Microbiology and Laboratory Diagnosis of Upper Respiratory Tract Infections

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In the article that follows, Carroll and Reimer address a number of issues related to the clinical and laboratory diagnosis of upper respiratory tract infections. These syndromes occur with great frequency in both adults and children and have tremendous economic impact, related not only to lost productivity in the workplace but also to the frequent prescription by physicians of antibiotics, even when the etiologic agents of infection almost certainly are not bacteria. Most of these infections are diagnosed clinically, and specimens for microbiological identification are not obtained. Indeed, the difficulty in obtaining microbiological specimens that are not contaminated by resident colonizing flora often results in laboratory culture reports of dubious clinical value. As the authors note, the most standardized procedures are for the diagnosis of pharyngitis due to Streptococcus pyogenes. The preferred culture methods are reviewed, as are the sensitivities, specificities, and limitations of rapid direct tests for group A streptococcal antigens. Currently, as the authors emphasize, a negative direct test mandates a conventional culture for S. pyogenes. More problematic are requests for isolation of other streptococci, Haemophilus species, corynebacteria, and gram-negative bacteria. Given limited resources, cost-containment imperatives, and the absence of clear evidence that these organisms are pharyngeal pathogens associated with important sequelae, my laboratory does not attempt to isolate these bacteria unless the ordering physician has directly consulted with me (the laboratory director). Carroll and Reimer emphasize that nasopharyngeal cultures have no place in the microbiological diagnosis of otitis media and that diagnostic tympanocentesis is the only procedure for obtaining specimens that yield reliable microbiological findings. They also point out the futility of using swabs to obtain material for the diagnosis of otitis externa, since the external auditory canal cannot be decontaminated sufficiently to obtain a meaningful culture result. Finally, the authors address the available methods for obtaining specimens to establish the etiology of sinusitis. For microbiological diagnosis, direct antral puncture has been the method of choice for many years. However, otorhinolaryngologists now obtain many specimens endoscopically. It probably is not possible to obtain specimens by this method without contamination by normal upper respiratory flora. Thus, results of cultures of endoscopic specimens are more difficult to interpret. For patients with complicated illnesses, use of the diagnostic “gold standard” of antral puncture, as well as biopsy with histopathologic correlation, should be encouraged.

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Upper respiratory tract infections (URIs) account for more visits to physicians than any other types of infectious disease [1]. Often considered trivial from the standpoint of mortality, these infections have a considerable economic impact. Respiratory tract infections in general account for more restricted activity and loss of time from work and school than any other category of infections [2–4]. Moreover, inappropriate and excessive treatment of these infections contributes to the reported problems of resistance among previously susceptible pathogens such as pneumococci [5, 6]. Finally, success in vaccine development for Haemophilus influenzae type b has remarkably reduced the incidence of epiglottitis [7], while the constant expansion of the immunocompromised host population underscores the importance of both unusual pathogens and unusual clinical presentations [8].

The upper respiratory tract as defined herein is the anatomic area extending from the anterior nasal passages to the larynx. This article will review the microbiology and laboratory diag-
Table 1. Causes of pharyngitis and their relative contribution to upper respiratory tract infections.

