

Epidemiology and Outcomes of Health-care–Associated Pneumonia*

Results From a Large US Database of Culture-Positive Pneumonia

Marin H. Kollef, MD, FCCP; Andrew Shorr, MD, MPH, FCCP;
Ying P. Tabak, PhD; Vikas Gupta, PharmD, BCPS; Larry Z. Liu, MD, PhD; and
R. S. Johannes, MD, MS

Context: Traditionally, pneumonia developing in patients outside the hospital is categorized as community acquired, even if these patients have been receiving health care in an outpatient facility. Accumulating evidence suggests that health-care–associated infections are distinct from those that are truly community acquired.

Objective: To characterize the microbiology and outcomes among patients with culture-positive community-acquired pneumonia (CAP), health-care–associated pneumonia (HCAP), hospital-acquired pneumonia (HAP), and ventilator-associated pneumonia (VAP).

Design and setting: A retrospective cohort study based on a large US inpatient database.

Patients: A total of 4,543 patients with culture-positive pneumonia admitted into 59 US hospitals between January 1, 2002, and December 31, 2003, and recorded in a large, multi-institutional database of US acute-care hospitals (Cardinal Health-Atlas Research Database; Cardinal Health Clinical Knowledge Services; Marlborough, MA).

Main measures: Culture data (respiratory and blood), in-hospital mortality, length of hospital stay (LOS), and billed hospital charges.

Results: Approximately one half of hospitalized patients with pneumonia had CAP, and > 20% had HCAP. *Staphylococcus aureus* was a major pathogen in all pneumonia types, with its occurrence markedly higher in the non-CAP groups than in the CAP group. Mortality rates associated with HCAP (19.8%) and HAP (18.8%) were comparable ($p > 0.05$), and both were significantly higher than that for CAP (10%, all $p < 0.0001$) and lower than that for VAP (29.3%, all $p < 0.0001$). Mean LOS varied significantly with pneumonia category (in order of ascending values: CAP, HCAP, HAP, and VAP; all $p < 0.0001$). Similarly, mean hospital charge varied significantly with pneumonia category (in order of ascending value: CAP, HCAP, HAP, and VAP; all $p < 0.0001$).

Conclusions: The present analysis justified HCAP as a new category of pneumonia. *S aureus* was a major pathogen of all pneumonias with higher rates in non-CAP pneumonias. Compared with CAP, non-CAP was associated with more severe disease, higher mortality rate, greater LOS, and increased cost. (CHEST 2005; 128:3854–3862)

Key words: community acquired; epidemiology; health care; mechanical ventilation; mortality; nosocomial; outcomes; pneumonia; resource use

Abbreviations: ASG = admission severity group; CAP = community-acquired pneumonia; CI = confidence interval; HAP = hospital-acquired pneumonia; HCAP = health-care–associated pneumonia; ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification; LOS = length of hospital stay; MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-susceptible *Staphylococcus aureus*; NP = nosocomial pneumonia; OR = odds ratio; VAP = ventilator-assisted pneumonia

Pneumonia is often classified as either community acquired or nosocomial, depending on whether the infection developed while the patient was in an outpatient setting or in an inpatient setting.¹ Nosocomial pneumonia (NP) is further differentiated into ventilator-associated pneumonia (VAP) if the process arose after the patient had been receiving at least 24 h of mechanical ventilation.^{2,3} This classification

scheme reflects differences in the pathogens responsible for these infections and forms the basis for treatment decisions and antibiotic selections. For example, *Streptococcus pneumoniae* is a common cause of community-acquired pneumonia (CAP)^{4,5} but is infrequently implicated in VAP.^{3,6} Similarly, many empiric regimens for VAP include antimicrobials active against *Pseudomonas aeruginosa*, as this

is regularly recovered from patients with VAP⁷ but is rarely seen in outpatients with CAP.

