Descriptive Analysis of Healthcare-Associated Infections Other than Bloodstream, Respiratory, Urinary Tract, or Surgical Site Infections, 2001–2011

It is estimated that healthcare-associated infections (HAIs) account for approximately 1.7 million infections and 99,000 deaths in US hospitals each year.[1] The Centers for Disease Control and Prevention (CDC) and the National Healthcare Safety Network (NHSN) have developed standardized surveillance definitions of HAIs including surgical site infection (SSI), pneumonia, bloodstream infection (BSI), and urinary tract infection (UTI).[2] All HAIs except for these "big four" infection types are categorized as "other" types of HAI. Of the estimated numbers of total HAIs (1,195,142) and deaths associated with HAI (98,987) in US hospitals among adults and children outside of intensive care units (ICUs), other types of HAI accounted for 22% (263,810) and 11% (11,062) of deaths, respectively,[1] which suggests that other HAIs represent a substantial burden in US healthcare facilities.

NHSN reports have focused on surveillance data for device-associated HAI such as central line–associated BSI, ventilator-associated pneumonia, and catheter-associated UTI.[3] The University of North Carolina (UNC) Hospitals have conducted comprehensive hospital-wide surveillance for all HAIs according to CDC criteria.[2,4] Data from UNC Hospitals suggest that approximately 50% of HAIs identified in a tertiary care hospital are not included in published NHSN reports.[5] Overall, 208 (16.5%) of a total of 1,264 HAIs were classified as other types of HAI at UNC Hospitals in 2010. In this article, we analyze the UNC Hospitals data in order to (1) investigate trends and break down HAI categorized as "other" according to the CDC criteria and (2) analyze other HAIs by selected variables (e.g., service, nurse station, and pathogen). We expect these data to be useful to infection preventionists who are interested in engaging in comprehensive efforts to reduce all HAIs and not just device-associated infections.

This study was conducted at UNC Hospitals, an 800-bed tertiary care facility, with 11 years of data (2001–2011). Comprehensive hospital-wide surveillance for all HAIs that involved all CDC-defined infections was performed in accordance with CDC criteria[2] by 5 infection preventionists and 2 full-time faculty members. All surveillance data were entered into an electronic database. This study was approved by the Institutional Review Board of UNC Chapel Hill.

A total of 19,357 HAIs were identified at UNC Hospitals from 2001 to 2011, as follows: BSI, 4,989 (25.8%); UTI, 4,791 (24.8%); respiratory tract infection, 3,389 (17.5%); SSI, 3,986 (20.6%); and other, 2,202 (11.4%). The 5 major other types of HAI that were identified were as follows: gastrointestinal system infection, 1,061 (48.2%); skin and soft tissue infection, 610 (27.7%); cardiovascular system infection, 295 (13.4%); ear, nose, throat, and mouth infection, 118 (5.4%); and intracranial infection, 70 (3.2%; Table 1). Additionally, we identified the following infection types: reproductive tract infection, 18 (0.8%); bone or joint infection, 15 (0.7%); systemic infection, 14 (0.6%); and miscellaneous, 1 (<0.1%). Overall, other infections occurred in the following wards: surgery, 877 (39.8%); medicine, 609 (27.7%); pediatric surgery, 310 (14.1%); pediatric medicine, 224 (10.2%); rehabilitation, 67 (3.0%); gynecology-obstetrics, 54 (2.5%); and miscellaneous, 61 (2.8%). Infection occurred in an ICU in 1,057 cases (48.0%), in a non-ICU setting in 1,041 cases (47.3%), and in an outpatient setting in 104 cases (4.7%).

