BRIEF OBSERVATION

THE AMERICAN JOURNAL of MEDICINE®

Incidence and Outcomes of Ventilator-associated Tracheobronchitis and Pneumonia

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ABSTRACT

BACKGROUND: Prolonged intubation with mechanical ventilation carries a risk for ventilator-associated respiratory infections manifest as tracheobronchitis or pneumonia. This study analyzed natural history, incidence, and outcomes of patients developing ventilator-associated tracheobronchitis and pneumonia.

METHODS: We studied 188 mixed intensive care unit (ICU) patients intubated ≥48 hours for the development of tracheobronchitis defined as quantitative endotracheal aspirate $\geq 10^5$ cfu/mL plus at least 2 clinical criteria (fever, leukocytosis, or purulent sputum). Pneumonia was defined as microbiologic criteria for tracheobronchitis and a new and persistent infiltrate on chest radiograph.

RESULTS: Airways of 41 (22%) patients became heavily colonized with a bacterial pathogen(s) at a concentration of $\geq 10^5$ cfu/mL. Tracheobronchitis developed in 21 (11%) study patients, of which 6 (29%) later progressed to pneumonia. Including these 6 patients, 28 (15%) study patients developed pneumonia. Multidrug-resistant pathogens were isolated in 39% of pneumonia patients. Patients with tracheobronchitis and pneumonia had significantly more ventilator days and longer stays in the ICU ($P \leq .02$).

CONCLUSIONS: Approximately one third of tracheobronchitis patients later developed pneumonia. Patients with tracheobronchitis or pneumonia experienced significantly more ventilator days and longer ICU stays, but had no difference in mortality. Better patient outcomes and reduced health care costs may be achieved by earlier treatment of ventilator-associated respiratory infections, manifest as tracheobronchitis or pneumonia.

 • *The American Journal of Medicine (2013) 126, 542-549*

KEYWORDS: Ventilator-associated pneumonia (VAP); Ventilator-associated tracheobronchitis (VAT); Ventilator-associated respiratory infections (VARI); Outcomes of ventilator-associated respiratory infections; Prevention of VAP; Diagnosis of VAT and VAP

Mechanically ventilated patients are at high risk for bacterial colonization that may progress to ventilator-associated respiratory infection, manifested as tracheobronchitis or pneumonia.[1-10] Bacteria may enter the lower respiratory tract at the time of intubation, by leakage around the endotracheal tube cuff, or from bacterial biofilms colonizing the endotracheal tube lumen.[1,2,5] Progression to tracheobronchial colonization, tracheobronchitis, and pneumonia depends on the pathogenicity of the invading pathogen and the effectiveness of host immune defenses.

Funding: This study was funded by the Lahey Clinic, the Wise Foundation, and a grant from Pfizer Pharmaceuticals.

Conflict of Interest: DEC has received grant support from the Wise Foundation, the Lahey Clinic, and Pfizer Pharmaceuticals and is on the Speakers' Bureaus of Merck, Covidien, Sanofi-Pasteur, and Pfizer. All other authors report no potential conflicts of interest.

Authorship: All authors had access to the data and played a role in writing this manuscript.

Abstracts of these data were presented at the 49th Annual Meeting of the Infectious Disease Society of America, Boston, MA, October 2011; the 50th Annual Meeting of the Infectious Disease Society of America, San Diego, CA, October 17, 2012; and the American Society of Chest Physicians, Honolulu, HI, October 2011.

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0002-9343/$ -see front matter
http://dx.doi.org/10.1016/j.amjmed.2012.12.012