<table>
<thead>
<tr>
<th>Type, cause of pharyngitis</th>
<th>Contribution (% of cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonexudative Virus</td>
<td>42</td>
</tr>
<tr>
<td>Rhinovirus*</td>
<td>?</td>
</tr>
<tr>
<td>Cytomegalovirus</td>
<td>?</td>
</tr>
<tr>
<td>Respiratory syncytial virus</td>
<td>2</td>
</tr>
<tr>
<td>Myxovirus</td>
<td>10</td>
</tr>
<tr>
<td>Bacterium</td>
<td></td>
</tr>
<tr>
<td>Neisseria gonorrhoeae</td>
<td>Rare</td>
</tr>
<tr>
<td>Mycoplasma pneumoniae</td>
<td>10</td>
</tr>
<tr>
<td>Chlamydia pneumoniae</td>
<td>13</td>
</tr>
<tr>
<td>Haemophilus species</td>
<td>?</td>
</tr>
<tr>
<td>Exudative Virus</td>
<td>19</td>
</tr>
<tr>
<td>Adenovirus type 1, 2, 3, or 5*</td>
<td>7–15</td>
</tr>
<tr>
<td>Epstein-Barr virus</td>
<td></td>
</tr>
<tr>
<td>Bacterium</td>
<td>5</td>
</tr>
<tr>
<td>Streptococcus pyogenes</td>
<td>20</td>
</tr>
<tr>
<td>β-Hemolytic streptococcus of group C or G</td>
<td>6</td>
</tr>
<tr>
<td>Corynebacterium diphtheriae</td>
<td>Rare</td>
</tr>
<tr>
<td>Francisella tularensis</td>
<td>Rare</td>
</tr>
<tr>
<td>Arcanobacterium haemolyticum</td>
<td>0.4–2.0</td>
</tr>
<tr>
<td>Ulcerative Coxsackievirus A</td>
<td>?</td>
</tr>
<tr>
<td>Herpes simplex virus</td>
<td>?</td>
</tr>
<tr>
<td>Enterovirus</td>
<td>?</td>
</tr>
<tr>
<td>Treponema pallidum</td>
<td>?</td>
</tr>
</tbody>
</table>

NOTE. * Value represents percentage of all viral infections caused by these agents.

nis of the common URI syndromes. Throughout the article the reader is referred to several recent reviews of the clinical manifestations and treatment of these syndromes.

Pharyngitis

Pharyngitis is an inflammatory syndrome of the oropharynx, and herein the term will be used synonymously with tonsillitis, tonsillopharyngitis, and pharyngotonsillitis. Table 1 lists the most frequently described pathogens involved, along with their relative contributions to disease in children and adults. The relative proportion of infecting agents varies with the season, age of patients, and other epidemiologic circumstances. The majority of cases of acute pharyngitis are caused by viruses. However, the resurgence of acute rheumatic fever in several geographic locations throughout the United States [9] and the increase in reported severe toxic or suppurative sequelae associated with Streptococcus pyogenes (group A β-hemolytic streptococci) [10, 11] reinforce the necessity of distinguishing this pathogen from other etiologic agents.

Despite studies by numerous clinicians in which “score cards” were used to predict which patients’ throat swab specimens would be culture-positive, the clinical diagnosis of streptococcal pharyngitis is unreliable [12–15]. Probability estimates are perhaps most useful in deciding who should not be tested or treated empirically while further diagnostic data are awaited. For example, the presence of cough, rhinorrhea, sneezing, and hoarseness has about an 80% negative predictive value for the presence of streptococcal pharyngitis, especially in the absence of fever, exudate, and cervical adenopathy [13, 14, 16].

Diagnostic testing begins with an appropriately collected swab specimen. The accuracy of results, whether of antigen detection or culture, depends heavily upon the specimen-collection technique. Both tonsils (or tonsillar fossae) and the posterior oropharynx should be vigorously swabbed, while the tongue and the buccal mucosa are avoided. Polyester swabs are preferred, and the quantity of normal oral flora and β-hemolytic streptococci recovered is enhanced if the swab is sent dry to the laboratory [14]. If processing is delayed beyond 24 hours, then the swab should be placed in an appropriate transport medium such as Amies agar or Stuart broth [17].

Many clinics and laboratories now use a dual swab system. One swab is used for direct antigen detection, and the second is sent to the laboratory for culture if the direct test is negative. There are abundant direct antigen detection systems (rapid Streptococcus screens) available that yield results, on average, within 10–20 minutes. Extracted antigen is detected by latex agglutination, coagglutination, or enzymatic reaction (ELISA) [18]. The specificity of all of these assays is between 95% and 99%; therefore, treatment can be reliably given when the test is positive and symptoms are compatible.

However, the sensitivities of these tests vary between 60% and 95% [18] and may be as low as 31%, depending on the comparative culture method [19]. In addition, in a study by Donatelli et al. [20], sensitivity and specificity of rapid methods were also affected when the tests were performed by nontechnical personnel. Overreading and operator differences with respect to assay performance (e.g., processing dry vs. moistened swabs) were two specific problems cited in this study, emphasizing the importance of adequate training [20].