Specific infections in the 5 categories of major other types of HAI and associated pathogens are shown in Table 1. Of the 1,061 gastrointestinal system infections, gastroenteritis and peritonitis accounted for 843 (79.5%) and 135 (12.7%), respectively, and *Clostridium difficile* was detected in 785 cases (74.0%). Of the 610 skin and soft tissue infections, 347 (56.9%) were burn wound infections, followed by 149 other skin and soft tissue infections (24.4%) and 60 cutaneous infections (9.8%), and *Staphylococcus aureus* was detected in 128 cases (21.0%). Venous infection and endocarditis were responsible for 264 (89.5%) and 15 (5.1%) of 295 cardiovascular system infections, respectively, and associated pathogens included coagulase-negative staphylococci (CNS), *S. aureus*, *Enterococcus* sp., *Pseudomonas* sp., and gram-negative rods. Conjunctivitis was the most common infection among ear, nose, throat, and mouth infections (69.5%), and meningitis or ventriculitis was the most common intracranial infection (98.6%).

In this study, we identified 5 major other types of HAI. Healthcare-associated gastroenteritis due to *C. difficile* was the most common type of gastrointestinal system infection, which may reflect the increasing incidence rates of *C. difficile* infection over time and across US healthcare institutions, as reported elsewhere.[6] Our previous study in UNC Hospitals that evaluated data collected over a 29-year period revealed increases in the relative proportion of pathogens, including *S. aureus*, CNS, *Enterococcus* sp., and *C. difficile* and other anaerobes.[7] The data from this study suggest that those pathogens have an important role in other types of HAI (Table 1).

In each year of our study period, 9%–17% of all HAIs comprised other HAIs. Specifically, the proportions of other HAIs by year are as follows: in 2001, 161 (9.0%); in 2002, 166 (9.4%); in 2003, 204 (10.5%); in 2004, 224 (11.6%); in 2005, 183 (10.1%); in 2006, 221 (12.8%); in 2007, 202 (11.6%); in 2008, 159 (9.3%); in 2009, 163 (10.2%); in 2010, 228 (13.9%); and in 2011, 291 (17.2%). Our data reveal that the frequency of other types of HAI per year significantly increased over 10 years, most substantially in 2011 largely because of increases in *C. difficile* infection. Although there are no published data regarding other HAIs, our data highlight the burden due to other types of HAI and should contribute to efforts to prevent such infections.

TABLE 1. Five Major "Other" Types of Healthcare-Associated Infections (HAIs) and Pathogens, University of North Carolina (UNC) Hospitals, 2001–2011

