Group A *Streptococcus* Infections

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EDUCATION GAPS

Clinicians should know: 1) throat swabs for rapid antigen detection tests and/or cultures are not recommended for children younger than 3 years unless the patient has a close infected contact; 2) treatment regimens exist for eradication of the carrier state and should be trialed before tonsillectomy; and 3) Clindamycin is important in the treatment of invasive group A *Streptococcus* infection for toxin mediation but should not be used alone due to possible resistance. Clindamycin can be used alone when sensitivities are known or to eliminate the group A *Streptococcus* pharyngeal carrier state.

OBJECTIVES *After completing this article, readers should be able to:*

1. Plan the appropriate diagnostic evaluation for a patient suspected of having group A *Streptococcus* (GAS) infection or postinfectious complications.
2. Recognize the features of invasive GAS infections.
3. Plan appropriate management for patients with different manifestations of GAS infection.

ABSTRACT

Group A *Streptococcus* causes a variety of clinical manifestations, including pharyngitis and skin and soft tissue infections as well as more invasive disease. There are also multiple nonsuppurative complications of group A *Streptococcus* infection, including acute rheumatic fever and poststreptococcal glomerulonephritis. Pediatricians should be able to diagnose and treat the various presentations of the infection.

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ABBREVIATIONS

ANF	acute necrotizing fasciitis
ARF	acute rheumatic fever
GAS	group A *Streptococcus*
PSGN	poststreptococcal glomerulonephritis
STSS	streptococcal toxic shock syndrome

EPIDEMIOLOGY

Streptococcus pyogenes, also known as group A *Streptococcus* (GAS), is a gram-positive coccus that grows in chains. GAS exhibit β-hemolysis when grown on blood agar plates. Transmission of GAS infections occur by respiratory droplets from persons with pharyngeal infection or by direct contact from those with skin manifestations. In those with invasive GAS infections, the bacteria spread to deep tissues and the

bloodstream. GAS pharyngitis and invasive infections most commonly occur in the winter months. Impetigo most commonly occurs in the summer months. (1) GAS is responsible for a variety of clinical manifestations, from less severe infections such as pharyngitis, impetigo, cellulitis, and erysipelas to more severe invasive diseases such as septicemia, streptococcal toxic shock syndrome (STSS), and acute necrotizing fasciitis (ANF). GAS is also linked to multiple nonsuppurative complications, including acute rheumatic fever (ARF) and poststreptococcal glomerulonephritis (PSGN). (1)(2) The virulence and ranges of infections are due to specific characteristics that the bacterium possesses, including the M protein, which inhibits opsonization and phagocytosis and facilitates tissue invasion and the hyaluronic acid capsule, which protects GAS from phagocytosis. For invasive GAS infections, streptococcal toxins called superantigens play an important role stimulating massive cytokine release, responsible for the rapid and overwhelming progression of disease. (3)

In 2020 and 2021 during the COVID-19 pandemic, invasive GAS infection rates in children 2 through 17 years of age were the lowest on record since 1997. There were also low numbers of less severe infections in all age groups. This decrease is likely attributable to school and work closures, social distancing, and masking. The Centers for Disease Control and Prevention (CDC) is currently investigating an increase in invasive GAS infections during the fall of 2022 and winter of 2023, with rates higher than prepandemic years, and occurring during the same time as increases in respiratory viruses. (4)

CLINICAL ASPECTS

Noninvasive GAS Infections

Streptococcal Pharyngitis. The most common GAS infection is acute pharyngitis. It is most common in school-age children, peaking at age 7 to 8 years, but can occur at all ages. It is uncommon in children younger than 3 years. For school-age children and adolescents, clinical signs and symptoms include fever, sore throat, vomiting, abdominal pain, tender anterior cervical adenopathy, and pharyngeal and tonsillar exudate (Fig 1). Younger children may present with rhinitis, fever, irritability, and generalized lymphadenopathy. Purulent complications of pharyngitis include suppurative cervical adenitis and retropharyngeal and peritonsillar abscesses. Acute bacterial sinusitis and acute otitis media can rarely occur. Scarlet fever occurs most commonly with pharyngitis, instead of other GAS manifestations. The rash of scarlet fever involves sandpaper-like tiny papules with a predilection for the neck and shoulder. (2)(5)

