significantly greater attributable mortality than non-MDR pathogens. Pneumonia caused by some pathogens (e.g., *S. maltophilia*) is simply a marker for a patient whose immune system is so compromised that death is almost inevitable.

Prevention (Table 153-7) Because of the significance of the endotracheal tube as a risk factor for VAP, the most important preventive intervention is to avoid endotracheal intubation or minimize its duration. Successful use of noninvasive ventilation via a nasal or full-face mask avoids many of the problems associated with endotracheal tubes. Strategies that minimize the duration of ventilation through daily holding of sedation and formal weaning protocols also have been highly effective in preventing VAP.

Unfortunately, a tradeoff in risks is sometimes required. Aggressive attempts to extubate early may result in reintubation(s) and increase aspiration, posing a risk of VAP. Heavy continuous sedation increases the risk, but self-extubation because of insufficient sedation also is a risk. The tradeoffs also apply to antibiotic therapy. Short-course antibiotic prophylaxis can decrease the risk of VAP in comatose patients requiring intubation, and data suggest that antibiotics decrease VAP rates in general. However, the major benefit appears to be a decrease in the incidence of early-onset VAP, which is usually caused by the less pathogenic non-MDR microorganisms. Conversely, prolonged courses of antibiotics consistently increase the risk of VAP caused by the more lethal MDR pathogens. Despite its virulence and associated mortality, VAP caused by *Pseudomonas* is rare among patients who have not recently received antibiotics.

Minimizing the amount of microaspiration around the endotracheal tube cuff also is a strategy for avoidance of VAP. Simply elevating the head of the bed (at least 30° above horizontal but preferably 45°) decreases VAP rates. Specially modified endotracheal tubes that allow removal of the secretions pooled above the cuff also may prevent VAP. The risk-to-benefit ratio of transporting the patient outside the ICU for diagnostic tests or procedures should be carefully considered, since VAP rates are increased among transported patients.

Emphasis on the avoidance of agents that raise gastric pH and on oropharyngeal decontamination has been diminished by the equivocal and conflicting results of recent clinical trials. The role in the pathogenesis of VAP that is played by the overgrowth of bacterial components of the bowel flora in the stomach also has been downplayed. MRSA and the nonfermenters *P. aeruginosa* and *Acinetobacter* species are not normally part of the bowel flora but reside primarily in the nose and on the skin, respectively. Therefore, emphasis on controlling overgrowth of the bowel flora may be relevant only in certain populations, such as liver transplant recipients and patients who have undergone other major intraabdominal procedures or who have bowel obstruction.

In outbreaks of VAP due to specific pathogens, the possibility of a breakdown in infection control measures (particularly contamination of reusable equipment) should be investigated. Even high rates of pathogens that are already common in a particular ICU may be a result of cross-infection. Education and reminders of the need for consistent hand washing and other infection-control practices can minimize this risk.

HOSPITAL-ACQUIRED PNEUMONIA

While significantly less well studied than VAP, HAP in nonintubated patients—both inside and outside the ICU—is similar to VAP. The main differences are the higher frequency of non-MDR pathogens and the better underlying host immunity in nonintubated patients. The lower frequency of MDR pathogens allows monotherapy in a larger proportion of cases of HAP than of VAP.

The only pathogens that may be more common in the non-VAP population are anaerobes. The greater risk of macroaspiration by nonintubated patients and the lower oxygen tensions in the lower respiratory tract of these patients increase the likelihood of a role for anaerobes. While more common in patients with HAP, anaerobes are usually only contributors to polymicrobial pneumonias except in patients with large-volume aspiration or in the setting of bowel obstruction/ileus. As in the management of CAP, specific therapy targeting anaerobes probably is not indicated (unless gross aspiration is a concern) since many of the recommended antibiotics are active against anaerobes.

Diagnosis is even more difficult for HAP in the nonintubated patient than for VAP. Lower respiratory tract samples appropriate for culture are considerably more difficult to obtain from nonintubated patients. Many of the underlying diseases that predispose a patient to HAP are also associated with an inability to cough adequately. Since blood cultures are infrequently positive (<15% of cases), the majority of patients with HAP do not have culture data on which antibiotic modifications can be based. Therefore, de-escalation of therapy is less likely in patients with risk factors for MDR pathogens. Despite these difficulties, the better host defenses in non-ICU patients result in lower mortality rates than are documented for VAP. In addition, the risk of antibiotic failure is lower in HAP.

154 Lung Abscess

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Lung abscess represents necrosis and cavitation of the lung following microbial infection. Lung abscesses can be single or multiple but usually are marked by a single dominant cavity >2 cm in diameter.

ETIOLOGY

The low prevalence of lung abscesses makes them difficult to study in randomized controlled trials. Although the incidence of lung abscesses has decreased in the postantibiotic era, they are still a source of significant morbidity and mortality.

Lung abscesses are usually characterized as either primary (~80% of cases) or secondary. *Primary* lung abscesses usually arise from aspiration, are often caused principally by anaerobic bacteria, and occur in the absence of an underlying pulmonary or systemic condition. *Secondary* lung abscesses arise in the setting of an underlying condition, such as a postobstructive process (e.g., a bronchial foreign body or tumor) or a systemic process (e.g., HIV infection or another immunocompromising condition). Lung abscesses can also be characterized as acute (<4–6 weeks in duration) or chronic (~40% of cases).

EPIDEMIOLOGY

The majority of the existing epidemiologic information involves primary lung abscesses. In general, middle-aged men are more commonly affected than middle-aged women. The major risk factor for primary lung abscesses is aspiration. Patients at particular risk for aspiration, such as those with altered mental status, alcoholism, drug overdose, seizures, bulbar dysfunction, prior cerebrovascular or cardiovascular events, or neuromuscular disease, are most commonly affected. In addition, patients with esophageal dysmotility or esophageal lesions (strictures or tumors) and those with gastric distention and/or gastroesophageal reflux, especially those who spend substantial time in the recumbent position, are at risk for aspiration.

It is widely thought that colonization of the gingival crevices by anaerobic bacteria or microaerophilic streptococci (especially in patients with gingivitis and periodontal disease), combined with a risk of aspiration, is important in the development of lung abscesses. In fact, many physicians consider it extremely rare for lung abscesses to develop in the absence of teeth as a nidus for bacterial colonization.

The importance of these risk factors in the development of lung abscesses is highlighted by a significant reduction in abscess incidence in the late 1940s that coincided with a change in oral surgical technique: beginning at that time, these operations were no longer performed with the patient in the seated position without a cuffed endotracheal tube, and the frequency of perioperative aspiration events was thus decreased. In addition, the introduction of penicillin around