The more recently developed novel tests such as the Gen-Probe group A Streptococcus direct test (Gen-Probe, San Diego, CA) and the BioStar optical immunoassay (Strep A OIA; BioStar, Boulder, CO) reportedly have better sensitivity (>93%) [21, 22]. Whether they will replace cultures as the diagnostic “gold standard” remains to be seen. Currently, the American Academy of Pediatrics recommends that a culture be performed in the event that a direct test is negative for a patient with clinical features compatible with streptococcal pharyngitis [23].

Once it has been decided to collect and send a swab specimen for culture, most laboratories will look only for the presence of group A β-hemolytic streptococci. Much has been written about the precise procedures for optimum recovery [17, 19, 24, 25]. Five percent sheep blood agar (SBA) produces the most consistent
colony morphology and hemolytic pattern and inhibits the growth of *Haemophilus haemolyticus*. After streaking, the plate should be vertically stabbed to allow for expression of oxygen-sensitive hemolysis by subsurface colonies.

Plates should be incubated in reduced oxygen tension and examined at 12–24 hours and again at 48 hours. Some investigators suggest that optimum growth occurs on selective media containing trimethoprim-sulfamethoxazole (SBA-SXT) [19, 25]. In summary, according to Kellogg [24], use of any of the following methods and approaches appears to result in 90%–95% accuracy of detection: (1) SBA incubated anaerobically for 48 hours; (2) SBA incubated in air for 48 hours, with a coverglass pressed onto the primary inoculum zone; (3) SBA-SXT incubated in 5%–10% CO2 for 48 hours; and (4) SBA-SXT incubated anaerobically for 48 hours.

Any suspicious β-hemolytic colonies should be confirmed as group A β-hemolytic streptococci by either detection of the enzyme pyrrolidonyl arylamidase (the PYR test) or any of the commercially available serogrouping assays. The PYR test is less expensive and labor-intensive than serogrouping. The bacitracin test should not be used as a confirmatory test, because other β-hemolytic streptococci may also be bacitracin-susceptible and group A *Streptococcus* may be bacitracin-resistant [17].

What to do when non–group A β-hemolytic streptococci are isolated is a matter of debate. In adolescents and young adults with pharyngitis, the causative agents may include groups C and G streptococci and *Arcanobacterium haemolyticum*. These pathogens have been associated with food-borne infections and sporadic clusters of endemic infections and cause manifestations indistinguishable from those of *S. pyogenes* infection, including a scarlatiniform rash [26–29]. Many laboratories will determine the serogroup if the organism is present in quantities that exceed the normal flora. Others will report any quantity present but will not identify the organisms by serogroup unless requested to do so by the clinician. The latter seems to be a reasonable approach, as reports of nonsuppurative sequelae are rare [30].

Clinicians must communicate directly with the laboratory if an unusual or fastidious pathogen, such as a gonococcus, *Corynebacterium diphtheriae*, or *Francisella tularensis* is suspected. Appropriate specimen collection and transport are essential for optimal results. There are currently no commercially available rapid assays for the detection of *Mycoplasma pneumoniae* or *Chlamydia pneumoniae* in pharyngeal specimens [31, 32]. Serological testing with microimmunofluorescence or CF has been recommended for the diagnosis of lower respiratory tract infections caused by these agents [31, 32].

Culture of the organisms with use of appropriate transport media and inoculation to cell culture lines specific for *C. pneumoniae* and *M. pneumoniae* has been reported, but the requirement for multiple passages and the prolonged time to detection make these methods impractical and expensive [31]. Such techniques are best reserved for elucidating the cause of atypical pneumonia in the hospitalized or otherwise compromised patient, when serology may not be helpful.

If herpesvirus, cytomegalovirus, or adenovirus is a suspected pathogen, then a swab specimen should be collected and placed in an appropriate viral transport medium. While Epstein-Barr virus has been isolated from pharyngeal specimens in a research setting, infectious mononucleosis is generally diagnosed by a positive heterophile antibody test or by more definitive serological tests when the heterophile test is negative. The reader is referred to several excellent recent reviews for a more comprehensive discussion of the approach to patients with pharyngitis [33–36].