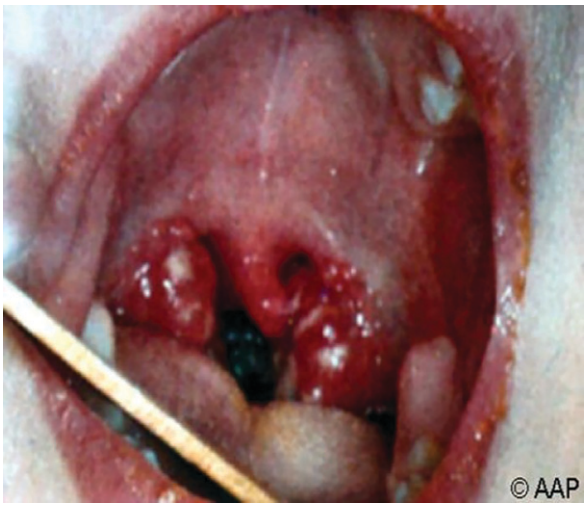

Figure 1. Erythematous tonsils with exudate in a child with group A streptococcal pharyngitis.

Children with signs and symptoms of acute GAS pharyngitis should be tested. Children with pharyngitis with other associated viral symptoms (conjunctivitis, rhinitis, coryza, rash, and cough) should not be tested or treated. Testing is also not generally recommended for children who are younger than 3 years because they are unlikely to manifest ARF. However, physicians may choose to test those younger than 3 years if risk factors exist, for example, the child has a relative with GAS. Several rapid antigen detection tests for GAS pharyngitis are available. The specificity of these tests is high, but sensitivity is generally 80% to 85%. Negative rapid antigen results require a confirmatory throat culture. Children with GAS in the pharynx without clinical symptoms are considered to be GAS carriers. Carriers are typically not infectious. Treatment is not recommended in patients with positive throat cultures without clinical symptoms of streptococcal pharyngitis. Throat cultures should not be obtained in asymptomatic patients. (2)(5)

Impetigo. Impetigo is a superficial skin infection most commonly affecting children 2 to 5 years of age but can occur at any age. Lesions typically occur at the site of breaks in the skin (eg, insect bites, traumatic wounds, varicella lesions). Nonbullous impetigo typically manifests as erythematous papules, which later evolve to vesicles that rupture to form characteristic "honey-colored" exudate and thick crust (Fig 2). Bullous lesions are most commonly caused by *Staphylococcus aureus,* whereas nonbullous impetigo may result from either GAS or *S aureus.* In the 1950s through the 1970s, the most common cause of impetigo was GAS, but now, *S aureus* is more common,

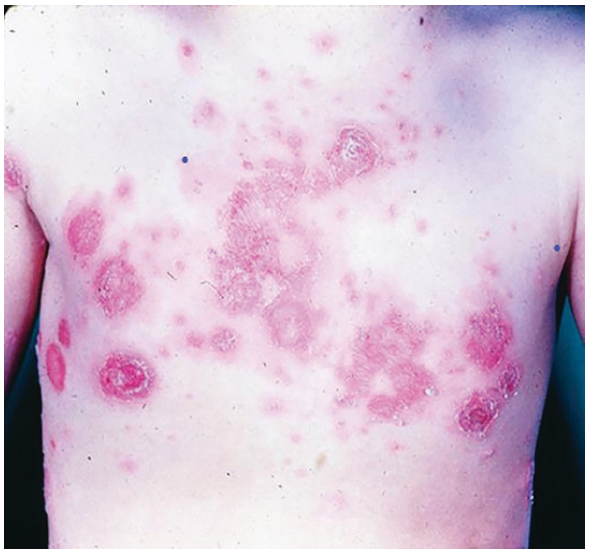

Figure 2. Group A streptococcal impetigo.

accounting for more than 80% of impetigo infections. Culture of the lesions can determine the responsible organism. (2)(5)

Erysipelas and Cellulitis. Erysipelas is an infection of the deeper dermis, whereas cellulitis is an infection of the dermis and subcutaneous tissue. Erysipelas classically presents as raised, painful skin erythematous lesions with distinct borders, most commonly on the face or extremities (Fig 3). Lymphatic involvement is frequently seen with ascending lymphangitis (erythematous streaking). In contrast, cellulitis typically presents as erythema and edema that is not sharply demarcated but can have associated pain and warmth. These infections are primarily caused by GAS; however, the presence of purulent lesions or abscesses should raise a clinician's suspicion for *S aureus*. (2)(6)

Invasive GAS Infections

In invasive infections, GAS is isolated from a normally sterile site, including blood, joint fluid, or cerebrospinal fluid.

