CLINICAL RESEARCH STUDY

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Incidence of *Pseudomonas aeruginosa* Bacteremia: A Population-Based Study

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ABSTRACT

BACKGROUND: The incidence of *Pseudomonas aeruginosa* bacteremia has not been defined in a population-based investigation.

METHODS: We performed a retrospective, population-based incidence study using resources of the Rochester Epidemiology Project of Olmsted County, Minnesota. We identified all Olmsted County residents with *P. aeruginosa* bacteremia between January 1, 1997, and December 31, 2006, by microbiology records in the only 2 laboratories in the county. Medical records were reviewed to confirm diagnosis, residency status, and clinical characteristics.

RESULTS: Age-adjusted incidence per 100,000 person-years was 10.8 (95% confidence interval [CI], 7.5-14.0) in men and 3.7 (95% CI, 2.2-5.2) in women for total *P. aeruginosa* bacteremia, and 8.4 (95% CI, 5.5-11.2) in men and 2.5 (95% CI, 1.3-3.8) in women for monomicrobial *P. aeruginosa* bacteremia. There was no significant change in incidence of total *P. aeruginosa* bacteremia during the past decade ($P = .418$). Incidence increased exponentially with age, with a greater magnitude of increase in men compared with women for total and monomicrobial *P. aeruginosa* bacteremia ($P = .007$ and $P = .015$, respectively). In patients with monomicrobial *P. aeruginosa* bacteremia, the median age was 69 years, and 78.4% of cases were either nosocomial or health care associated. Most patients had multiple comorbid conditions. The urinary tract was the most common primary source of infection. The 28-day all-cause mortality of monomicrobial *P. aeruginosa* bacteremia was 25.5%. In vitro susceptibility to ciprofloxacin was 95.3%.

CONCLUSION: To our knowledge, this is the first population-based incidence study of *P. aeruginosa* bacteremia. The incidence of *P. aeruginosa* bacteremia has remained stable during the past decade. Fluoroquinolone susceptibility is high among local *P. aeruginosa* bacteremia isolates.

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KEYWORDS: Antibiotic susceptibility; Bacteremia; Epidemiology; Mortality; *Pseudomonas aeruginosa*

The incidence of *Pseudomonas aeruginosa* bacteremia has never been defined in a population-based investigation.[1] Data that address *P. aeruginosa* bacteremia incidence are, for the most part, derived from cross-sectional studies that have been performed at large tertiary care centers where referral bias is a major limitation. *P. aeruginosa* is the third most common gram-negative pathogen causing bloodstream infections. Estimates from a cross-sectional study performed in tertiary care centers in North and Latin America published by the SENTRY Antimicrobial Surveillance Program showed that *P. aeruginosa* contributed to 10.6% of gram-negative nosocomial and community-acquired bloodstream infections in 1997.[2]

Increasing resistance of *P. aeruginosa* to fluoroquinolones and other antimicrobial agents has greatly affected management decisions in patients with this infection. Oral therapy is no longer a treatment option in many patients, and in others, there might be no safe and active parenterally ad-

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There are no conflicts of interest for any of the authors. MNA had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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ministered antibiotic available for use. It is estimated that resistance to ciprofloxacin in *P. aeruginosa* blood isolates in intensive care units in this country has increased from 9% to 31.7% between 1995 and 2002.[3] With the increasing use of newer fluoroquinolones, resistance is expected to continue to increase. In one investigation, exposure to levofloxacin was associated with increased risk of isolation of fluoroquinolone-resistant *P. aeruginosa*.[4]

The aims of this study are to establish the incidence, certain clinical characteristics, short- and long-term outcomes, and in vitro antibiotic susceptibility patterns of *P. aeruginosa* bacteremia in patients from Olmsted County, Minnesota. To our knowledge, our work is the first incidence investigation of *P. aeruginosa* bacteremia and fluoroquinolone-resistant *P. aeruginosa* bacteremia in a population-based setting.

