# Group A Streptococcal Infections

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Author Disclosure
Drs Langlois and Andreae have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

## Objectives

After completing this article, readers should be able to:

1. Discuss the symptoms and signs that help differentiate group A streptococcal pharyngitis from viral pharyngitis.
2. Review the recommended diagnostic evaluation and antibiotic treatment regimens for group A streptococcal pharyngitis.
3. Recognize the clinical manifestations of group A streptococcal skin infections.
4. Describe the nonsuppurative and suppurative complications of group A streptococcal infections.
5. Know the Jones criteria for the diagnosis of acute rheumatic fever and the diagnostic criteria for streptococcal toxic shock syndrome.

## Introduction

Group A *Streptococcus* (GAS) is a gram-positive bacterium that grows in pairs or chains and causes complete, or $\beta$-hemolysis when cultured on sheep blood agar. GAS cause a broad spectrum of disease, from primary upper respiratory tract and skin infections to secondary complications such as acute rheumatic fever (ARF) and glomerulonephritis, as well as severe invasive illness, including toxic shock syndrome (TSS) and necrotizing fasciitis, which may involve almost every organ system. Despite the beneficial effects of antibiotics, clinicians continue to encounter GAS disease frequently in practice.

## Pharyngitis

GAS pharyngitis, the most common GAS infection, occurs most often in school-age children and accounts for 15% to 30% of all cases of pharyngitis in this age group, with the peak incidence seen during winter and early spring. Transmission results from contact with infected respiratory tract secretions and is facilitated by close contact in schools and child care centers. The rate of GAS transmission from an infectious case to close contacts is approximately 35%. The incubation period for GAS pharyngitis is 2 to 4 days. Although one specific symptom or sign cannot distinguish GAS infection from other causes of pharyngitis, comparison of composite features may help differentiate GAS pharyngitis from viral pharyngitis (Table 1). Typical findings in GAS pharyngitis include sore throat, fever, headache, abdominal pain, nausea, vomiting, pharyngeal erythema, palatal petechiae, inflammation of the uvula, and anterior cervical lymphadenopathy. Scarlet fever, characterized by a diffuse, erythematous, blanching, fine papular rash that resembles sandpaper on palpation, is another manifestation of GAS infection. Scarlet fever is caused by erythrogenic toxin-producing strains of GAS and may manifest desquamation after the rash starts to fade. Exudative pharyngitis may occur, but this finding also is common with viral pharyngitis. In children younger than 3 years, an atypical symptom complex known as streptococcosis may occur, consisting of persistent nasal congestion, rhinorrhea, low-grade fever, and anterior cervical lymphadenopathy. In infants, the only symptoms may be low-grade fever, fussiness, and decreased feeding.

### Abbreviations

| | |
|---|---|
| ARF: | acute rheumatic fever |
| GAS: | group A *Streptococcus* |
| IGIV: | immune globulin intravenous |
| IV: | intravenous |
| NSAID: | nonsteroidal anti-inflammatory drug |
| OCD: | obsessive compulsive disorder |
| PANDAS: | pediatric autoimmune neuropsychiatric disorder associated with group A streptococci |
| PSGN: | poststreptococcal glomerulonephritis |
| PSRA: | poststreptococcal reactive arthritis |
| RADT: | rapid antigen detection test |
| SSRI: | selective serotonin reuptake inhibitor |
| TSS: | toxic shock syndrome |

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Table 1. **Differential Features of Group A *Streptococcus* (GAS) and Viral Pharyngitis**

| Findings Suggestive of GAS Infection | Findings Suggestive of Viral Infection |
|---|---|
| Symptoms | |
| Sore throat | Cough |
| Dysphagia | Runny nose |
| Fever | Hoarse voice |
| Headache | Diarrhea |
| Abdominal pain | |
| Nausea | |
| Vomiting | |
| Signs | |
| Soft palate petechiae | Stomatitis |
| Anterior cervical lymphadenopathy | Conjunctivitis |
| Scarlet fever rash | |