Streptococcal Toxic Shock Syndrome. STSS is defined as GAS infection accompanied by sudden onset of shock and organ failure. Patients often begin with influenzalike symptoms such as fever, chills, myalgias, nausea, and vomiting and then rapidly progress to sepsis with signs and symptoms concerning for multiorgan failure within 24 to 48 hours (Table 1). (2)

Type II ANF. ANF is a rare infection involving rapidly progressing deep tissue infection. Type I ANF is a polymicrobial infection, whereas type II is caused by GAS alone or in combination with another bacterium. It is a rare

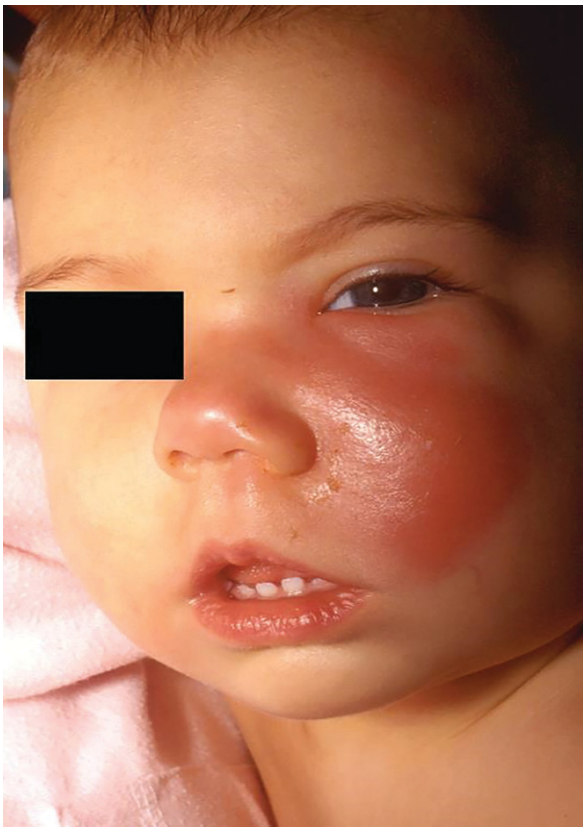

Figure 3. Facial erysipelas in a 1-year-old.

infection that usually occurs after trauma or surgery. Type II ANF can also occur as a superinfection complication of varicella infection. Type II ANF most commonly affects the extremities, particularly the legs. Clinical findings of necrotizing fasciitis include profound pain, swelling, and erythema in the affected area. Typically, the pain experienced by the patient is out of proportion to the signs of the local skin infection. Within 24 to 48 hours, skin necrosis may occur, indicating that small vessels have thrombosed in the dermal papilla. Decreased sensation due to destruction of superficial nerves, bullae with hemorrhagic fluid, and crepitus can be palpated. Prompt surgical exploration and obtaining cultures is recommended if there is clinical suspicion. If there is low suspicion for necrotizing fasciitis, imaging studies such as computed tomography or magnetic resonance imaging can aid in the diagnosis by detecting subcutaneous and fascial edema or tissue gas (which is a classic finding in ANF). (6)

NONSUPPURATIVE COMPLICATIONS

Acute Rheumatic Fever

ARF is a nonsuppurative sequela after untreated GAS pharyngitis, and in endemic areas, it is the leading cardiovascular

Table 1. Streptococcal Toxic Shock Syndrome: Clinical Case Definition[a]

