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Major article

Changes in the incidence of health care–associated pathogens at a university hospital from 2005 to 2011

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Background: Data on health care–associated infections (HAIs) outside of intensive care units (ICU) are scarce. We assessed hospital-wide changes in the incidence of health care–associated pathogens by infection site and by service between 2005 and 2011.

Methods: All data on health care–associated pathogens in 2005-2011 based on comprehensive hospital-wide surveillance were extracted from an electronic database. The incidence of HAI by pathogen was calculated per 1000 patient-days and per 1000 device-days. Regression analyses were conducted to estimate trend changes in the yearly incidence of pathogens for selected HAIs.

Results: The majority (8784 of 10,070; 87.2%) of the HAIs recorded over the 7-year period had at least 1 pathogen; a total of 10,585 pathogens were isolated. Overall, across all major service categories (eg, ICU, medicine), significant trends toward decreasing incidence were observed for all pathogens except *Clostridium difficile*. The decrease in incidence was greatest for central line–associated bloodstream infections, less for catheter-associated urinary tract infections, and lowest for ventilator-associated pneumonias.

Conclusions: This study showed significant decreases in incidence of the majority of HAIs caused by various pathogens, but significant increases in patient-days during the study period. Only HAIs due to *C difficile* showed a significantly increased incidence.

Monitoring changes in the incidence of health care–associated infections (HAIs) through surveillance is essential to planning, implementing, and evaluating infection control measures to prevent HAIs in the hospital setting. Incidence data on HAIs occurring outside of intensive care units (ICU) are scarce, however, ever since targeted (ie, priority-based) surveillance emerged as a cost-effective method, leading to the discontinuation of hospital-wide surveillance in the Centers for Disease Control and Prevention's National Nosocomial Infections Surveillance System (NNIS) in 1986.[1] In a recent study comparing the number of HAIs included in targeted surveillance (National Healthcare Safety Network [NHSN] surveillance) and hospital-wide surveillance, targeted surveillance detected only 77.7% of the bloodstream infections, 74.5% of the surgical site infections (SSIs), 62.3% of the urinary tract infections, and 18.6% of the respiratory tract infections (including 100% of the ventilator-associated pneumonia [VAP] cases) that were identified with hospital-wide surveillance.[2]

Information on pathogens isolated from HAIs has implications for both treatment and the implementation of infection control and prevention strategies. However, in contrast to the increasing focus on antimicrobial-resistant pathogens, there are few reports on HAI pathogens. The NHSN reports from 2006-2007 and 2009-2010 identified the 10 most common health care–associated pathogens during these time periods as coagulase-negative staphylococci (CoNS; 15.3% and 11.4%, respectively), *Staphylococcus aureus* (14.5% and 15.6%), *Enterococcus* spp (12.1% and 13.9%), *Candida* spp (6.8% and 9.5%), *Escherichia coli* (9.6% and 11.5%), *Pseudomonas aeruginosa* (7.9% and 7.5%), *Klebsiella pneumoniae/oxytoca* (5.8% and 8.0%), *Enterobacter* spp (4.8% and 4.7%), *Acinetobacter baumannii* (2.7% and 1.8%), and *Proteus* spp (not stated and 2.5%).[3,4] Changes in the spectrum of health care–associated pathogens may arise from

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increasing numbers of immunocompromised patients, older patients with multiple comorbidities, and the increased use of broad-spectrum antibiotics and invasive procedures.[5]

There is no established framework for determining the incidence of HAI by pathogen based on hospital-wide surveillance data. Despite challenges (eg, potential imprecision if the population of patients at risk is small), hospital-wide surveillance has the strong advantage of providing comprehensive HAI data, including information about HAI pathogens isolated across hospital settings.[6] Thus, in this study we examined the incidence of HAIs by pathogen using comprehensive hospital-wide surveillance data at a university hospital.

METHODS

This study was conducted at University of North Carolina (UNC) Health Care, an 806-bed academic facility, and was approved by UNC's Institutional Review Board. UNC Health Care has conducted comprehensive hospital-wide surveillance by trained full-time infection preventionists (IPs) since 1978. Hospital-wide surveillance has been actively performed through a chart review of each patient who had isolated pathogen(s) based on daily microbiology records.

All health care–associated pathogen (numerator) data, with information on the service, location (nursing station), HAI category, and multidrug resistance, were extracted from the UNC Health Care electronic epidemiology database for 2005-2011, because device-days (denominator) data have been collected from 2005. Isolated pathogens were grouped into 18 categories of related species based on previous studies at UNC Health Care.[5,7] For the incidence of multidrug-resistant (MDR) pathogens, 4 additional subgroups of MDR pathogens were created: methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), MDR-*Acinetobacter*, and MDR-*Pseudomonas*. Patient-day data were extracted from the hospital census database for the study period (2005-2011) to calculate the service-associated incidence. To calculate the incidence of device-associated HAIs, device-days (eg, ventilator-days, central line-days, and Foley catheter-days) were extracted for 2006-2011 because of incomplete data for 2005, when UNC Health Care first mandated the daily recording of device-days by nursing station.