Diagnosis of acute GAS pharyngitis requires microbiologic testing. The decision to test should take into consideration patient age, clinical symptoms and signs, time of year, and exposure to sick contacts who have confirmed GAS infection. Testing for GAS pharyngitis, therefore, is recommended for the following patients who have symptoms suggestive of GAS: those who do not have symptoms or signs of viral infection, those exposed to diagnosed GAS infection, and those who are ill when there is a high prevalence of GAS infection in the community. Of note, testing of asymptomatic contacts in homes, child care centers, or schools is not indicated unless the contact is at increased risk of developing complications from GAS infection.

Microbiologic testing includes the rapid antigen detection test (RADT) and throat culture. Throat culture is the gold standard, with 90% to 95% sensitivity. RADT is suggested for initial use in patients who are likely to have GAS pharyngitis and in those whose throat culture results will not be available for more than 48 hours. RADT has a specificity of 95% and greater and a sensitivity of 65% to 90%. If RADT is negative, a back-up throat culture should be performed. Anecdotal evidence indicates that the RADT may remain positive for "a week or so" after a 10-day treatment course, despite a bacteriologic cure.

Serologic testing may be used to confirm GAS pharyngitis. However, because this antibody response occurs 2 to 3 weeks after the onset of infection, it is not useful for the diagnosis of acute GAS pharyngitis. Serologic testing consists of measurements of antistreptococcal antibody titers, such as antistreptolysin O and antideoxyribonuclease B, and may be useful in identifying the cause of conditions that may occur as complications of GAS infection.

Treatment of GAS pharyngitis has several goals: reducing the incidence of suppurative and nonsuppurative complications, reducing the duration and relieving symptoms and signs of infection, and reducing transmission to others. Oral penicillin V K (250 mg to 500 mg twice to three times a day for 10 d) is the antibiotic treatment of choice for GAS pharyngitis because of its efficacy, safety, and narrow spectrum. No GAS isolate to date has shown penicillin resistance. For patients who cannot swallow pills, amoxicillin (50 mg/kg, maximum 1 g, once daily for 10 d) often is used instead of oral penicillin because of its more palatable liquid formulation. Cephalosporins or macrolides may be used as first-line therapy in patients allergic to β-lactam antibiotics but otherwise are not recommended as first-line therapy. A 5-day course of the cephalosporins cefpodoxime or cefdinir or the macrolide azithromycin at a higher dose (12 mg/kg per day) is comparable in terms of clinical and bacteriologic cures to a typical 10-day course of penicillin (Table 2).

For patients who experience recurrent acute pharyngitis and positive repeat diagnostic test results shortly after treatment, the same oral drug can be administered or an intramuscular injection of penicillin G benzathine can be provided if poor adherence is suspected. Alternative choices include a narrow-spectrum cephalosporin, amoxicillin-clavulanate, clindamycin, erythromycin, clarithromycin, or an azalide such as azithromycin. There is no expert consensus on this issue.

Patients who have multiple recurrent episodes may represent a carrier state. Pharyngitis in carriers is likely due to intercurrent viral infection, but if a GAS carrier develops an acute illness consistent with GAS pharyngitis, treatment is indicated. It is estimated that up to 20% of asymptomatic school-age children may be GAS carriers.

Chronic carriers are unlikely to transmit infection to contacts and are at low risk for developing complications of GAS. Diagnosis of GAS carriage should take into consideration whether signs and symptoms of recurrent illness are more suggestive of a viral cause, the prevalence of GAS currently in the community, the patient's response to antibiotic therapy, and throat culture results when the patient is asymptomatic. Treatment to eradicate GAS carriage may be considered for patients who have a history of acute rheumatic fever or a close contact who has a history of rheumatic fever, for families experiencing repeated episodes of GAS pharyngitis, and for patients who are carriers when there is an outbreak of serious GAS infections in their community.

