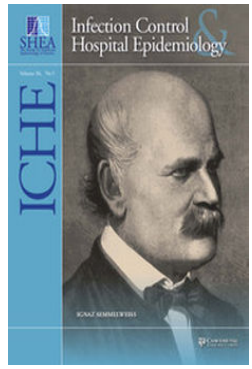

Rates of Hospital-Associated Respiratory Infections and Associated Pathogens in a Regional Burn Center, 2008–2012

Anne M. Lachiewicz, David van Duin, Lauren M. DiBiase, Samuel W. Jones, Shannon Carson, William A. Rutala, Bruce A. Cairns and David J. Weber

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RESEARCH BRIEFS

Rates of Hospital-Associated Respiratory Infections and Associated Pathogens in a Regional Burn Center, 2008–2012

Each year in the United States, medical care is sought for ~450,000 burn injuries, but limited data are available regarding burn infections.[1] The most frequent clinically related complication among acute burn admissions reported in the National Burn Repository is pneumonia, which occurs in 5.8% of fire-/flame-injured patients.[2] However, reporting infectious complications to the National Burn Repository is optional, and this database lacks a standard pneumonia definition. Inhalation injury, the immunological response to burn injury, and the need for prolonged mechanical ventilation place burn intensive care unit (BICU) patients at extremely high risk for pneumonia.[3] We performed a retrospective cohort analysis of patients admitted to a large regional BICU to examine rates of hospital-associated respiratory infections and associated pathogens. We compared the incidence of respiratory infections and frequency of multidrug-resistant (MDR) pathogens in the BICU to those of other ICUs in the hospital.

METHODS

The University of North Carolina Hospitals (UNCH) is an 806-bed tertiary care facility including a 21-bed ICU for severely ill adult and pediatric patients with burns or extensive exfoliating skin conditions. UNCH's 7 other adult, pediatric, and neonatal ICUs with 171 beds were used for comparison. Comprehensive hospital-wide surveillance for hospital-associated respiratory infections was prospectively collected over a 5-year period (2008–2012) in accordance with the National Health and Safety Network (NHSN) criteria and entered into an electronic database.[4] Methicillin-resistant *S. aureus* (MRSA) and Gram-negative bacilli susceptible to $\leq$1 class of clinically relevant antibiotic classes[5] were considered MDR. Incidence of ventilator-associated pneumonia (VAP) was calculated as infections/1,000 ventilator days. Incidence of tracheobronchitis was calculated as infections/1,000 patient days. Denominator data were collected following CDC criteria.[6] Change in incidence rate was assessed by linear regression and compared to a zero slope line. Two-tailed *P* values for differences in categorical variables were calculated using generalized estimating equations.

RESULTS

Over the 5-year period with 1,772 admissions to the BICU, 60 VAP (50%), 7 non-ventilator-associated pneumonias (6%), and 52 episodes of tracheobronchitis (44%) occurred. The VAP rate was 4.22/1,000 ventilator days, and yearly rates ranged from 2.78 to 5.55/1,000 ventilator days. In other ICUs, the BICU VAP rate was 2.60/1,000 ventilator days (range, 1.57–4.53/1,000 ventilator days). A trend towards decreased VAP rates over time was noted in both populations (Figure 1A). The BICU tracheobronchitis rate was 1.49 infections/1,000 patient days (range, 0.95–2.14/1,000 patient days). In other ICUs, the tracheobronchitis rate was 1.59/1,000 patient days (range, 1.21–1.8/1,000 patient days). Little difference was found in rates over time or between the BICU and other ICUs.

In the BICU, 165 organisms were isolated from 119 hospital-associated respiratory infections (ie, 1.39 pathogens/infection, excluding 4 with no pathogen identified). The most common BICU respiratory pathogens were *P. aeruginosa* (24%), enteric Gram-negative bacilli (22%), *S. aureus* (18%), *Acinetobacter* spp. (17%), and *S. maltophilia* (10 %). Many BICU isolates were MDR: 36% of *P. aeruginosa*, 17% of enteric Gram-negative bacilli, 57% of *S. aureus*, 100% of *Acinetobacter* spp., and 18% of *S. maltophilia.* MDR-*Acinetobacter* outbreaks occurred in the BICU from September 2007 to April 2008 and from January 2009 to September 2010, and no additional cases were noted in the BICU outside these time periods. The outbreak strain also caused infections among patients in other ICUs, primarily the surgical ICU. The percentage of MDR pathogens in the BICU ranged from 21% to 51% per year with no clear trend over time. Compared with other ICUs, the BICU had a higher percentage of all MDR pathogens (41% vs 14%; $P < .001$) and MDR-Gram negative bacilli (32% vs 3%; $P < .001$) but a similar percentage of MRSA infections (10% vs 11%; $P = .63$) (Figure 1B).

