Acute Onset of Pneumococcal Pneumonia Following Instrumentation of the Respiratory Tract

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We describe 22 patients who developed pneumococcal pneumonia within 96 hours of respiratory tract instrumentation. In 59% of cases, the time to onset of symptoms was <24 hours. Instrumentation bypasses normal protective barriers and carries organisms directly to the lower airways, leading to the rapid development of pneumonia.

Keywords. postinstrumentation; pneumococcus; pneumonia.

Pneumococcal pneumonia results when pneumococci that colonize the upper respiratory tract are carried to the alveoli replicate and stimulate an inflammatory response. Micro-aspiration of secretions from the nasopharynx in persons who lack antipneumococcal antibody is usually regarded as responsible. We hypothesized that instrumentation of the airways by intubation or bronchoscopy might inoculate Streptococcus pneumoniae directly into the lower airways, leading to the development of pneumococcal pneumonia. We now describe a series of patients who developed pneumococcal pneumonia immediately following respiratory tract instrumentation.

RESULTS

Of 495 patients with pneumococcal pneumonia, 22 (4.4%) developed pneumonia within 96 hours of an invasive procedure involving the respiratory tract: 17 (77.3%) after intubation, 3 (13.6%) after tracheotomy, and 2 (9.1%) after bronchoscopy. Primary indications for the procedure included elective or urgent abdominal surgery (14 cases), cardiopulmonary arrest (2 cases), airway compression (2 cases), neurologic event (1 case), amyotrophic lateral sclerosis (1 case), fungal infection (1 case), and inability to extubate (1 case). The mean age was 62.3 years. The most common comorbid conditions included tobacco use (17 cases, 77.3%), chronic lung disease (7 cases, 31.8%), and congestive heart failure (4 cases, 18.2%) (Table 1). The onset of pneumonia was within the first 24 hours postprocedure in 59.1% of cases and the first 48 hours in 81.8% of cases.

In accordance with definitions accepted by the US Centers for Disease Control and Prevention, 1 patient had proven pneumococcal pneumonia (blood culture positive), and 21 had presumptive pneumococcal pneumonia (organism identified by sputum Gram stain and culture or by finding pneumococcal antigen in urine). All patients initially received empiric antibiotic therapy for hospital-acquired pneumonia. In 15 cases

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In this report, we describe a group of patients who developed pneumococcal pneumonia immediately following instrumentation of the lower respiratory tract. *Streptococcus pneumoniae* colonizes the upper respiratory tract in 5%–10% of healthy adults. Instrumentation bypasses normal protective barriers and carries organisms from the upper directly to the lower airways, which may lead to pneumonia. Although colonization normally stimulates production of protective antibody [1], colonization may have been so recent that antibody had not yet been produced. Some individuals are unable to respond to capsular polysaccharides with appropriate production of antcapsular IgG [2]. In the patients we describe, instrumentation served to inoculate virulent bacteria directly into the lower airways of susceptible subjects. The acuteness of onset of pneumonia in our cases is consistent with this hypothesis. The median time from the procedure to the onset of symptoms or signs of pneumonia was 24 hours, reflecting the introduction of a potentially infective bacterium directly into the lower airways. The majority of patients described herein do not meet standard accepted definitions for nosocomial pneumonia, but physicians would be rightly reluctant to label them community acquired, hence our preference for the term postinstrumentation pneumonia.

Pneumococcal pneumonia has been recognized in hospitalized patients [3–10], and outbreaks have been described [11, 12]. Kollef et al. [3] reported these infections in postsurgical cases, and in a table of predisposing conditions, Bouza et al. [6] showed that about one-third of their patients with nosocomial pneumococcal pneumonia had previously had intubation or bronchoscopy, but neither group commented further on the closeness of the association or the possibility of a direct relation between the respiratory tract instrumentation and the pneumonia. Both Rello et al. [13] and Lowy et al. [14] described postintubation pneumococcal pneumonia, but their cohorts included patients intubated emergently for respiratory failure; thus, it is unclear to what extent pneumonia was a cause of intubation and to what extent it was a result of intubation. When hospitalized patients develop pneumonia, Gram-negative bacteria and/or *Staphylococcus aureus* are considered the usual causes, and broad-spectrum antibiotic therapy is begun empirically. In our patients, this approach was usually followed once pneumonia was recognized. In nearly one-third of cases, however, antibiotic treatment was not de-escalated appropriately after culture results demonstrated pneumococcus as the etiology.