Eradication regimens include clindamycin, cephalosporins, amoxicillin-clavulanate (45 mg/kg per dose of the

Table 2. **Treatment of Group A Streptococcal Pharyngitis**

| Antibiotic | Dose | Duration |
|---|---|---|
| Penicillin V K | 250 mg bid or tid if ≤27 kg (60 lb); 500 mg bid or tid if >27 kg (60 lb) | 10 d |
| Amoxicillin | 50 mg/kg, maximum 1 g, once daily | 10 d |
| Benzathine penicillin G | 600,000 U if ≤27 kg (60 lb); 1,200,000 U if >27 kg (60 lb) | Single dose |
| For penicillin-allergic patients: | | |
| Cephalexin | 25 to 50 mg/kg per day divided bid; maximum 1 g/d | 10 d |
| Cefpodoxime | 5 mg/kg, maximum 100 mg, bid | 5 d |
| Cefdinir | 7 mg/kg bid, maximum 600 mg/d | 5 d |
| Clindamycin | 20 mg/kg per day divided tid; maximum 1.8 g/d | 10 d |
| Azithromycin | 12 mg/kg, maximum 500 mg, once daily | 5 d |
| Clarithromycin | 15 mg/kg per day divided bid; maximum 250 mg/dose | 10 d |

bid=twice a day, tid=three times a day
All doses are for oral administration, except for benzathine penicillin G, which is administered intramuscularly.

amoxicillin component twice a day), azithromycin, or penicillin plus rifampin (10 to 20 mg/kg per day, maximum 600 mg/d, administered once daily or divided twice a day for the last 4 d of the penicillin treatment course). The most effective treatment regimen for eradicating streptococcal carriage is reported to be a 10-day course of clindamycin at 20 mg/kg per day in 3 doses (maximum 1.8 g/d).

Indications for tonsillectomy include more than seven documented GAS infections in 1 year or more than five episodes in each of the preceding 2 consecutive years. Because the incidence of streptococcal pharyngitis declines with age, the potential benefits of tonsillectomy must be balanced against the risks and cost of surgery.

## Skin Infections

Skin is the second most common site of GAS infection. The location of the infection and the inflammatory response determine the clinical picture, which ranges from superficial impetigo to the more severe suppurative complication of necrotizing fasciitis. In general, the characteristic features of GAS skin infection are profuse edema, rapid spread through tissue planes, and dissemination through lymphatic or hematogenous routes.

### Impetigo

GAS impetigo is a superficial skin infection that begins with acquisition of GAS on healthy skin (usually from close contacts whose skin was colonized or infected with GAS) and leads to development of skin infection at sites of minor trauma, such as abrasions, lacerations, insect bites, and burns. The incubation period for GAS impetigo is 7 to 10 days. GAS impetigo initially appears as a discrete papulovesicular lesion surrounded by localized erythema. As the infection evolves, the lesion becomes purulent and covered with an amber-colored crust. Diagnosis is clinical and usually straightforward at the stage of crusting. Cultures of lesions are not indicated routinely because they often yield both streptococci and staphylococci. Treatment for localized disease consists of topical mupirocin or retapamulin. Multiple localized lesions may require systemic treatment that covers both GAS and staphylococcal infections, such as cephalexin or clindamycin.

### Erysipelas

Erysipelas is a superficial cellulitis caused by GAS that is confined to the lymphatics and subcutaneous tissues. Erysipelas occurs most commonly in infants and young children. The source of GAS commonly is the upper respiratory tract of the patient or a close contact. The head and face are involved most often, although the neonate may develop periumbilical infection (omphalitis). Lesions are characterized by erythema and edema, with a sharply defined and elevated border tender to palpation. Systemic signs such as fever often are present. Lymphangitis may occur. Diagnosis is primarily clinical. Treatment consists of systemic antibiotic therapy; parenteral antibiotics may be needed, especially in immunocompromised patients.