Otitis Media

Acute otitis media (AOM) is the most frequently diagnosed infectious disease of childhood. In the Greater Boston study that observed children from birth until age 7, 62.4% and 83% of children had at least one episode by the ages of 1 and 3 years, respectively. A significant percentage (75%) had ≥3 episodes by age 7 years [37]. Recent evidence suggests that the number of cases has increased from 10 million office visits for AOM in 1975 to 25 million in 1990 [38]. This may be attributed in part to the increase over the past 2 decades in the number of children attending day-care facilities.

The diagnosis of AOM is usually made clinically and, in ambiguous cases, with the assistance of techniques such as tympanometry and acoustic reflectometry [39]. Nasopharyngeal cultures have only a 47% positive predictive value in determining the etiologic agent when compared with middle ear aspiration [40] and therefore cannot be relied upon in the management of AOM. Recently, otolaryngologists and pediatricians have suggested the revival of diagnostic tympanocentesis [41, 42]. Antimicrobial resistance in many communities has many practitioners resorting to this procedure sooner in the evaluation of children with otitis media.

Bluestone [43] has summarized the indications for tympanocentesis as follows: (1) appearance of toxicity, severe otalgia, or serious illness; (2) unsatisfactory response to antimicrobial therapy; (3) onset of otitis media in a child receiving adequate therapy; (4) occurrence of otitis media associated with suspected or confirmed suppurative complications; and (5) cases in which the microbiology is unpredictable, as in those involving newborns, sick neonates, and immunocompromised children.

The bacterial etiology of AOM has not changed significantly over the last 16 years [44–46]. The adoption of more sophisticated virological techniques in the 1980s has added to our understanding of the role of viruses in the pathogenesis of middle ear infections [47–49]. Viruses account for 8%–25% of isolates recovered from middle ear effusions [47]. The most common viruses are respiratory syncytial virus, rhinovirus, influenza virus, and adenovirus. Parainfluenza virus and enteroviruses are less frequently recovered [47]. Table 2 lists the distribution of the more common pathogens in neonates, children, and adults.
Table 2. Microbiology of otitis media.

<table>
<thead>
<tr>
<th>Pathogen identified</th>
<th>Acute otitis media</th>
<th>Chronic otitis media</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neonates</td>
<td>Children</td>
</tr>
<tr>
<td><strong>Bacterium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>Haemophilus influenzae</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>Moraxella catarrhalis</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Streptococcus pyogenes</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Coagulase-negative Staphylococcus</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>None</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td><strong>Virus</strong></td>
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<td></td>
</tr>
<tr>
<td>Respiratory syncytial virus</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Influenza A</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Adenovirus</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Parainfluenza virus</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Enterovirus</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Data were compiled from [44, 45, 47, 50].

Streptococcus pneumoniae, nontypeable H. influenzae, and Moraxella catarrhalis are the bacteria most frequently recovered from middle ear effusions [44-46]. In addition to the above agents, Staphylococcus aureus, coagulase-negative staphylococci, and enteric bacteria are also important in neonates [41, 50]. In cases of chronic otitis media, anaerobes are found—usually in association with aerobes—but their exact role in pathogenesis is uncertain [41, 46, 51].

Striking shifts in antimicrobial resistance patterns, especially among S. pneumoniae, have been observed in isolates from middle ear effusions [42, 45, 52]. In an early study by Teel et al. [53], 60% of children whose treatment failed had sterile middle ear effusions, 20% had isolates recovered that were susceptible to the prescribed antibiotic, and 20% had isolates recovered that were resistant to the original therapy. In this study, however, few of the cases were caused by S. pneumoniae [53].

More recent data from PCR-based assays to detect M. catarrhalis, H. influenzae, and S. pneumoniae suggest that bacteria may be present in a greater number of myringotomy specimens from patients whose treatment failed than previous studies have indicated [54]. Treatment failure rates may be higher among children with infection caused by S. pneumoniae than among children with infection caused by other pathogens [42]. Such observations emphasize the need for earlier tympanocentesis in neonates and children with recurrent and chronic disease. Earlier tympanocentesis in conjunction with molecular techniques may help target those pneumococcal serotypes that should be incorporated into a vaccine for infants and small children.

Otitis Externa

External otitis (EO) is an inflammatory condition of the auricle, external ear canal, or outer surface of the tympanic membrane. Infectious EO can be classified as acute localized, acute diffuse (swimmer’s ear), chronic, or malignant (necrotizing) [55].