I. Isolation of group A *Streptococcus (Streptococcus pyogenes)*
A. From a normally sterile site (eg, blood or cerebrospinal, peritoneal, joint, pleural, or pericardial fluid)
B. From a nonsterile site (eg, throat, sputum, vagina, open surgical wound, or superficial skin lesion)
II. Clinical signs of severity
A. Hypotension: systolic pressure ≤90 mm Hg in adults or lower than the fifth percentile for age in children <16 y
and
B. ≥2 of the following signs of multiorgan involvement:
• Renal impairment: creatinine concentration ≥2 mg/dL (≥177 μmol/L) for adults or ≥2 times the upper limit of normal for age[b]
• Coagulopathy: platelet count ≤100×10^3/μL (≤100×10^9/L) and/or disseminated intravascular coagulation defined by prolonged clotting times, low fibrinogen level, and the presence of fibrin degradation products
• Hepatic involvement: elevated alanine aminotransferase, aspartate aminotransferase, or total bilirubin concentrations ≥2 times the upper limit of normal for age[b]
• Acute respiratory distress syndrome defined by acute onset of diffuse pulmonary infiltrates and hypoxemia in the absence of cardiac failure or by evidence of diffuse capillary leak
• A generalized erythematous macular rash that may desquamate
• Soft tissue necrosis, including necrotizing fasciitis, myositis, or gangrene

[a]An illness fulfilling criteria IA, IIA, and IIB can be defined as a confirmed case. An illness fulfilling criteria IB, IIA, and IIB can be defined as a probable case if no other cause for the illness is identified. Manifestations need not be detected within the first 48 hours of illness or hospitalization.
[b]In patients with preexisting renal or hepatic disease, concentrations 2-fold or greater over patient's baseline.
Adapted with permission from The Working Group on Severe Streptococcal Infections. Defining the group A streptococcal toxic shock syndrome: rationale and consensus definition. *JAMA*. 1993;269(3):390–391.

cause of death in children. Typical onset is 2 to 4 weeks after GAS pharyngitis. Children aged 5 to 14 years have the greatest incidence of ARF. Jones criteria for diagnosis of ARF were established in 1944 and were revised and modified most recently in 2015. The revised Jones criteria distinguish between low-risk and moderate- to high-risk populations (Table 2). Laboratory evidence of antecedent GAS infection must be confirmed in suspected ARF cases because this is part of the diagnostic criteria. Laboratory evidence includes increased or an increasing antistreptolysin O or anti-DNAse B titer or a positive streptococcal rapid antigen test or throat culture. (2)(7)(8)

Poststreptococcal Reactive Arthritis

Reactive arthritis may develop after an episode of acute GAS pharyngitis without other clinical or laboratory findings to fulfill the Jones criteria for the diagnosis of ARF. This syndrome is referred to as poststreptococcal reactive arthritis. In contrast to patients with ARF, patients with poststreptococcal reactive arthritis do not respond dramatically to nonsteroidal anti-inflammatory agents. Careful observation is recommended for 1 to 2 years for the development of carditis because a small proportion of patients with poststreptococcal reactive arthritis have been reported

Table 2. Modified Jones Criteria 2015

1. All patients require evidence of antecedent GAS infection for diagnosis of ARF (except in case of chorea, where evidence of antecedent GAS infection is not required).
2. To confirm an initial diagnosis of ARF, need 2 major OR 1 major and 2 minor criteria.
3. To confirm recurrent ARF diagnosis, need 2 major OR 1 major and 2 minor OR 3 minor criteria.
4. Criteria for diagnosis depend on whether the patient is from a low-risk or a moderate-/high-risk population. Moderate- and high-risk populations include countries where ARF remains endemic (Africa, Asia-Pacific, indigenous population of Australia). The United States, Canada, and Europe are examples of low-risk areas.
5. Major and minor criteria are listed below, by risk categorization; differences for moderate-/high-risk populations are **bolded**.

Low-risk population	Moderate- and high-risk population
Major criteria	Major criteria
• Carditis (clinical or subclinical)	• Carditis (clinical or subclinical)
• Arthritis (polyarthritis only)	• Arthritis (polyarthritis **or monoarthritis, or polyarthralgia**)
• Chorea	• Chorea
• Subcutaneous nodules	• Subcutaneous nodules
• Erythema marginatum	• Erythema marginatum
Minor criteria	Minor criteria
• Polyarthralgia	• **Monoarthralgia**
• Fever (≥101.3°F [≥38.5°C])	• **Fever (≥100.4°F [≥38°C])**
• ESR ≥60 mm/hr and/or CRP ≥3 mg/dL (≥30 mg/L)	• **ESR ≥30 mm/hr** and/or CRP ≥3 mg/dL (≥30 mg/L)
• Prolonged PR interval (in the absence of carditis)	• Prolonged PR interval (in the absence of carditis)