### Cellulitis

GAS cellulitis involves the deeper subcutaneous tissues and may appear anywhere on the body, including the perianal area. History of a preceding skin lesion or skin trauma is common. Cellulitis is characterized by erythematous and edematous skin with poorly defined margins that is tender to palpation. Systemic signs such as fever often are present. Lymphangitis may occur. Diagnosis is clinical, although GAS can be isolated readily from the perianal skin in perianal infection. Treatment consists of systemic antibiotic therapy; parenteral antibiotics may be needed if there is an inadequate response to oral antibiotics.

**Table 3. Jones Criteria for the Diagnosis of Acute Rheumatic Fever**

**Diagnosis:** Requires 2 major criteria or 1 major and 2 minor criteria plus evidence of recent group A streptococcal infection

| Major Criteria | Minor Criteria | Evidence of Recent GAS Infection |
|---|---|---|
| Carditis | Fever | Positive throat culture or RADT |
| Polyarthritis | Arthralgia | OR |
| Chorea | Elevated acute-phase reactants | Elevated or rising antistreptococcal antibody titers |
| Erythema marginatum | Prolonged PR interval | |
| Subcutaneous nodules | | |

RADT=rapid antigen detection test

## Streptococcal Nonsuppurative Complications

### Rheumatic Fever

ARF is caused by previous GAS pharyngeal infection, with a latent period of 2 to 4 weeks. The disorder is most common among children ages 5 to 15 years. Currently, most cases of ARF occur in developing countries, a distribution that is believed to be due to improved hygiene and routine use of antibiotics for GAS pharyngitis in developed countries.

ARF presents as an acute febrile illness, with clinical manifestations that include arthritis, carditis or valvulitis, skin lesions, and neurologic disturbances. The arthritis, occurring in 75% of patients who have ARF, is a migratory polyarthritis, affecting several joints in rapid succession, most commonly larger joints. Synovial fluid analysis of involved joints displays sterile inflammation. Treatment with nonsteroidal anti-inflammatory drugs (NSAIDs) or salicylates may lead to resolution, potentially blunting the migratory feature; thus, monoarticular arthritis may occur. The relationship between poststreptococcal reactive arthritis (PSRA), a migratory arthritis that occurs after a streptococcal infection, and ARF is debated. Some speculate this is a separate disorder; others think PSRA is part of the clinical spectrum of ARF.

The carditis of ARF is a pancarditis that occurs in 50% of patients. Symptoms and signs include chest pain, pericardial friction rub or murmur on auscultation, and heart failure. Varying degrees of heart block may be seen on electrocardiography, and cardiomegaly may be noted on chest radiographs. Echocardiography may show a variety of findings, including valvular regurgitation or stenosis, chamber enlargement or dysfunction, and pericardial effusion. Rheumatic heart disease is the most serious complication of ARF, consisting of inflammation of the valves and endocardium, which leads to valvular insufficiency or stenosis. The mitral valve is involved most commonly, followed by the aortic valve; right-sided valvular lesions are rare. Rheumatic heart disease may occur up to 20 years after the onset of ARF, making the diagnosis difficult in the absence of other acute features.

Skin findings, which tend to occur only in patients who have carditis, consist of subcutaneous nodules and erythema marginatum. The firm, painless, noninflammatory subcutaneous nodules, typically located over bony prominences or near tendons, may be present for up to 1 month. Erythema marginatum, also known as erythema annulare, is an evanescent, nonpruritic, rapidly advancing, pink-to-slightly red rash that typically is found on the trunk or proximal limbs and spares the face.

Central nervous system involvement in ARF manifests as Sydenham chorea, which consists of abrupt, purposeless, nonrhythmic involuntary movements that cease during sleep; muscular weakness; and emotional disturbances that range from outbursts of inappropriate behaviors to transient psychosis. Sydenham chorea can occur as late as 8 months after GAS infection and usually resolves completely but occasionally lasts 2 to 3 years.