Limitations of the present study include the absence of information on how many patients at our medical center undergo instrumentation of the respiratory tract each year. It is likely that there are additional cases of postinstrumentation pneumococcal pneumonia in which pneumococcus is not recognized because appropriate studies are not done, but for which empiric antibiotic treatment is given.

**Table 1. Patient Characteristics**

| Age, y    |          |          |
|-----------|----------|----------|
| <60       | 9 (40.9%)|          |
| >60       | 13 (59.1%)|         |

| Sex       |          |          |
|-----------|----------|----------|
| Male      | 21 (95.5%)|          |
| Female    | 1 (4.5%) |          |

| Comorbidities       |          |          |
|---------------------|----------|----------|
| Liver disease       | 3 (13.6%)|          |
| Kidney disease      | 1 (4.5%) |          |
| Uncontrolled diabetes| 1 (4.5%)|          |
| Congestive heart failure | 4 (18.2%)|          |
| Chronic lung disease| 7 (31.8%)|          |
| Immunosuppression   | 0 (0.0%) |          |
| Tobacco use         | 17 (77.3%)|         |
| Alcohol use         | 3 (13.6%)|          |
| Drug use            | 3 (13.6%)|          |

| Procedure type |          |          |
|---------------|----------|----------|
| Intubation    | 17 (72.3%)|         |
| Tracheotomy   | 3 (13.6%)|          |
| Bronchoscopy  | 2 (9.1%) |          |

| Time to onset, h |          |          |
|-----------------|----------|----------|
| <24             | 13 (59.1%)|         |
| 24–48           | 5 (22.7%) |          |
| 48–72           | 2 (9.1%) |          |
| 72–96           | 2 (9.1%) |          |

DISCUSSION

(68.2%), antibiotics were appropriately de-escalated after cultures yielded *S. pneumoniae*. Twenty-one patients recovered and were discharged; 1 died in the hospital from unrelated causes 20 days after diagnosis. Three of the patients developed pneumococcal pneumonia while receiving antibiotics: cefazolin, ertapenem, and gatifloxacin, respectively. In the first case, the infecting organism was resistant to penicillin and intermediately resistant to cefotaxime. In the second, the organism was intermediately resistant to penicillin but susceptible to cefotaxime. In the third, the organism was penicillin susceptible; susceptibility to a quinolone was not tested.

In this case series, physicians tended, initially, to attribute clinical signs of infection to a condition other than pneumonia; commonly implicated causes included the condition that led to instrumentation, a surgical site infection, or a urinary tract infection. In the case of the patient who developed pneumonia while on cefazolin, the treatment regimen was not changed until the results of antibiotic susceptibility testing were available. In 2 other cases, patients were treated with ciprofloxacin, but it appeared as if pneumonia was never suspected.

Of 22 patients with postinstrumentation pneumococcal pneumonia, 11 (50.0%) had received pneumococcal capsular polysaccharide vaccine, 8 (36.4%) within the preceding 5 years. This compares to 353 of 473 (74.6%) vaccinated patients whose pneumococcal pneumonia developed in the absence of respiratory tract instrumentation.

When hospitalized patients develop pneumonia, Gram-negative bacteria and/or *Staphylococcus aureus* are considered the usual causes, and broad-spectrum antibiotic therapy is begun empirically. In our patients, this approach was usually followed once pneumonia was recognized. In nearly one-third of cases, however, antibiotic treatment was not de-escalated appropriately after culture results demonstrated pneumococcus as the etiology.
In conclusion, we describe a series of cases in which pneumococcal pneumonia occurred within 96 hours of instrumentation of the respiratory tract. The median time of onset of symptoms was 1 day. Instrumentation bypasses normal protective barriers and may carry organisms from the upper to the lower airways, leading to the rapid development of pneumonia in a nonimmune host. Pneumonia should be considered a complication of airway instrumentation, and pneumococcus should be regarded a possible cause.

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