ARF=acute rheumatic fever; CRP=C-reactive protein; ESR=erythrocyte sedimentation rate; GAS=group A streptococcal.
Modified with permission from Gewitz MH, Baltimore RS, Tani LY, et al. Revision of the Jones criteria for the diagnosis of acute rheumatic fever in the era of Doppler echocardiography: a scientific statement from the American Heart Association. *Circulation*. 2015;131(20):1806–1818.

to develop late valvular disease. Secondary prophylaxis during the observation period is recommended by some experts, and if carditis develops, the patient is considered to have ARF. (2)

Poststreptococcal Glomerulonephritis

PSGN is a nonsuppurative complication occurring during or after GAS infection. It most commonly occurs after GAS impetigo infections. Typical onset is 2 to 4 weeks after infection in the skin and 7 to 10 days after streptococcal pharyngitis. Presenting signs and symptoms include hematuria, proteinuria, hypertension, and edema. PSGN usually manifests as acute nephritic syndrome but can cause nephrotic syndrome, and rarely, rapidly progressive glomerulonephritis and renal failure. Laboratory findings may be significant for evidence of past GAS infection with elevated antistreptolysin O or anti-DNAse B antibody titers and a low complement C3 level. (2)

Pediatric Autoimmune Neuropsychiatric Disorder Associated with GAS or Pediatric Acute-Onset Neuropsychiatric Syndrome

An association between GAS infection and sudden onset of tic disorders and obsessive-compulsive behaviors has been proposed based on a small number of studies, and this proposal remains a controversial diagnosis. The diagnosis of pediatric autoimmune neuropsychiatric disorder associated with GAS must be preceded by a documented GAS infection with elevated antistreptolysin O or anti-DNAse B antibody titers. Symptoms typically occur within days to weeks after infection. GAS testing by culture or antigen testing is not recommended in the absence of acute clinical symptoms of pharyngitis for these patients. Currently there is also insufficient evidence to support treatment or prophylaxis with antibiotics, immunoglobulin, and plasmapheresis. Management entails psychiatric treatments focusing on tics, obsessive-compulsive behaviors, and other neurologic and behavioral manifestations. (2)

MANAGEMENT

Streptococcal Pharyngitis

To prevent ARF, treatment for patients with streptococcal pharyngitis must be initiated within 9 days of symptom onset. (7)(8) Treating the infection does not prevent PSGN but will help prevent nephritogenic strains from being spread to close contacts. The preferred oral antibiotic regimen is oral penicillin V or amoxicillin for a 10-day course. Intramuscular benzathine penicillin G is also an option in patients who may have difficulty taking oral medications. In penicillin-allergic patients, an oral first-generation cephalosporin is recommended for a 10-day course. Other options include clarithromycin or clindamycin for 10-day courses or azithromycin for 5 days, but there are evolving increasing resistance patterns of GAS to antibiotics other than penicillin, in particular clindamycin and macrolides. (2)(5) See Table 3 for suggested antibiotic dosing for streptococcal infections.

For children who are GAS carriers, eradication may be considered in specific situations, such as 1) a community outbreak of PSGN or ARF, 2) patients with a family history of ARF, 3) patients with multiple episodes of documented symptomatic GAS pharyngitis occurring in the family for many weeks despite appropriate antimicrobial therapy, or 4) when a patient is being considered for tonsillectomy due to frequent GAS infections. Antibiotic options for eradication include a 10-day course of clindamycin, penicillin with rifampin, and amoxicillin/clavulanic acid. (2) Based on the Infectious Diseases Society of America guidelines, there is no credible evidence suggesting that family pets serve as reservoirs for GAS, and, therefore, culturing of pets is not recommended. (5)

Skin Manifestations

Impetigo is a self-limited disease, but treatment can shorten the time to resolution and decrease direct spread of the infection to others. For localized lesions, topical treatment such as mupirocin or retapamulin ointment is recommended.

For more extensive impetigo lesions, and for cellulitis and erysipelas, oral antibiotics may be considered. A first-generation cephalosporin, cephalexin, is effective at treating GAS and methicillin-susceptible *S aureus*. If the prevalence of methicillin-resistant *S aureus* is high in the community, clindamycin or trimethoprim/sulfamethoxazole can be prescribed. (2)(6)

Invasive Infections

Treatment of STSS involves initiation of broad-spectrum antibiotics as soon as possible. Once STSS is confirmed, penicillin or ampicillin combined with clindamycin (to inhibit toxin production) should be administered. Clindamycin should not be used alone in life-threatening infections because of potential resistance. In 2017, 22% of invasive GAS case isolates from the CDC Active Bacterial Core surveillance system in the United States were resistant to clindamycin. Surgical debridement of deep tissue infections may be necessary.