The diagnosis of ARF is based on the Jones criteria (Table 3), which were published initially in 1944 and later revised by Jones and subsequently the American Heart Association, with the most recent revision published in 2002. Diagnosis requires evidence of a preceding GAS infection along with the presence of two major manifestations or one major and two minor manifestations. The rate of isolation of GAS from the oropharynges of patients who have ARF is only between 10% and 20%. Therefore, serologic testing, which demonstrates either elevated antibody titers or rising titers with serial testing, is used more often for confirmation of infection. The streptozyme test measures five streptococcal antibodies: antistreptolysin O (ASO), antihyaluronidase (AHase), antistreptokinase (ASKase), antinicotinamide-adenine dinucleotidase (anti-NAD), and antideoxyribonuclease B (anti-DNase B) antibodies.

Treatment of ARF focuses on eradication of GAS, relief of acute disease manifestations, and prophylaxis against future GAS infection to prevent recurrent ARF. Eradication of GAS requires the same antibiotic regimens that are used to treat GAS pharyngitis. In addition,

household contacts should have throat cultures performed and be treated if the cultures are positive for GAS. Aspirin, administered at 80 to 100 mg/kg per day and continued until all symptoms have resolved, is the major anti-inflammatory agent used for symptom relief. Carditis is managed with therapies used for heart failure. Valve repair or replacement is indicated when heart failure due to valvular lesions cannot be managed with medical therapy alone. Because patients who have a history of ARF are at high risk for recurrent ARF with subsequent GAS pharyngitis infections, antimicrobial prophylaxis is indicated. Prophylactic antibiotics should be started immediately after the therapeutic antibiotic course is complete. Options for prophylaxis include penicillin V K, sulfadiazine, or macrolides for patients at lower risk of ARF recurrence and benzathine penicillin G intramuscularly every 4 weeks for patients at higher risk of ARF recurrence. Prophylaxis should continue for several years, typically until a patient is an adult and recurrence-free for 10 years; longer prophylaxis is indicated if the patient has residual heart disease.

## Poststreptococcal Glomerulonephritis

Poststreptococcal glomerulonephritis (PSGN) is the most common cause of acute nephritis worldwide. PSGN is caused by previous throat or skin infection with nephritogenic strains of GAS. Although the exact mechanism is unclear, antigens of nephritogenic streptococci are believed to induce immune complex formation in the kidneys. The latent period is 1 to 3 weeks following GAS pharyngitis and 3 to 6 weeks following GAS skin infection. Deposition of GAS nephritogenic antigens within the glomerular subendothelium leads to glomerular immune complex formation, which triggers complement activation and subsequent inflammation; deposition within the glomerular subepithelium leads to epithelial cell damage and subsequent proteinuria.

The clinical presentation of PSGN ranges from asymptomatic microscopic hematuria to a nephritic syndrome consisting of hematuria, proteinuria, edema, hypertension, and elevated serum creatinine values. Gross hematuria is present in up to 50% of patients. Edema occurs because of sodium and fluid retention, which may lead to secondary hypertension. Decreased glomerular filtration rate results in increased serum creatinine concentration; acute renal failure requiring dialysis is possible. Urinalysis shows hematuria with or without red blood cell casts, proteinuria, and often pyuria. Serum C3 complement values are low due to activation of the alternative complement pathway, and C4 and C2 values are normal to mildly decreased. Throat or skin cultures often are negative at the time of diagnosis, given the latent period from onset of infection to onset of nephritis.

Diagnosis requires clinical findings of acute nephritis in the setting of a recent GAS infection. If throat or skin cultures are negative, confirmation of a recent GAS infection may be obtained through serologic testing. Low C3 is characteristic of, but not specific to, PSGN. Renal biopsy typically is not performed to confirm the diagnosis of PSGN.

Treatment for PSGN focuses on supportive management of the clinical manifestations. Loop diuretics such as furosemide may be prescribed for the hypertension and edema in addition to sodium and water restriction. Hypertensive urgencies and emergencies, although uncommon, require immediate attention. Some patients require dialysis during their acute illness because of the reduction in renal function. Evidence of persistent GAS infection requires antibiotic treatment.