CLINICAL SIGNIFICANCE

- Monomicrobial *Pseudomonas aeruginosa* bacteremia is relatively uncommon with an age- and gender-adjusted incidence of 4.7 per 100,000 person-years.
- Monomicrobial *P. aeruginosa* bacteremia is more likely to be community acquired in patients aged 70 years or more compared with those aged less than 70 years (40% vs 3.8%, $P = .007$).
- The in vitro susceptibility of *P. aeruginosa* bacteremia isolates to ciprofloxacin is high (95.3%) in this population-based study.

MATERIALS AND METHODS

Setting

Olmsted County is located in southeastern Minnesota, with a population of 124,277 according to the 2000 census.[5] With the exception of a lower prevalence of injection drug use, a higher prevalence of middle-class individuals, and a higher proportion being employed in the health-care industry, the population characteristics of Olmsted County residents are similar to those of US non-Hispanic whites.[6,7] The Rochester Epidemiology Project is a unique medical records-linkage system that encompasses care delivered to residents of Rochester and Olmsted County, Minnesota. The microbiology laboratories at Mayo Medical Center and Olmsted Medical Center are the only 2 laboratories in Olmsted County. These 2 medical centers are geographically isolated from other urban centers. The closest competing medical centers are in Minneapolis, Minnesota (139 km to the north), La Crosse, Wisconsin (114 km to the east), Iowa City and Des Moines, Iowa (317 and 333 km to the south, respectively), and Sioux Falls, South Dakota (376 km to the west). Although best known as a tertiary referral center, Mayo Clinic has always provided primary, secondary, and tertiary care to local residents. Because the Mayo and Olmsted Medical Centers offer care in every medical and surgical specialty and subspecialty, local residents are able to obtain health care within the community, rather than seeking health care at a distant geographic location.[6,8]

Case Ascertainment

A population-based retrospective cohort with *P. aeruginosa* bacteremia from January 1, 1997, to December 31, 2006, was identified using the microbiology databases at the Mayo Medical Center Rochester and Olmsted Medical Center. We used complete enumeration of the population of Olmsted County, Minnesota. All patients with positive blood cultures for *Pseudomonas* species during the study period were considered for inclusion, regardless of age, gender, or whether they were hospitalized or in the ambulatory care setting at the time of bacteremia. Among 5268 episodes of gram-negative bacteremia identified in both clinical microbiology laboratories during the study period, 742 (14.1%) and 656 (12.5%) were due to *Pseudomonas* species and *P. aeruginosa*, respectively. Patients with an initial episode of *P. aeruginosa* bacteremia were included for analysis; patients without valid research authorization (n = 10), who lived outside Olmsted County (n = 574), or with recurrent *P. aeruginosa* bacteremia (n = 3) were excluded. Medical records were reviewed by the primary investigator (MNA) to confirm the diagnosis, determine patient residency status, and obtain baseline clinical features, outcome, and isolate in vitro susceptibility data. Patients were followed from the time of the initial episode of *P. aeruginosa* bacteremia until the latest health care encounter; long-term follow-up was available through the Rochester Epidemiology Project.

Case Definition

P. aeruginosa bacteremia was defined as growth of *P. aeruginosa* in a blood culture. Monomicrobial *P. aeruginosa* bacteremia was defined as growth of *P. aeruginosa* as the only isolate in a blood culture and polymicrobial *P. aeruginosa* bacteremia as the growth of *P. aeruginosa* and other organisms in a blood culture, excluding coagulase-negative staphylococci and *Propionibacterium* spp. The term "total *P. aeruginosa* bacteremia" was used to describe cases of both monomicrobial and polymicrobial *P. aeruginosa* bacteremia combined. Recurrent *P. aeruginosa* bacteremia was defined as *P. aeruginosa* bacteremia occurring 90 days after the initial episode of *P. aeruginosa* bacteremia. Cases of *P. aeruginosa* bacteremia were classified into community acquired, health care associated, or nosocomial.[9] Blood cultures were identified using standard microbiology techniques according to the Clinical and Laboratory Standards Institute. Both laboratories are certified by the College of American Pathologists. Clinical and Laboratory Standards Institute methods were used to evaluate in vitro antibiotic susceptibility results of *P. aeruginosa* isolates.