Treatment of necrotizing fasciitis involves early and aggressive surgical debridement of necrotic tissue along with

Table 3. Suggested Antibiotic Dosing for Select Group A *Streptococcus* Infections

INFECTION/CONDITION	ANTIBIOTIC (ROUTE)	DOSING	DURATION
Pharyngitis	Penicillin V (oral)	≤27 kg: 250 mg 2–3 times daily >27 kg: 500 mg 2–3 times daily	10 d
	Amoxicillin (oral)	50 mg/kg per day once daily (max: 1,000 mg/dose)	10 d
	Benzathine penicillin G (IM)	≤27 kg: 600,000 units IM as a single dose >27 kg:1.2 million units IM as a single dose	1 dose
	Cephalexin (oral) (preferred for nonanaphylactic allergy to penicillin)	40 mg/kg per day divided 2 times daily (max: 500 mg/dose)	10 d
	Clindamycin (oral) (preferred for anaphylactic or type I hypersensitivity to penicillin)	20 mg/kg per day divided 3 times daily (max: 300 mg/dose)	10 d
	Azithromycin	12 mg/kg per day once daily (max: 500 mg/dose)	5 d
	Clarithromycin	15 mg/kg per day divided 2 times daily (max: 250 mg/dose)	10 d
Decolonization	Clindamycin (oral)	20–30 mg/kg per day divided 3 times daily (max: 300 mg/dose)	10 d
	Penicillin and rifampin (oral)	Penicillin V 50 mg/kg per day divided 4 times daily for 10 d (max: 500 mg/dose) and rifampin 20 mg/kg per day once daily for the last 4 d of treatment (max: 600 mg/dose)	10 d of penicillin and 4 d of rifampin
	Amoxicillin-clavulanic acid (oral)	Amoxicillin 40 mg/kg per day divided 3 times daily (max: 2,000 mg/d)	10 d
	Benzathine penicillin G (IM) and rifampin (oral)	≤27 kg: 600,000 units IM as a single dose >27 kg:1.2 million units IM as a single dose and rifampin 20 mg/kg per day divided 2 times daily (max: 600 mg/d)	1 dose of benzathine penicillin G and 4 d of rifampin
Acute rheumatic fever prophylaxis	Benzathine penicillin G (IM)	≤27 kg: 600,000 units >27 kg:1.2 million units	1 dose every 4 wk
	Penicillin V (oral)	250 mg 2 times daily	
	Sulfadiazine or sulfisoxazole	≤27 kg: 0.5 g once daily >27 kg: 1 g once daily	
Skin infections	Mupirocin (topical)	3 times daily	5 d
	Retapamulin (topical)	2 times daily	5 d
	Cephalexin (oral)	50 mg/kg per day divided 4 times daily (max: 500 mg/dose)	5 d
	Clindamycin (oral)	30–40 mg/kg per day divided 3 times daily (max: 450 mg/dose)	5 d
Empirical therapy for streptococcal toxic shock syndrome and streptococcal acute necrotizing fasciitis	Clindamycin (IV)	40 mg/kg per day divided 3–4 times daily (max: 2,700 mg/d)	
	AND Meropenem (IV) OR	30–60 mg/kg per day divided 3 times daily (max: 1,000 mg/dose)	
	Piperacillin-tazobactam (IV)	≥9 mo of age: 300 mg/kg per day piperacillin component divided 3–4 times daily (max: 16 g/d)	
	AND Vancomycin (if *Staphylococcus aureus* cannot be ruled out)	45–60 mg/kg per day divided 3–4 times daily (max: 4 g/d)	

IM=intramuscular, IV=intravenous, max=maximum.

broad-spectrum parenteral antibiotic therapy. Intravenous immunoglobulin can be considered in severe cases of STSS and necrotizing fasciitis, although efficacy has not been proved. (2)(6)(9)