The clinical manifestations of PSGN typically resolve quickly. Diuresis usually begins within 1 week, with serum creatinine concentrations returning to baseline by 3 to 4 weeks and hematuria resolving within 3 to 6 months. Proteinuria starts to resolve as the patient recovers, but at a slower rate, and may persist for up to 3 years. Failure to treat the primary infection, if persistent, may delay recovery. The prognosis for most children who have PSGN is excellent. Although rare, recurrent proteinuria, hypertension, and renal insufficiency may develop up to several years after the initial illness.

## Streptococcal Toxic Shock Syndrome

GAS TSS is a form of invasive GAS disease associated with the acute onset of shock and organ failure. Invasive GAS disease is defined as isolation of GAS from a normally sterile body site. Another form of invasive GAS disease is necrotizing fasciitis. Risk factors for the development of invasive GAS infections include injuries resulting in bruising or muscle strain, surgical procedures, viral infections including varicella, and use of NSAIDs.

The pathogenesis of GAS TSS is believed to be mediated by streptococcal exotoxins that act as superantigens, which activate the immune system. The resultant release of cytokines causes capillary leak, leading to hypotension and organ damage.

GAS TSS typically presents with fever and the abrupt onset of severe pain, often associated with a preceding soft-tissue infection such as cellulitis. GAS TSS also may present in association with other invasive GAS diseases such as necrotizing fasciitis, bacteremia, pneumonia, osteomyelitis, myositis, or endocarditis. However, cases may present with no identified focus of infection. Pa-

**Table 4. Diagnostic Criteria for Group A Streptococcal Toxic Shock Syndrome**

- Isolation of group A *Streptococcus* from a normally sterile site such as blood, cerebrospinal fluid, pleural fluid, peritoneal fluid, or surgical wound
- Hypotension AND two or more of the following:
  - –Renal impairment
  - –Coagulopathy: thrombocytopenia or disseminated intravascular coagulation
  - –Hepatic involvement: elevated bilirubin or transaminases values
  - –Acute respiratory distress syndrome
  - –Erythematous macular rash that may desquamate
- Soft-tissue necrosis, such as necrotizing fasciitis or myositis

tients may be normotensive initially, but hypotension develops quickly. Erythroderma, a generalized erythematous macular rash, may occur. Laboratory findings include leukocytosis with immature neutrophils, elevated serum creatinine values, hypoalbuminemia, hypocalcemia, increased creatine kinase concentration, myoglobinuria, hemoglobinuria, and positive blood cultures.

Diagnosis of GAS TSS requires isolation of GAS from a normally sterile body site such as blood, cerebrospinal fluid, pleural fluid, peritoneal fluid, or a surgical wound in the presence of hypotension plus two or more additional signs (Table 4). Probable GAS TSS may be diagnosed when GAS is isolated from a nonsterile site such as throat, skin, or vagina and the other criteria are fulfilled.

Treatment for GAS TSS includes hemodynamic support, surgical therapy, antibiotic therapy, and management of multiorgan system failure, including respiratory failure and cardiac failure. Aggressive fluid replacement is essential to maintain adequate perfusion to prevent end-organ damage; vasopressors also may be required. Immediate surgical exploration and debridement is necessary, and repeated resections may be required. Empiric therapy with broad-spectrum intravenous (IV) antibiotics to cover both streptococcal and staphylococcal infections is recommended pending identification of GAS. Once GAS has been identified, antibiotic therapy with clindamycin IV (13 mg/kg, maximum 600 mg, every 8 h) plus penicillin G IV (300,000 U/kg per day divided every 4 to 6 h) may be continued. The duration of antibiotic therapy depends on the clinical course. In general, antibiotics should be continued for a minimum of 14 days in patients who have bacteremia and for 14 days after the last positive culture obtained during surgical debridement for patients who have deep soft-tissue infections. Of note, immune globulin intravenous (IGIV) also may be used as adjunctive therapy.