DISCUSSION

The NHSN reported a pooled mean VAP rate in BICUs of 4.4 infections/1,000 ventilator days in 2012, which was similar to the 4.1 infections/1,000 ventilator days noted in our BICU during the same year.[7] Tracheobronchitis comprised nearly half of our BICU hospital-associated respiratory infections. The incidence of VAP and tracheobronchitis is reported to be even higher among those with inhalation burn injury. In a Czech burn center from 2004 to 2009, the VAP rate and the ventilator-associated tracheobronchitis rate among those with inhalation burn were 30.8 and 98.8 infections/1,000 ventilator days, respectively.[8] In a Belgian burn unit from 2002 to 2010, the VAP rate among inhalation burn injury patients was 55 episodes/1,000 ventilator days.[9]

In this study, a decreasing trend in VAP rates was noted from 2008 to 2012, during which time our hospital began sending Process and Outcome reports to ICU directors on VAP incidence and on compliance with VAP bundle measures. However, the trend was not statistically significant, and our small number of time points did not provide sufficient

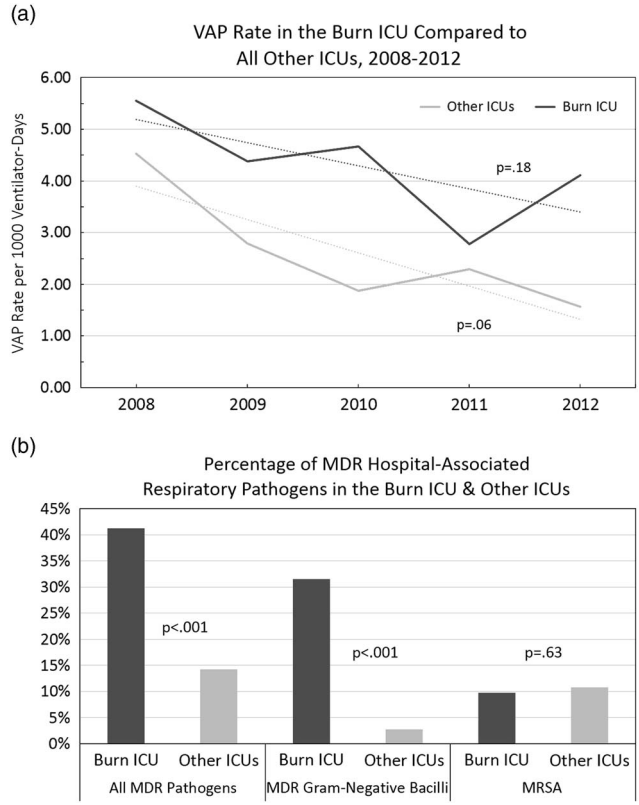

FIGURE 1. (A) Incidence of VAP in the BICU compared to all other ICUs from 2008 to 2012. (B) Multi-drug resistance among respiratory pathogens in the BICU compared with all other ICUs.

statistical power to assess for differences in VAP rates between the BICU and other ICUs.

The most common respiratory pathogens in our BICU were *P. aeruginosa*, enteric Gram-negative bacilli, and *S. aureus*. Similar pathogens were reported by the NHSN for 2009–2010, with VAPs at all US hospitals most frequently due to Gram-negative enteric bacilli and *S. aureus*, followed by *P. aeruginosa*.[10] VAP associated with inhalation burn injury is often caused by Gram-negative pathogens, including *P. aeruginosa*.[8,9] Respiratory pathogens in the BICU were more frequently MDR when compared to common VAP pathogens reported for all ICUs in NHSN during 2009–2010: *Acinetobacter* spp. (100% vs 63%), *S. aureus* (57% vs 48%), and *P. aeruginosa* (36% vs 18%).[10]

Although the data for this study were prospectively collected by infection preventionists according to standardized definitions, these surveillance data provide only limited insight into all patients treated for respiratory infections in the BICU. Many additional burn patients require treatment for clinically diagnosed respiratory infections that do not meet the very specific NHSN criteria. Frequent inhalation injury and acute respiratory distress syndrome in burn patients often make pulmonary findings difficult to interpret; this difficulty may also make NHSN definitions less reliable in the burn population. Our study was further limited by the inability to identify potentially important differences in respiratory infection rates or pathogens that may exist between child and adult burn patients or among patients with different types of burns, especially inhalational injury.

