

# In-Hospital Deaths Among Adults With Community-Acquired Pneumonia

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**BACKGROUND:** Adults hospitalized with community-acquired pneumonia (CAP) are at high risk for short-term mortality. However, it is unclear whether improvements in in-hospital pneumonia care could substantially lower this risk. We extensively reviewed all in-hospital deaths in a large prospective CAP study to assess the cause of each death and assess the extent of potentially preventable mortality.

**METHODS:** We enrolled adults hospitalized with CAP at five tertiary-care hospitals in the United States. Five physician investigators reviewed the medical record and study database for each patient who died to identify the cause of death, the contribution of CAP to death, and any preventable factors potentially contributing to death.

**RESULTS:** Among 2,320 enrolled patients, 52 (2.2%) died during initial hospitalization. Among these 52 patients, 33 (63.4%) were  $\geq 65$  years old, and 32 (61.5%) had  $\geq$  two chronic comorbidities. CAP was judged to be the direct cause of death in 27 patients (51.9%). Ten patients (19.2%) had do-not-resuscitate orders prior to admission. Four patients were identified in whom a lapse in quality of care potentially contributed to death; preexisting end-of-life limitations were present in two of these patients. Two patients seeking full medical care experienced a lapse in in-hospital quality of pneumonia care that potentially contributed to death.

**CONCLUSIONS:** In this study of adults with CAP at tertiary-care hospitals with a low mortality rate, most in-hospital deaths did not appear to be preventable with improvements in in-hospital pneumonia care. Preexisting end-of-life limitations in care, advanced age, and high comorbidity burden were common among those who died. CHEST 2018; ■(■):■-■

**KEY WORDS:** mortality; pneumonia; quality of care

**ABBREVIATIONS:** CAP = community-acquired pneumonia; DNR = do not resuscitate; EPIC = Etiology of Pneumonia in the Community; IRB = institutional review board

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As a frequent cause of hospitalization and mortality, community-acquired pneumonia (CAP) has received significant attention from physicians, researchers, payers, and regulators.<sup>1-7</sup> Understanding the circumstances in which patients with CAP die could facilitate improvements in the treatment of CAP by enabling future improvement efforts to focus on common preventable causes of death.

However, it is unclear whether improvements in in-hospital pneumonia care delivered to patients after they have received a diagnosis of CAP and been hospitalized could substantially reduce mortality in hospitals in the United States. Prior studies suggest

## Methods

This analysis was a secondary analysis of the Etiology of Pneumonia in the Community (EPIC) study funded by the Centers for Disease Control and Prevention.<sup>16</sup> Adults hospitalized with CAP between January 2010 and June 2012 were enrolled at five tertiary-care hospitals, including three in Chicago (John H. Stroger, Jr. Hospital of Cook County, Northwestern Memorial Hospital, Rush University Medical Center) and two in Nashville (University of Tennessee Health Science Center-Saint Thomas Health, Vanderbilt University Medical Center). Institutional review board (IRB) approval was obtained at each site. IRB protocol numbers were as follows: Cook County, #09-163; Northwestern, #STU00019685; Rush, #09102105; Sterling IRB for Saint Thomas Health, #3476-001; and Vanderbilt, #091422. Written informed consent for study participation was obtained from each patient or an authorized representative.

Patient inclusion and exclusion criteria for the EPIC study have been described previously.<sup>16</sup> Major inclusion criteria included clinical features of acute respiratory infection on hospital presentation, a chest radiograph or CT scan consistent with pneumonia, and hospital admission. Major exclusion criteria included recent hospitalization (< 28 days for immunocompetent patients and < 90 days for immunosuppressed patients), tracheotomy, gastric tube, cystic fibrosis, cancer with neutropenia, solid organ or stem cell transplantation in the prior 90 days, active graft-versus-host disease, bronchiolitis obliterans, and HIV infection with a CD4 cell count < 200/mm<sup>3</sup>. The EPIC study had no interventional component. Additional blood, urine, and respiratory specimens were collected to perform microbiologic diagnostic testing for research purposes; these results were not available to treating physicians. All patient treatment decisions were at the discretion of the treating physicians.

Using the EPIC study data set, we first assessed the clinical characteristics of patients who died in the hospital, and compared them with those of patients who survived to hospital discharge. For these comparisons, the following comorbidities were considered severe chronic comorbidities based on their association with increased mortality and ICU admission in previously developed CAP severity scores<sup>17,18</sup>: chronic heart failure, COPD, coronary artery disease, chronic kidney disease, chronic liver disease, cerebrovascular disease, cancer (not including skin cancer), and diabetes mellitus. The rank-sum test and  $\chi^2$  test were used for comparisons of continuous and dichotomous data, respectively.

that one-half of deaths among patients hospitalized with pneumonia are caused by nonpneumonia illnesses, and mortality is strongly associated with preexisting comorbid illnesses<sup>8-15</sup>; hence, many of these deaths may not be preventable with improved adherence to current standards for acute pneumonia care. These prior studies were limited by small sample sizes, specific geographic regions, and retrospective designs.<sup>8-15</sup> Therefore, to further understand why patients admitted with CAP die in the hospital, we evaluated all in-hospital deaths in a large, population-based, prospective study of CAP in the United States to determine the cause of each death and the extent of preventable mortality.

In addition, the medical record and EPIC study database of each patient who died during the index CAP hospitalization were reviewed by a panel of five physician investigators at each study city with subspecialty expertise in pulmonary, critical care, infectious disease, and emergency medicine. Cause of death was assigned by the review panel according to criteria developed a priori on the basis of previously published trials.<sup>8,19,20</sup> Each panelist reviewed cases with a standardized case report form that included these criteria (e-Appendix 1).

The following causes of death were considered directly related to CAP: septic shock, respiratory failure, multisystem organ failure, cardiopulmonary arrest prior to stabilization of CAP, and endocarditis (e-Appendix 1). The following causes of death were considered indirectly related to CAP: acute cardiovascular disease, stroke, acute renal failure, and secondary infections that developed after hospitalization. Causes of death indirectly related to CAP were further classified as CAP having a major or minor contribution to death. A major contribution indicated death would likely not have occurred without pneumonia, for example, a patient admitted with CAP who developed a myocardial infarction during the acute inflammatory phase of pneumonia and subsequently died of cardiac ischemia. A minor contribution indicated CAP was the primary reason for initial hospitalization but death was due to a cardiovascular, renal, or infectious event not immediately related to pneumonia, for example, a patient admitted with CAP who had a urinary catheter placed and then subsequently developed a catheter-associated urinary tract infection and died of urosepsis. Other causes of death, such as cancer, cirrhosis, and chronic neurologic conditions, were considered unrelated to CAP (e-Appendix 1).

Patient medical records were also systematically examined to determine whether treatment was consistent with current recommendations in quality-of-care metrics, including antibiotics consistent with the guidelines published by the Infectious Diseases Society of America (IDSA) and American Thoracic Society (ATS),<sup>21</sup> antibiotics delivered within 6 h of presentation in the absence of shock and within 1 h in the presence of shock, and assessment of oxygenation by pulse oximetry or arterial blood gas analysis.

End-of-life limitations in care were also gathered by medical records review. An end-of-life limitation in care was defined as decisions by the patient and/or family to forego full medical treatment; this included do-not-resuscitate (DNR) orders, do-not-intubate (DNI) orders, as well as decisions to forego ICU admission or transfer, invasive procedures, or antibiotics.

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