S. aureus is the most common cause of acute localized EO, which occurs when bacteria become trapped in a hair follicle, causing a pustule. Cultures are rarely necessary but may be performed by needle aspiration at the time of abscess drainage if the patient does not respond to antistaphylococcal therapy [55].

Acute diffuse EO usually occurs during hot, humid weather and most often is the result of infection with S. aureus or Pseudomonas aeruginosa [55, 56]. Rarely are Candida albicans, Aspergillus species, or anaerobes implicated [55, 56]. Culture is unnecessary because of the predictable microbiology and the inadequacy of swab specimens. On occasion this entity may be difficult to distinguish from malignant (necrotizing) external otitis. When a patient’s condition worsens, culture of granulation tissue or tissue recovered during surgical debridement may be helpful [57].

Chronic EO is usually secondary to a persistent, suppurrative middle ear infection accompanied by perforation. The bacteriology reflects the cause of the middle ear disease (see above).

Finally, malignant EO is a severe infection of the external ear canal, mastoid, and bone of the skull; it is most often seen in diabetic patients and caused by P. aeruginosa (reviewed in [58-60]). Fewer than 1% of cases are caused by agents other than Pseudomonas species, such as Aspergillus species, other gram-negative bacilli, and S. aureus [58, 59]. CT currently is the modality of choice for defining the anatomic extent of the disease. Culture and gram staining of the usually copious drainage allow for confirmation and susceptibility testing of the recovered Pseudomonas species; however, fungi and other more fastidious organisms must be visualized in histopathology or recovered in culture of tissue obtained at the time of surgical debridement [58, 59].

Sinusitis

Sinusitis is one of the most frequently treated infections in outpatient clinics. About 0.5% of URIs in adults [61] and 5%-10% of URIs in children [62] are complicated by acute sinusitis. Sinusitis is also a cause of morbidity and mortality in intubated patients and immunocompromised hosts, such as bone marrow transplant recipients, neutropenic patients, and those with primary immunodeficiency diseases [63, 64].

In most circumstances, the diagnosis of acute sinusitis is made on the basis of clinical signs and symptoms, and addi-
tional diagnostic studies are not required. Sinus films and CT scans may be useful adjuncts. One study found a 72%–96% correlation between radiographic findings and positive cultures of sinus aspirations [65].

Multiple studies indicate that results of nasal swab cultures correlate poorly (64%) with those of sinus aspirate cultures [66, 67] and therefore are not useful for guiding therapy. The major pathogens recovered are similar to those found in cases of AOM (table 2). These include H. influenzae, S. pneumoniae, S. pyogenes, and M. catarrhalis [61, 67–69].

Sinusitis that lasts from 3 weeks to 3 months is called subacute sinusitis, and when symptoms persist longer than 3 months the condition is labeled chronic [63]. Chronic disease is usually the result of abnormalities of the osteomeatal complex that often are related to residual infection of the ethmoid sinus [70–73]. A more complete understanding of the pathophysiological events has led to some specific recommendations for the management of chronic sinus disease (reviewed in [70–73]).

Since the bacteriology in such situations is less predictable, sinus aspiration is recommended [62, 72, 73]. This may be accomplished either through antral puncture or, more safely, transnasally. It is questionable, however, whether proper decontamination of the nasal mucosa is possible with endoscopic aspiration. In cases of acute and subacute disease, infection is defined as the presence of at least 10^4 cfu/mL [62]. Few studies address bacterial quantitation in cases of chronic sinusitis.

While the organisms associated with acute disease may be found frequently, α-hemolytic streptococci, gram-positive and gram-negative anaerobes, S. aureus, and P. aeruginosa—especially in patients with nasal polyps and cystic fibrosis—account for the organisms noted in a substantial proportion of cases [64, 71–73]. Anaerobes are found in a higher percentage of cases caused by odontogenic infection [68]. Infections may be polymicrobial, and a higher percentage of cultures are negative than in association with acute disease [71].