### Pediatric Autoimmune Neuropsychiatric Disorder Associated With Group A Streptococci

Pediatric autoimmune neuropsychiatric disorder associated with group A streptococci (PANDAS) describes a group of neuropsychiatric disorders, in particular obsessive compulsive disorder (OCD), tic disorders, and Tourette syndrome, that are exacerbated by GAS infection. GAS infection in a susceptible host is believed to lead to an abnormal immune response, with production of autoimmune antibodies that crossreact with brain tissue, which leads to central nervous system manifestations. This proposed association is controversial, with uncertainty focused on whether the association is causal or incidental, given the rates of GAS infection and GAS carriage and the frequency of OCD and tic disorders in children.

The clinical course is characterized by abrupt onset of exacerbations that are associated with GAS infection, with gradual resolution over weeks to months. Diagnostic criteria for PANDAS include OCD and tic disorders, including Tourette syndrome; abrupt onset in childhood; an episodic course of symptoms; and a temporal relationship between GAS infection confirmed by RADT, throat culture, or skin culture or serologic testing. Evaluation for GAS infection should be considered in children who present with the abrupt onset of OCD or tic disorder.

Management of PANDAS includes treatment of the GAS infection and neuropsychiatric therapy. Behavioral therapy and pharmacological therapies, including selective serotonin reuptake inhibitors (SSRIs) for OCD and clonidine for tics, are used in treatment. Of note, because of the proposed autoimmune pathogenesis, immunomodulatory therapies such as plasma exchange and IGIV may be beneficial and are under study. The prognosis is not known. The use of prophylactic antibiotics to prevent PANDAS recurrence also is under review.

## Streptococcal Suppurative Complications

### Tonsillopharyngeal Cellulitis and Abscess

Cellulitis or abscess can arise in the peritonsillar or retropharyngeal spaces. Retropharyngeal infection is more common in younger children; peritonsillar disease occurs more commonly in older children and adolescents. Although these infections are often polymicrobial, GAS is the predominant bacterial species due to the spread of GAS pharyngitis to adjacent structures. Clinical manifes-

tations include an ill-appearing child who has fever, severe sore throat, dysphagia or odynophagia, muffled or "hot potato" voice, trismus, neck swelling and pain, or torticollis. Physical findings may include pharyngeal erythema and enlarged exudative tonsils in peritonsillar cellulitis; a swollen and fluctuant tonsil with deviation of the uvula to the opposite side in peritonsillar abscess; and swelling of the posterior pharyngeal wall in retropharyngeal cellulitis or abscess. In all cases, cervical and submandibular lymphadenopathy is present. Laboratory findings include leukocytosis with a predominance of neutrophils and immature neutrophils and a positive RADT result or throat culture for GAS. Imaging studies such as computed tomography scan with IV contrast and lateral neck radiographs that show thickening of the retropharyngeal space in retropharyngeal infections may be necessary to differentiate peritonsillar from retropharyngeal infections and abscess from cellulitis.

Treatment starts with rapid assessment of the degree of upper airway obstruction. Supportive care, including hydration, pain control, and monitoring for progression of infection, is essential. Empiric therapy with broad-spectrum IV antibiotics to cover streptococcal, staphylococcal, and respiratory anaerobic infections is recommended. If drainage is performed, culture results may be used to guide antibiotic therapy. Patients may be transitioned to oral antibiotic therapy with amoxicillin-clavulanate or clindamycin when they are afebrile and improving clinically. The duration of antibiotic therapy is 14 days. For peritonsillar and retropharyngeal cellulitis, medical management alone is sufficient. Peritonsillar abscess and retropharyngeal abscess, however, require medical and surgical management. Surgical drainage options include needle aspiration, incision and drainage, and tonsillectomy.