Nonsuppurative Complications

Treatment for ARF includes the eradication of GAS with a standard pharyngitis regimen and the treatment of acute manifestations such as arthritis or valvulitis-associated heart failure. Patients are also initiated on secondary prophylaxis to prevent subsequent GAS infections. Prophylaxis regimens include intramuscular benzathine penicillin G once monthly or daily oral penicillin. A macrolide is typically used for penicillin-allergic patients. See Table 4 for duration of prophylaxis. (8)

Typical treatment of PSGN is supportive but may also include antihypertensive medications, sodium and fluid restrictions, corticosteroid administration, and in severe cases,

Table 4. Duration of Prophylaxis for People Who Have Had Acute Rheumatic Fever (ARF): Recommendations of the American Heart Association

CATEGORY	DURATION
Rheumatic fever without carditis	5 y since last episode of ARF or until age 21 y, whichever is longer
Rheumatic fever with carditis but without residual heart disease (no valvular disease[a])	10 y since last episode of ARF or until age 21 y, whichever is longer
Rheumatic fever with carditis and residual heart disease (persistent valvular disease[a])	10 y since last episode of ARF or until age 40 y, whichever is longer; consider lifelong prophylaxis for people with severe valvular disease or likelihood of ongoing exposure to group A streptococcal infection

[a]Clinical or echocardiographic evidence.

Modified with permission from Gerber M, Baltimore R, Eaton C, et al. Prevention of rheumatic fever and diagnosis and treatment of acute streptococcal pharyngitis: a scientific statement from the American Heart Association, Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. *Circulation*. 2009;119(11):1541–1551.

dialysis. If GAS infection is still present at the time of diagnosis of PSGN, appropriate antibiotics should be prescribed.

PROGNOSIS

Despite aggressive treatment, the mortality rates of STSS and necrotizing fasciitis are quite high, ranging from 30% to 70% for STSS and 11% to 22% for necrotizing fasciitis. Mortality rates are lower in children compared with adults. (9) Complications of shock and organ failure can occur, including tissue necrosis and loss of extremities. The CDC does not recommend routine screening or initiating chemoprophylaxis for household contacts of patients with invasive GAS infection.

Summary

- Group A *Streptococcus* (GAS) is responsible for a variety of clinical manifestations, from less severe infections such as pharyngitis, impetigo, cellulitis, and erysipelas to more severe invasive diseases such as septicemia, streptococcal toxic shock syndrome (STSS), and acute necrotizing fasciitis. GAS is also linked to multiple nonsuppurative complications, including acute rheumatic fever and poststreptococcal glomerulonephritis. (Based on high-quality evidence) (1)(2)
- Children with signs and symptoms of acute GAS pharyngitis should be tested. Testing is not generally recommended for children who are younger than 3 years because they are unlikely to manifest acute rheumatic fever. However, physicians may choose to test those younger than 3 years if risk factors exist, for example, the child has a relative with GAS. (Strong recommendation, high-quality evidence) (2)(5)
- Patients with acute GAS pharyngitis should be treated with an appropriate antibiotic at an appropriate dose for a duration likely to eradicate the organism from the pharynx (usually 10 days). (Strong recommendation, high-quality evidence) (2)(5)
- Treatment is not recommended in patients with positive throat cultures without clinical symptoms of streptococcal pharyngitis. (Strong recommendation, high-quality evidence) (2)(5)
- To prevent acute rheumatic fever, treatment for patients with streptococcal pharyngitis must be initiated within 9 days of symptom onset. Treating the infections does not prevent poststreptococcal glomerulonephritis but will help prevent nephritogenic strains from being spread to close contacts (Strong recommendation, high-quality evidence) (7)(8)
- Treatment of STSS involves initiation of broad-spectrum antibiotics as soon as possible. Once STSS is confirmed, penicillin or ampicillin combined with clindamycin (to inhibit toxin production) should be administered. Clindamycin should not be used alone in life-threatening infections because of potential resistance (Strong recommendation, high-quality evidence) (2)(3)(4)

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PIR QUIZ

1. A 9-year-old girl is brought to the clinic in March by her parents with a 1-day history of sore throat and fever (maximum temperature, 101.9°F [38.8°C]). She does not have cough, nasal congestion, conjunctival redness, or eye discharge. There have been multiple school classmates with a sore throat the past 1 to 2 weeks. Five weeks ago, she was diagnosed as having group A *Streptococcus* (GAS) pharyngitis at an urgent care center and was treated with amoxicillin for 10 days. She has no allergies. On physical examination, she is mildly ill-appearing. Her oral temperature is 101.5°F (38.6°C). There is increased pharyngeal erythema with an exudate. She has bilateral anterior cervical lymphadenopathy. Which one of the following is the most appropriate next step in management?