Some clinicians consider diagnostic nasal endoscopy the procedure of choice for the evaluation of patients with chronic sinusitis [70–74]. There are two types of endoscopes: flexible and rigid. Flexible fiberoptic endoscopes with a small diameter can be readily introduced into the upper nasal cavities and posterior nasopharynx. These instruments are easier for patients, especially children, to tolerate. Purulent discharge from the meatus and structural abnormalities down to the larynx can be visualized [70, 72]. However, flexible scopes do not allow for diagnostic sampling for cultures [72].

Rigid endoscopes have the advantage of better image clarity. In addition, images seen may be photographed or recorded for use in consultation with other clinicians [70, 73]. Sampling of purulent material can be facilitated. Richtsmeier [72] suggested modification of an ear suction device with a secretion trap to sample sinus ostia (for culture and gram staining) during endoscopy. Care should be taken to collect the specimens under as sterile conditions as possible.

Insertion of Calgee swabs into the middle meatus, with care taken to avoid the vestibule and anterior aspect of the nose, has also been recommended [75]. Orobelo et al. found that results of cultures performed in this manner had an ~81% overall correlation with results of cultures of surgical specimens [75]. Specimens should be sent to the laboratory in appropriate anaerobic transport media. Correlation of leukocytes and organisms seen on gram stain with the results of culture is useful for making therapeutic decisions [64].

Fungal Sinusitis

Fungal sinusitis has increased in incidence in recent years, both as a result of an increase in predisposing factors and because of better diagnostic techniques [64]. There are four fungal sinus syndromes that can be distinguished by histopathologic criteria [76].

Allergic fungal sinusitis is characterized by the presence of noninvasive fungal elements in an eosinophil-rich mucin. The reader is referred to the report de Shazo and Swain for a more complete discussion of this topic [77]. A mycetoma (or fungus ball) is a mass of hyphae on the mucous membrane. No inflammation or invasion of tissue is seen on biopsy. Fungus balls may be removed endoscopically, and antifungal therapy is usually not required. Indolent fungal sinusitis is characterized clinically by a moldy smell or nasal crusting. Granulomas with giant cells are seen on biopsy, but there is no invasion of the tissues by the organisms. However, if the condition is untreated, local bony destruction may occur [64].

Finally, invasive fungal sinusitis most often occurs in the immunocompromised patient. Lesions are characterized by soft-tissue necrosis and invasion of blood vessels with associated orbital, meningeal, and other CNS complications [64, 78]. Prolonged granulocytopenia appears to be the major predisposing factor. Diabetics and patients receiving chronic steroid therapy are also at risk.

Aspergillus species, Rhizopus species, C. albicans, and Fusarium and Alternaria species have been most frequently noted in cases involving bone marrow transplant recipients, neutropenic patients, and patients with AIDS [8, 78, 79]. Diabetics with ketoacidosis are at risk for rhinocerebral mucormycosis. CT or MRI should be performed on any immunocompromised patient suspected of having fungal sinusitis. Early surgical debridement and sampling of tissue for fungal stains, fungal culture, and histologic review should be performed as soon as the diagnosis is suspected.

Summary

URIs cause considerable morbidity and are the most frequently treated infections in the primary care setting. These conditions are most often diagnosed clinically. The laboratory has an important role in the diagnosis of resistant pathogens
in refractory cases and in the diagnosis of the more unusual organisms in immunocompromised patients.

In cases of pharyngitis, the accuracy of diagnostic tests depends on the quality of the specimens collected. The goal of diagnostic testing is usually to distinguish group A β-hemolytic streptococci from other flora. Rapid tests are useful when positive but should be followed by culture if they are negative and the clinical syndrome is suggestive of streptococcal disease.

Nasal swabs are not useful in the management of AOM or sinusitis. Early performance of tympanocentesis is indicated in cases of recurrent infection and when a complication is suspected. The pathogens responsible for most cases of acute sinusitis are identical to those recovered from patients with AOM.

Sinus aspiration is usually not required in cases of acute disease but is helpful in those of chronic sinusitis and mandatory for immunocompromised patients when fungal and resistant gram-negative bacteria are important pathogens. Care must be taken to properly sterilize the nasal cavity and to transport the specimens in media appropriate for anaerobes. Quantitation of bacteria and correlation of the results of staining with those of culture, especially in cases of fungal disease, are helpful in guiding appropriate therapeutic strategies.

References