To analyze the incidence of isolated pathogens in device-associated HAI, we sorted all pathogens related to device utilization according to infection site information and then classified them into 5 major categories: central line–associated bloodstream infection (CLABSI), catheter-associated urinary tract infection (CAUTI), VAP, SSI, and other infections (eg, endocarditis, osteomyelitis, meningitis), following NHSN definitions.[8] To analyze the pathogen incidence according to service type, all cases (regardless of infection site) and all locations where pathogens were isolated (nursing station and inpatient hospital service) were classified into 6 major service categories: 2 acuity-based categories (ICU and non-ICU) and 4 service-based categories (Medicine, Surgery, Pediatrics, and Other [eg, dermatology, gynecology, psychiatry, rehabilitation medicine]). Step-down units (SDUs) were categorized as non-ICU, because the HAI rates in SDUs were closer to the rates in the general wards than to rates in the ICUs.[9] Denominator data (device-days and patient-days) were classified into the same major infection site and service categories as the numerator (pathogens) data.

SAS version 9.2 (SAS Institute, Cary, NC) was used to compute descriptive statistics of the yearly incidence of HAI for the study period for each category of analysis. The incidence of HAI according to the health care–associated pathogen in each category were calculated as the number of HAIs per 1000 patient-days or device-days. Simple linear regression was used to test for overall changes in patient-days during the study period, because HAI pathogen incidence may be associated with the number of patients admitted or the patients' length of hospital stay.

For estimating trend changes in the yearly incidence of HAIs according to pathogen across the study period, Poisson regression analysis was used to determine goodness of fit and adjust for overdispersion. When the Poisson regression result was statistically significant ($P < .05$), a logistic regression analysis for linear fit was conducted to estimate the incidence difference between the first and last years of the study and to examine the trend change across the study years. The estimated incidence difference and the relative incidence difference were used to summarize the changes in incidence difference over time and were calculated using following formulas:

Estimated incidence difference (EID) = Exp (log odds of incidence of last study year)/[1 + Exp (log odds of incidence of last study year)] − Exp (log odds of incidence of study year 1)/[1 + Exp (log odds of incidence of study year 1)]

Relative incidence difference (RID) = [(estimated incidence of study year 1 − incidence of last study year)/incidence of study year 1] × 100.

RESULTS

Overall, at least 1 pathogen was isolated for 8784 of the 10,070 HAIs (87.2%) that occurred during the 7-year study period. Because some HAIs involved multiple pathogens, a total of 10,585 pathogens were isolated (Table 1); the mean number of pathogens per HAI was 1.21. The number of total patient-days per year increased significantly during the study period ($P < .05$). Although our top 10 pathogens are similar to those reported by the NHSN,[5] the rank order is somewhat different. Among our top 10 pathogens, the incidence of *E coli*, *Enterococcus* spp, CoNS, *Candida* and other yeasts, *Enterobacter* spp, and other streptococci decreased significantly, whereas the incidence of *Clostridium difficile* increased significantly per 1000 patient-days (Table 1 and Fig 1). The estimated incidence of *C difficile* increased by 0.42 per 1,000 patient-days between 2005 and 2011; the RID was 159% during that period.

Service

The incidence of HAIs by pathogen and service category are summarized in Table 2. Overall, across service categories, trends toward decreasing incidence were observed for all pathogens except *C difficile*. *C difficile* was the most frequently occurring health care–associated pathogen in Medicine, and it had a significantly increased incidence in all service categories except Pediatrics. *S aureus* was the most common pathogen identified in Other service categories, and its incidence was significantly lower in Medicine and ICU settings. A significantly decreased incidence of *E coli* was seen in Medicine and non-ICU settings. The incidences of CoNS and of *Candida* and other yeast were significantly decreased in all service categories, the incidences of *Enterococcus* spp and of *P aeruginosa* were significantly decreased in Medicine, the incidence of *Enterobacter* spp was significantly decreased in Medicine and ICU settings, and the incidences of other streptococci were significantly decreased in Pediatrics and non-ICU settings.

Device-associated HAIs

Overall and across service categories, all device-associated HAIs by pathogen showed significant decreases or no significant change in incidence per 1000 device-days (Table 3). The decreases in incidences of specific pathogens were greatest for CLABSI, less for CAUTI, and lowest for VAP.