   A. Intramuscular benzathine penicillin.
   B. Oral amoxicillin.
   C. Oral cefdinir.
   D. Pharyngeal swab for GAS rapid antigen assay, and if negative, check culture.
   E. Pharyngeal swab for GAS rapid antigen assay, and if negative, no further testing is recommended.

2. A previously healthy 28-month-old boy is brought to the clinic by his parents in June with fever and mildly decreased appetite for 2 days. He has had nasal congestion and cough and developed nonbloody diarrhea today. Mom states that multiple other children at his daycare center have been ill. No household contacts have been recently ill. At 5 months of age, he had a generalized erythematous rash when taking amoxicillin for an ear infection. His temperature is 100.6°F (38.1°C), and his other vital signs are normal. He is alert and in no distress. Physical examination is remarkable for increased pharyngeal erythema and no ulcerative lesions. The remainder of his physical examination findings are normal. Which one of the following is the most appropriate next step in management?

   A. No further testing or antimicrobial treatment is indicated.
   B. Oral amoxicillin.
   C. Oral cephalexin.
   D. Pharyngeal swab for GAS testing.
   E. Stool for multiplex polymerase chain reaction panel.

3. An 8-year-old boy is brought by his parents to the emergency department with a painful red area of his left calf that started last night and has increased in size. He was thought to have a previous mosquito bite at that site that he scratched to the point of bleeding. He has had tactile fever at home. On physical examination his temperature is 101.1°F (38.4°C) and his other vital signs, including blood pressure, are normal. He answers questions appropriately, and he rates the pain as 6 of 10 when the area is touched. There is a raised 5 × 7-cm area of erythema with sharply demarcated margins of his left calf. There is a linear erythematous streak extending to his knee. There is no discharge or fluctuance, and there are no bullae. Which one of the following is the most likely diagnosis?

   A. Abscess.
   B. Cellulitis.
   C. Erysipelas.
   D. Necrotizing fasciitis.
   E. Pyomyositis.

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4. A 10-year-old girl is brought to the clinic by her parents with a 1-day history of right knee pain. Eight days ago, she complained of a sore throat, and her maximum recorded oral temperature was 100.6°F (38.1°C). A throat swab performed in the office at that time had a positive GAS antigen assay. She has been taking oral penicillin for the past 7 days. She has been afebrile since starting the penicillin. She had mild relief of the joint pain with ibuprofen. She has never traveled outside the United States. On physical examination she is afebrile, and her vital signs are normal. Her pharyngeal examination findings are normal. There is pain with motion of her right knee and mild swelling. There is no redness or warmth of the knee. Cardiac examination has normal heart sounds and no murmur. There is no rash or subcutaneous nodules, and her neurologic examination findings are normal. Her erythrocyte sedimentation rate is 28 mm/hr and c-reactive protein level is 1.6 mg/dL (16 mg/L). Electrocardiography and echocardiography findings are normal. Which one of the following is the most likely diagnosis?

   A. Acute rheumatic fever.
   B. GAS pyogenic arthritis.
   C. Pauciarticular juvenile idiopathic arthritis.
   D. Reactive arthritis.
   E. Systemic-onset juvenile idiopathic arthritis.

5. A 9-year-old girl is seen in the office for a 1-day history of sore throat and temperatures up to 101.1°F (38.4°C). The GAS antigen assay from a throat swab is positive. During the past 14 months she has been diagnosed with 5 episodes of GAS pharyngitis and has been treated with oral amoxicillin each time with clinical improvement. When she was seen 2 weeks ago for a preparticipation sports physical examination, mom asked that she have a throat swab done to see whether she is a carrier and her GAS antigen was positive. Mom had a history of recurrent pharyngitis as a child resulting in a tonsillectomy and asks if her daughter should be referred to an otolaryngologist. Which one of the following is the most appropriate next step in management?

   A. Intravenous ampicillin.
   B. Intravenous azithromycin.
   C. Oral penicillin and oral rifampin.
   D. Referral to otolaryngology for tonsillectomy and adenoidectomy.
   E. Throat swab for culture of all household members and the pet dog.