### Necrotizing Fasciitis

GAS necrotizing fasciitis is a form of invasive GAS disease that may be found in association with other invasive GAS diseases, such as GAS TSS. This infection is characterized by extensive local necrosis of subcutaneous soft tissues and skin. The pathogenesis of GAS necrotizing fasciitis is believed to be mediated by GAS pyrogenic exotoxins that act as superantigens, which activate the immune system. The resultant release of cytokines leads to tissue destruction. Clinical manifestations of GAS necrotizing fasciitis include systemic findings such as fever, hypotension, malaise, and myalgias; rapidly increasing pain; and erythematous skin that progresses to blisters, bullae, and crepitus with subcutaneous gas. Laboratory findings include leukocytosis with a predominance of neutrophils; elevated creatine kinase, lactate, and creatinine values; and positive blood cultures. Diagnosis is clinical and requires a high degree of suspicion because of the rapid progression of infection.

Treatment of GAS necrotizing fasciitis includes early and aggressive surgical exploration and debridement, antibiotic therapy, and hemodynamic support if GAS TSS is present as well. Surgical exploration facilitates debridement of necrotic tissue and obtaining of cultures to guide antibiotic therapy. Repeat surgery is necessary until all necrotic tissue has been removed. Antibiotic therapy with penicillin G IV (300,000 U/kg per day divided every 4 to 6 h) plus clindamycin IV (13 mg/kg, maximum 600 mg, every 8 h) is recommended. Antibiotic therapy should continue for several days after completion of surgical debridement.

## Summary

- GAS is a common cause of upper respiratory tract and skin infections.
- Based on strong research evidence, (1) throat culture is the gold standard for diagnosing GAS pharyngitis.
- Based on strong research evidence, (1) oral penicillin V K is the antibiotic treatment of choice for GAS pharyngitis because of its efficacy, safety, and narrow spectrum.
- Based on strong research evidence, (2) primary prevention of complications of GAS such as ARF involves prompt diagnosis and antibiotic treatment of GAS pharyngitis.
- GAS nonsuppurative and suppurative complications may occur and are mediated by interactions between GAS antigens or exotoxins and the patient's immune system.

## References

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## Suggested Reading

Wald ER, Green MD, Schwartz B, Barbadora K. A streptococcal score card revisited. *Pediatr Emerg Care.* 1998;14:109–111

## PIR Quiz

Quiz also available online at: http://pedsinreview.aappubliations.org.
NOTE: Beginning in January 2012, learners will only be able to take *Pediatrics in Review* quizzes and claim credit online. No paper answer form will be printed in the journal.

6. Among the following symptoms, the one that is seen *most* commonly in both toddlers and infants who have streptococcosis is:

   A. Anterior cervical adenopathy.
   B. Diffuse rash.
   C. Joint inflammation.
   D. Low-grade fever.
   E. Mucopurulent rhinorrhea.

7. Testing of asymptomatic contacts for GAS is typically recommended only when the contact is:

   A. At risk of developing complications.
   B. Living in the same household.
   C. Not a known carrier.
   D. Suffering from exudative pharyngitis.
   E. Younger than age 12 months.

8. The antibiotic treatment of choice for GAS pharyngitis is:

   A. Amoxicillin.
   B. Azithromycin.
   C. Cefdinir.
   D. Cefpodoxime.
   E. Penicillin.

*For each of the following conditions, which finding is most characteristic?*

9. Cellulitis.
10. Erysipelas.
11. Impetigo.

    A. Amber-colored crust.
    B. Fever.
    C. Lymphangitis.
    D. Omphalitis.
    E. Perianal lesions.

12. The cause of PANDAS has been suggested to be a GAS infection in a susceptible host that leads to the production of:

    A. Autoimmune antibodies.
    B. Cytokines.
    C. Nephritogenic antigens.
    D. Pyrogenic exotoxins.
    E. Superantigens.

### Parent Resources From the AAP at HealthyChildren.org

The reader is likely to find material to share with parents that is relevant to this article by visiting this link: http://www.healthychildren.org/English/health-issues/conditions/infections/pages/Group-A-Streptococcal-Infections.aspx

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