Timely and accurate diagnosis of pneumonia is of critical importance to initiate early antibiotic therapy, improve patient outcomes, and reduce associated health care costs.[1,2,11-16] Unfortunately, there is no currently accepted "gold standard" for the diagnosis of ventilator-associated pneumonia.[2,11,15,16] Several different clinical and microbiological criteria have been used to diagnose ventilator-associated tracheobronchitis and pneumonia.[6,17,18] Some clinicians rely on endotracheal tube aspirates (ETA) analyzed by either semi-quantitative (SQ-ETA) or quantitative (Q-ETA) methods to diagnose ventilator-associated tracheobronchitis and pneumonia. Others have used invasive diagnostic methods, such as bronchoscopic or nonbronchoscopic bronchoalveolar lavage, or protected specimen brush samples to diagnose ventilator-associated pneumonia. It is important to emphasize that pneumonia and tracheobronchitis may overlap in terms of microbiologic ETA criteria and clinical signs, and differ only by the presence or absence of new infiltrate on chest radiograph.[5,6,19] However, a new infiltrate on chest radiograph may be delayed, nonspecific, or represent noninfectious conditions.[5,6,19] Shorr et al[16] reviewed 4 randomized, controlled trials and concluded that invasive diagnosis of pneumonia did not alter mortality, but decreased antibiotic use when compared with noninvasive ETA diagnosis. However, an extensive review of different diagnostic criteria for pneumonia by Rea-Neto et al[11] and others concluded that there was no difference in mortality or other patient outcomes when using invasive methods versus endotracheal aspirates.[12,20]

Limited data are available on the natural history, incidence, and outcomes of patients who develop heavy tracheal colonization and subsequent progression of tracheobronchitis to pneumonia.[3,4,7,21,22] Several studies suggest that tracheobronchitis is a precursor to pneumonia, and that treatment of tracheobronchitis can prevent pneumonia and improve patient outcomes.[3,4,7,10,21] Debate continues on the relative importance of tracheobronchitis, and the definitive microbiologic criteria needed for diagnosis and therapy.[6-8,23] Different Q-ETA and SQ-ETA thresholds have been used to define heavy colonization, tracheobronchitis, and pneumonia.[3,12,16,17,24-26]

The purpose of this study was to examine the incidence and clinical outcomes of heavy colonization, tracheobronchitis, and pneumonia in medical and surgical intensive care unit (ICU) patients. Clinical outcomes included duration of mechanical ventilation and length of stay in the ICU and hospital, as well as mortality rates.

CLINICAL SIGNIFICANCE

- Data revealed a ventilator-associated tracheobronchitis rate of 11%, pneumonia rate of 15%, and the rate of tracheobronchitis that progressed to pneumonia was 29%.
- Clinical outcomes, including intubation days and length of stay in the intensive care unit were significantly increased in ventilated patients who developed heavy colonization, tracheobronchitis, and pneumonia. But the mortality was not increased in these 3 groups of patients.

METHODS

Study Population and Data Collection

Our study was conducted from May 3 to December 23, 2010 in 2 medical ICUs (12 and 8 beds) and one surgical ICU (18 beds). All patients ≥18 years of age, intubated, and mechanically ventilated ≥48 hours were consecutively enrolled in the study. Endotracheal aspirates were collected daily when clinically indicated. Patients exited the study at time of extubation, tracheostomy, death, or when comfort measures only were used.

The research protocol was approved by the Lahey Clinic Institutional Review Board. Initial clinical screening for enrollment was done by the research assistants, who also collected demographic data and clinical information. Chest radiographs of patients with microbiologic criteria for tracheobronchitis and pneumonia were evaluated for the presence of new or increasing infiltrate by one of the authors (AS) and compared with the official radiology report. In case of disagreement, 3 investigators (AS, JH, DC) reviewed films again and decided on the final reading. Treating physicians were not aware of the study results, and study data were not entered into the patient's medical record.

Microbiologic Methods

Study ETA samples were coded and sent to the microbiology laboratory for Gram stain and culture. Gram stains were examined for the presence of polymorphonuclear leukocytes per low power field and numbers of bacteria per high power field using a scale from 0 to many (++++) for both. Q-ETA samples were initially treated with Mucomyst (n-acetyl cysteine; American Regent, Shirley, NY) and vortexed to dissolve mucous. Q-ETA samples with growth of a pathogen at a concentration of Q-ETA $\geq 10^5$ cfu/mL were considered heavy colonization. Patients with Q-ETA $< 10^5$ cfu/mL were regarded as insignificant colonization.

Diagnosis of Tracheobronchitis and Pneumonia

The diagnosis of tracheobronchitis required heavy tracheal colonization, as defined above, plus at least 2 of 3 clinical signs of infection: temperature ≥38°C or ≤36°C, leukocytosis ≥12,000/mm^3, or purulent sputum. Purulent sputum was defined as a Gram stain with moderate (+++) or many (++++) bacteria/high power microscopic field and moderate (+++) or many (++++) polymorphonuclear leukocytes.[4,5,8]