May be used to start therapy when staphylococcal infection suspected.

#### Adult Dose

MSSA: 2 g IV q4h for 4-6 wk

#### Pediatric Dose

MSSA: 150-200 mg/kg/d IV divided q4h for 4-6 wk; not to exceed 12 g/d

### Contraindications

- Documented hypersensitivity

### Interactions

- Decreases effects of contraceptives and tetracycline; administered concomitantly with disulfiram and probenecid may increase levels; effect of anticoagulants increase when large IV doses given

### Pregnancy

- B - Usually safe but benefits must outweigh the risks.

### Precautions

- Caution in impaired renal function (adjust dose)

### Drug Name

**Amphotericin B (Amphocil, Fungizone)** -- Produced by strain of *Streptomyces nodosus*; can be fungistatic or fungicidal. Binds to sterols (eg, ergosterol) in fungal cell membrane, causing intracellular components to leak with subsequent cell death.

#### Adult Dose

1 mg/kg/d IV for 4-6 wk

#### Pediatric Dose

Administer as in adults

### Contraindications

- Documented hypersensitivity

### Interactions

- Other nephrotoxins (eg, antineoplastic agents, aminoglycosides, radiocontrast) may enhance potential for renal toxicity, bronchospasm, and hypotension; corticosteroids, digitalis, and thiazides may potentiate hypokalemia; risk of renal toxicity increased with cyclosporine

### Pregnancy

- B - Usually safe but benefits must outweigh the risks.

### Precautions

- Monitor renal function, levels of serum electrolytes (eg, magnesium, potassium), liver function, CBC, and hemoglobin concentrations; resume therapy at lowest
Further Inpatient Care:

- Further inpatient care is mostly supportive.
- Hemodynamic and ventilatory support may be required for critically ill children.
- Physical and occupational therapy is given to patients who are hospitalized for a long period.
- Important aspects of care include treatment of complications, such as CHF, neurologic injury, and splenic abscess.

Further Outpatient Care:

- With the advent of home health facilities, more patients can complete parenteral antimicrobial therapy as outpatients after the initial acute infection is controlled.
- After initial stabilization in hospital, patients in whom outpatient therapy is being considered must be hemodynamically stable and afebrile, they must have negative blood cultures, and they must be at low risk for complications.
- Follow-up for monitoring of adherence to drug therapy and possible complications is essential.

Transfer:

- Depending on their initial clinical presentation, patients may be monitored initially in the intensive care unit and transferred to an inpatient ward when the clinical condition has stabilized and when a response to treatment is evident.
- Patients at high risk for developing complications from endocarditis may require transfer to a tertiary care center where pediatric cardiothoracic surgery is available.

Deterrence/Prevention:

- Prevention of bacterial endocarditis with antimicrobial prophylaxis in high risk children is key to their long-term survival and quality of life.
  - American Heart Association (AHA) guidelines for the prevention of bacterial endocarditis should be emphasized to the family of each patient identified at high risk.
  - All children at risk should also be instructed about the importance of maintaining the best possible oral health.
  - Antibiotics for endocarditis prophylaxis are required for patients before performing procedures that may cause bacteremia.
  - For more information, see Antibiotic Prophylactic Regimens for Endocarditis.
- Antibiotic prophylaxis for patients undergoing oral or upper respiratory procedures include the following:
  - Amoxicillin 50 mg/kg by mouth (PO) 1 hour before procedure, or ampicillin 50 mg/kg given IV or intramuscularly (IM) 30 minutes before the procedure
  - Patients with a penicillin allergy, clindamycin 20 mg/kg PO 1 hour before the procedure or azithromycin 15 mg/kg PO 1 hour before the procedure
Antibiotic prophylaxis for patients undergoing genitourinary or GI procedures include the following:

- Amoxicillin 50 mg/kg PO 1 hour before the procedure or ampicillin 50 mg/kg IV or IM 30 minutes before the procedure
- Patients who are at high risk, ampicillin 50 mg/kg IV or IM plus gentamicin 1.5 mg/kg IV or IM 30 minutes before the procedure then ampicillin or amoxicillin 25 mg/kg 6 hours later
- Patients with a penicillin allergy at high risk, vancomycin 20 mg/kg IV plus gentamicin 1.5 mg/kg IV 1 hour before the procedure
- Patients with a penicillin allergy at moderate risk, vancomycin 20 mg/kg IV alone

Complications:

- Cardiac complications include heart failure, valvular disease, valve ring abscess, myocardial disease or abscess, conduction abnormalities (including arrhythmia or heart block), and pericardial disease. In rare cases, coronary artery embolic events can occur.
- Extracardiac complications can occur.
  - Embolic complications are most common in patients with large lesions. Peripheral vascular complications include splenic emboli with infarction or abscess, embolization to the pulmonary artery, and emboli to the femoral artery, resulting in extremity pain and decreased pulses.
  - Mycotic aneurysms occur in 10-20% of patients with endocarditis. They are often multiple and may involve any vessel.
  - Vasculitis may result from circulating immune complexes that may deposit in various endothelial surfaces. Local complement activation appears to generate an immune response that causes vascular injury.
  - Cutaneous manifestations include petechiae, Osler nodes, Janeway lesions, and splinter hemorrhages.
  - Neurologic syndromes include cerebral embolism, infarction, and intracerebral hemorrhage and stroke. Seizures, meningitis, and mental status changes have also been reported.
  - Renal embolism and infarction is the most common renal lesion in patients with bacterial endocarditis. This complication may result in pain in the flank or abdomen but may be asymptomatic in as many as 50% of cases. Glomerular disease is a common finding, and usually is not of serious clinical significance because renal failure rarely occurs.

Prognosis:

- The prognosis of bacterial endocarditis varies with the etiologic agent. Infection by a penicillin-sensitive Streptococcus, diagnosed early, has a cure rate of almost 100%.
- Because many infections are diagnosed late or due to resistant organisms, the average mortality rate is approximately 20-25%.

Patient Education:

- Patient and parent education is critical to ensure appropriate antimicrobial prophylaxis before high-risk procedures are performed in children with congenital heart disease.

Medical/Legal Pitfalls:

- Failure to explain the need for antibiotic prophylaxis before medical procedures in high-risk patients
- Failure to adequately administer or prescribe antibiotics to a high-risk patient
- Failure to consider infective endocarditis in the differential diagnosis with a delay of treatment
- Failure to detect the development of heart failure or other complications in a patient with infective endocarditis

**BIBLIOGRAPHY**


**NOTE:**

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