The Role of Anaerobic Bacteria in Lung Abscess

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(See the article by Wang et al. on pages 915–22)

The classic studies of lung abscess were done by David Smith at Duke in the late 1920s [1–3]. At that time, approximately one-third of patients with lung abscess died as a result of this infection. Dr. Smith observed that the bacteria found in the walls of the lung abscesses at autopsy resembled the bacteria noted in the gingival crevice, leading him to postulate that aspiration of oral bacteria was the mechanism of infection. He proceeded to attempt to prove this hypothesis by inoculation of various bacteria from the gingival crevice intratracheally in experimental animals of diverse sorts. No single microbe reproduced this disease, but he was able to produce typical lung abscesses with an inoculum containing 4 microbes that are somewhat vague by current taxonomy but that are thought to have been an anaerobic spirochete, *Fusobacterium nucleatum*, *Peptostreptococcus* species, and a fastidious gram-negative anaerobe (possibly *Prevotella melaninogenicus*). This was one of the first demonstrations of bacterial synergy, and it was also an important milestone in our understanding of lung abscess.

At the time of this work, there were no antibiotics. A review of 2114 cases reported before 1936 showed that therapies for lung abscess were equally divided between conservative management, drainage by posturing or bronchoscopy, and surgery; the mortality rate was reported to have been 32%–34% for all 3 therapies [4]. A subsequent report by Smith [3] included a review of 1650 cases reported from the period of 1935–1945, when sulfanamides were available, and the report showed that use of these agents had essentially no impact on the outcome. Penicillin became available in the late 1940s, and thoracic surgery became refined, and there was then substantial controversy about the relative merits of each. Penicillin eventually won favor, and William Weiss at Philadelphia General Hospital became the leading authority on medical management [4–6]. At that time, bacteriological studies of expectorated sputum samples generally yielded no pathogens with routine aerobic culture, the work of David Smith was quietly forgotten, and these cases of lung abscess with enigmatic etiologic agents accounted for 60%–80% of cases of lung abscess, with the predominant isolates being *Peptostreptococcus* species, *F. nucleatum*, and *P. melaninogenicus*. Percutaneous needle aspiration confirmed the prevalence of anaerobic bacteria, and the specific organisms recovered provided testimony to the validity of transtracheal aspiration for these studies [12, 13].

The next chapter in the study of lung abscess involved a multitude of reports favoring clindamycin as a preferred treatment, including 2 controlled clinical trials that showed that clindamycin was superior to penicillin in terms of rates of response, duration of fever, and time to resolution of putrid sputum [12, 14]. More-recent studies show that β-lactam/β-lactamase inhibitor combinations are also effective [15–17]. Metronidazole does not appear to be particularly effective, presumably because of the important role of microaerophilic streptococci, such as *Streptococcus milleri* [18–20].

That anaerobic bacteria and microaerophilic streptococci are the major etiologic agents of lung abscess in the immunocompetent host seemed well confirmed at this juncture: the disease was reproduced with anaerobes recovered from the gingival crevice, multiple studies of transtracheal and transthoracic aspiration rates consistently implicated these bacteria; and treatment with β-lactams or clindamycin yielded favorable results.
In this issue of Clinical Infectious Diseases, Wang et al. [21] suggest, on the basis of their study from Taiwan, that the bacteriological characteristics of lung abscess have changed. These investigators reviewed 90 consecutive cases for which bacteriology studies were performed using transthoracic lung aspiration. The results showed that anaerobes were recovered from just 28 patients (31%). The predominant bacterium was Klebsiella pneumoniae, which was recovered from 30 patients (33%). The conclusion of their study is that K. pneumoniae has become more common as a cause of lung abscess, and they suggest that antibiotics be selected with this organism, as well as anaerobes and S. milleri.

This is the first large report on the bacteriological characteristics of lung abscess to be published that I am aware of for over a decade. In general, transthoracal aspiration has essentially disappeared as a method for bacteriological study of the lower airways, and transthoracic aspiration is rarely done by most physicians for immunocompetent hosts. Wimberley et al. [22] perfected the technique for bronchoscopic aspiration using a protected brush and special methods to expedite anaerobic culture; this technique has been infrequently reproduced by others. Wimberley et al. [22] showed a high yield of anaerobes in patients with lung abscess, but only when the procedure was performed before administration of antibiotic treatment. These observations possibly explain the dearth of bacteriological studies involving patients with lung abscess in recent years. In fact, the majority of patients do well when treated with empirical antibiotics selected on the basis of the presumed bacteriological findings in a fashion that is somewhat analogous to the management of anaerobic infections at other anatomical sites. The report by Wang et al. [21] suggests a potentially important role for other bacteria, especially K. pneumoniae. There have been reports that multiple bacteria are involved in lung abscess, including several studies of K. pneumoniae from the prechemotherapy era [23, 24]. These classic studies from the pretherapeutic era concerned “Friedlander’s bacillus” (K. pneumoniae), which accounted for 50 (1%) of 4416 cases of pneumonia reported by Bullowa [25] at Harlem Hospital in New York City. This organism, like the pneumococcus, was classified serologically in 3 specific types. Most patients had bacteremia, and necrosis with abscess formation was relatively common; most patients had a rapid course of disease, with death occurring by day 4 of hospitalization [25]. In the classic 1939 monograph on pneumonia by Heffron [26], the author notes that lung abscess was rarely or never a complication of pneumococcal pneumonia; instead, he attributed its pathogenesis to “the aspiration of putrefactive organisms into the deeper parts of the respiratory tract” and noted that “the sputum eventually becomes abundant and foul” (p. 605).

There are many organisms that have been implicated as causes of lung abscess. The data summarized above suggest that anaerobes and microaerophilic streptococci account for the majority of organisms. There are several reasons to be somewhat skeptical of the report by Wang et al. [21]:

1. During the period reviewed, there were 336 cases of lung abscess; thus, the 90 reported cases represent just 27% of the total. These were not studied bacteriologically in any randomized fashion, so there may well have been selection bias, particularly if these were the cases that were more serious, rapidly progressive, and/or nonresponsive to standard empirical antibiotic therapy.

2. It was noted that ∼25% of the patients had received antibiotics for >3 days before bacteriological studies were done. It is well established that anaerobic bacteria in lung infections cannot be easily recovered after receipt of any antibiotic treatment.

3. For anaerobic bacteria, the burden of proof is always on the investigator or laboratory that does not find them, simply because they are relatively fastidious bacteria; and culturing them seems to be beyond reach for many or most clinical laboratories.

These concerns aside, this report represents one of the largest studies of lung abscess for which bacteriological studies were performed, and it comes at a time when there are no reports of the bacteriological characteristics of lung abscess. The method used to obtain culture specimens (transthoracic aspiration) is a refreshing change at a time when most clinicians have given up on performing any bacteriological studies in cases of pulmonary infection. In addition, it is noteworthy that 11 of the cases attributed to gram-negative bacilli had blood culture results positive for these organisms, and K. pneumoniae was detected in only 1 patient who had putrid sputum. These are strengths supporting some of the bacteriology conclusions that cannot be ignored.

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References