Despite the popularity of this dichotomous classification scheme for pneumonia, recent evidence⁸⁻¹⁰

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indicates that this system may have significant limitations. Specifically, health care now reflects a continuum of care with many traditional inpatient services provided in outpatient settings. Invasive medical therapies are now routinely administered in nursing homes and rehabilitation hospitals, and many surgeries are performed in outpatient-based surgical centers. Additionally, some patients regularly utilize significant medical resources and transition from the hospital to a subacute care facility but are then soon thereafter return to the hospital, never truly residing in the "community." In each of these instances and despite the close link to traditional inpatient care, physicians often categorize new infections in such subjects as "community acquired."¹¹ Data indicate, however, that these health-care-associated infections have a unique epidemiology and that the pathogens causing and the outcomes related to these infections more closely resemble those seen with nosocomial processes.^{8,11-13} Some experts^{8,11,14} advocate creating a new class of "health-care-associated" infection. Clarifying the epidemiology of these health-care-associated infections generally, and of health-care-associated pneumonia (HCAP) specifically, is crucial to efforts to design appropriate empiric antimicrobial treatment guidelines.

Accumulating evidence pointing to the potentially significant impact of HCAP results in the very recent recognition of HCAP by the American Thoracic Society and the Infectious Diseases Society of America.^{15,16} However, to date, no multi-institutional data exist describing the epidemiology and microbiology of HCAP. Additionally, prior work on this topic has been limited to observations coming from mainly large, academic teaching hospitals. Therefore, to

better characterize HCAP and to compare it with CAP, hospital-acquired pneumonia (HAP), and VAP, we retrospectively analyzed the records of patients with culture-positive pneumonia registered in a large US database between January 1, 2002, and December 31, 2003. We hypothesized that HCAP would represent a distinct clinical entity, with the pathogens recovered more closely resembling those seen in HAP and VAP. We also sought to determine if HCAP was clinically distinct from these other types of pneumonia and to assess the economic impact of HCAP.

MATERIALS AND METHODS

Study Design

A retrospective cohort analysis was performed to characterize the epidemiology, microbiology, and clinical/economic outcomes of patients with culture-positive CAP, HCAP, HAP, and VAP in the first 5 days of hospital admission. Data were obtained for all patients with pneumonia admitted to 59 US hospitals between January 1, 2002, and December 31, 2003.

Data Source

Data for the present analysis were obtained from a large, multi-institutional database of US acute-care hospitals, the Atlas database (Cardinal Health-Atlas Research Database; Cardinal Health Clinical Knowledge Services; formerly MedisGroup; Marlborough, MA).² Details of this database were published previously.^{2,17-19} Briefly, Cardinal Health Clinical Knowledge Services develops the Atlas software and distributes it to acute-care hospitals in the United States for the collection and analysis of detailed clinical and administrative data. As the largest database of its kind, the Atlas database collects information on approximately 950,000 inpatient admissions to > 200 US acute-care hospitals annually. Hospitals included in the database are similar in bed size to American Hospital Association-member hospitals.

The Atlas database registers patient demographics, admission source, type of ICU, all documented procedure and diagnosis codes (International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]), admission and discharge dates for each stay in the ICU, total length of hospital stay (LOS) in hospital, billed total and ancillary hospital charges, discharge disposition, specific interventions received, and information on > 400 key clinical findings,^{2,20} including clinical history and pathophysiologic findings, such as vital signs, laboratory test results, culture findings, and physician assessments. During the study period from January 1, 2002, to December 31, 2003, a total of 162 hospitals in the Atlas database met the data quality criteria for inclusion, of which 59 hospitals (16 teaching hospitals and 43 nonteaching hospitals) collected clinical and culture data for the first 5 days of patient hospitalization and were included for the present study.

Sample Populations

Pneumonia was defined by the presence of either primary or secondary ICD-9-CM codes indicative of pneumonia and a concomitant positive respiratory bacterial culture. The study

*From the Pulmonary and Critical Care Division (Dr. Kollef), Washington University School of Medicine, St. Louis, MO; Pulmonary and Critical Care Medicine Service (Dr. Shorr), Walter Reed Army Medical Center, Washington, DC; Cardinal Health Clinical Knowledge Services Research Group (Drs. Tabak, Gupta, and Johannes), Marlborough, MA; and Pfizer Inc. (Dr. Liu), New York, NY.

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Correspondence to: Marin H. Kollef, MD, FCCP, Campus Box 8052, Washington University School of Medicine, 660 South Euclid Ave, St. Louis, MO 63110; e-mail: mkollef@im.wustl.edu

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