Hospital-associated respiratory infections remain a major problem in the BICU with a high prevalence of MDR pathogens. The true incidence of burn respiratory infections remains to be determined. In addition, further studies are needed on risk factors, treatment, and the attributable mortality of respiratory infections in this vulnerable population.

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Anne M. Lachiewicz, MD, MPH;[1]
David van Duin, MD;[1]
Lauren M. DiBiase, MS;[2]
Samuel W. Jones, MD;[3,4]
Shannon Carson, MD;[5]
William A. Rutala, PhD;[2]
Bruce A. Cairns, MD;[3,4]
David J. Weber, MD[1,2]

Affiliations: 1. Division of Infectious Diseases, University of North Carolina, Chapel Hill, North Carolina; 2. Department of Hospital Epidemiology, University of North Carolina Health Care, Chapel Hill, North Carolina; 3. Department of Surgery, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina; 4. North Carolina Jaycee Burn Center, Chapel Hill, North Carolina; 5. Division of Pulmonary Diseases and Critical Care Medicine, University of North Carolina, Chapel Hill, North Carolina.

Address correspondence to Anne M. Lachiewicz, MD, MPH, Division of Infectious Diseases, Department of Medicine, University of North Carolina, 130 Mason Farm Road, Mail code CB# 7030, Chapel Hill, NC 27599-7030 (anne_lachiewicz@med.unc.edu).

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Staphylococcus aureus Bacteremia in Hospitalized Children: Incidence and Outcomes

Staphylococcus aureus bacteremia is associated with significant morbidity and mortality in adults.[1] The incidence and outcomes of *S. aureus* bacteremia in hospitalized children, particularly since the emergence of community-onset (CO) methicillin-resistant *S. aureus* (MRSA), remains relatively unknown. Published reports are limited to single-center studies with few patients,[1–5] and they often focus on MRSA infections[1,5] and examine either CO or hospital-onset (HO) infections individually.[3,4] We sought to determine the epidemiology and outcomes of *S. aureus* bacteremia using a large, nationally representative cohort of children hospitalized in the United States.

PATIENTS AND METHODS

Study Design/Population

To determine the incidence, resistance profile, clinical characteristics and outcomes associated with pediatric *S. aureus* bacteremia, we assembled a cohort of nonneonatal children <19 years of age hospitalized between 2009 and 2012 using the Premier Perspective™ Database (PPD). PPD is an administrative database of 600 US acute-care hospitals that includes patient demographics, admission/discharge dates, admission and discharge diagnoses, procedure codes, discharge disposition, and medications.[6] Microbiology data, including blood culture results and sensitivity testing were available for 146 hospitals, served as the source for this cohort.

Study Definitions

We identified all unique hospitalizations with a *S. aureus* bloodstream infection. Adults (≥19 years), neonates (based on the All Patient Refined Diagnosis Related Groups [APR-DRG] subclass code), and patients transferred from outside hospitals or with an initial positive outpatient culture for *S. aureus* were excluded. *S. aureus* isolates resistant to nafcillin, oxacillin, or cefazolin were considered MRSA; those sensitive to these antibiotics were considered methicillin-sensitive *S. aureus* (MSSA). Isolates not tested against any of these antibiotics were considered to have an unknown resistance status. *S. aureus* blood cultures obtained within the first 2 days of hospitalization were considered to originate from CO infections;[7] those obtained beyond 2 days were considered were considered to originate from HO infections.

To determine the likely primary source of bacteremia, two infectious disease physicians (BF and JG) independently reviewed all International Classification of Diseases, Ninth Revision (ICD-9) codes per admission using predefined infection categories. Discrepancies were resolved through subsequent review and discussion.

We used a previously validated, ICD-9-CM code-based diagnostic classification system to identify underlying complex chronic conditions.[8]

Statistical Analysis

The χ^2 test for categorical variables and Wilcoxon rank-sum test for continuous variables were used to compare CO versus HO infections. Tests were 2-tailed, and results with $P < .05$ were considered significant. All analyses were conducted using SAS, version 9.3 (SAS Institute).

RESULTS

We identified 411 unique episodes of *S. aureus* bacteremia for a rate of 1.54 per 1,000 hospitalizations. A total of 57 patients (14%) had HO infections and 354 (86%) had CO infections (Table 1). Patients were more frequently white (n = 217, 53%) and male (n = 259, 63%), with median age of 7 years (interquartile range [IQR], 2–14 days). Median length of stay (LOS) prior to onset of *S. aureus* bacteremia was 4 days (IQR, 2–10 days) for HO patients. Median LOSs following onset of *S. aureus* bacteremia were 5 days (IQR, 2–8 days) for CO patients and 7 days (IQR, 4–20 days) for HO ($P = .002$). Patients with