Type of HAI, specific infection	No. (%)	Associated pathogens (no. [%])
Gastrointestinal system infections	1,061 (100.0)	*Clostridium difficile* (785 [74.0]), other (74 [7.0]), unknown (72 [6.8]), rotavirus (45 [4.2]), *Candida* sp. (26 [2.5]), *Enterococcus* sp. (19 [1.8]), coagulase-negative staphylococci (17 [1.6]), *Enterobacter* sp. (12 [1.1]), *Escherichia coli* (11 [1.0])
Gastroenteritis	843 (79.5)	
Peritonitis	135 (12.7)	
Necrotizing enterocolitis	37 (3.5)	
Intraabdominal infection or infection involving multiple sites	16 (1.5)	
Gastrointestinal tract infection	10 (0.9)	
Other gastrointestinal system infection	7 (0.7)	
Cholecystitis	6 (0.6)	
Pancreatic abscess or other infection	3 (0.3)	
Liver abscess or other infection	2 (0.2)	
Splenic abscess or other infection	1 (0.1)	
Subphrenic or subdiaphragmatic abscess	1 (0.1)	
Skin and soft tissue infections	610 (100.0)	Unknown (296 [48.5]), *Staphylococcus aureus* (128 [21.0]), other (59 [9.7]), *Candida* sp. (25 [4.1]), *Pseudomonas aeruginosa* (23 [3.8]), coagulase-negative staphylococci (23 [3.8]), *Enterococcus* sp. (18 [3.0]), *Aspergillus* sp. (14 [2.3]), *Mucor* sp. (9 [1.5]), *Streptococcus* sp. (8 [1.3]), *E. coli* (7 [1.1])
Burn infection	347 (56.9)	
Other skin and soft tissue infection	149 (24.4)	
Cutaneous infection	60 (9.8)	
Cellulitis	28 (4.6)	
Decubitus ulcer infection	9 (1.5)	
Pustulosis in infant	6 (1.0)	
Myositis	4 (0.7)	
Necrotizing fasciitis or gangrene	3 (0.5)	
Omphalitis in newborn	3 (0.5)	
Lymphadenitis or lymphangitis	1 (0.2)	
Cardiovascular system infection	295 (100.0)	Coagulase-negative staphylococci (59 [20.0]), *S. aureus* (38 [12.9]), *Enterococcus* sp. (33 [11.2]), *Pseudomonas* sp. (31 [10.5]), gram-negative rods (30 [10.2]), *Enterobacter* sp. (21 [7.1]), *Candida* sp. (20 [6.8]), other (15 [5.1]), *Acinetobacter* sp. (13 [4.4]), unknown (13 [4.4]), *E. coli* (6 [2.0]), *Klebsiella* sp. (6 [2.0]), *Serratia marcescens* (5 [1.7]), *Streptococcus* sp. (5 [1.7])
Venous infection	264 (89.5)	
Endocarditis	15 (5.1)	
Arterial infection	8 (2.7)	
Pericarditis	5 (1.7)	
Other cardiovascular system infection	2 (0.7)	
Mediastinitis	1 (0.3)	
Ear, nose, throat, and mouth infections	118 (100.0)	*S. aureus* (24 [20.3]), coagulase-negative staphylococci (16 [13.6]), other (16 [13.6]), *P. aeruginosa* (14 [11.9]), unknown (10 [8.5]), *E. coli* (9 [7.6]), *Enterobacter* sp. (6 [5.1]), *Haemophilus* sp. (6 [5.1]), gram-negative rods (5 [4.2]), *Streptococcus* sp. (4 [3.4]), *S. marcescens* (4 [3.4]), diphtheroids (4 [3.4])
Conjunctivitis	82 (69.5)	
Other mouth infection	6 (5.1)	
Keratitis	5 (4.2)	
Oral cavity infection	5 (4.2)	
Other ocular infection	5 (4.2)	
Superficial eye infection (blepharitis)	5 (4.2)	

TABLE 1 (*Continued*)

Type of HAI, specific infection	No. (%)	Associated pathogens (no. [%])
Otitis media	4 (3.4)	
Otitis externa	3 (2.5)	
Endophthalmitis	2 (1.7)	
Dental infection	1 (0.8)	
Intracranial infections	70 (100.0)	Coagulase-negative staphylococci (18 [25.7]), unknown (10 [14.3]), other (10 [14.3]), *S. aureus* (8 [11.4]), *Enterococcus* sp. (6 [8.6]), *Enterobacter* sp. (5 [7.1]), *Klebsiella pneumoniae* (5 [7.1]), *Acinetobacter* sp. (4 [5.7]), *E. coli* (4 [5.7])
Meningitis or ventriculitis	69 (98.6)	
Brain abscess	1 (1.4)	

In summary, we conducted a descriptive analysis of HAIs other than BSI, respiratory infection, UTI, or SSI by performing comprehensive hospital-wide surveillance at an academic hospital. Infections classified as "other" made up 9%–17% of all HAIs. These types of HAI were most prevalent in surgery patients, and the incidence of other HAIs was higher in ICU versus non-ICU patients. Further investigation is necessary to clarify epidemiology (patient characteristics, risk factors for infection, etc) and establish infection control strategies for "other" HAIs.

ACKNOWLEDGMENTS

We thank all staff of the Department of Hospital Epidemiology, University of North Carolina Health Care, for their cooperation and contribution.

Financial support. University of North Carolina Health Care.

Potential conflicts of interest. All authors report no conflicts of interest relevant to this article. All authors submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and the conflicts that the editors consider relevant to this article are disclosed here.

Hajime Kanamori, MD, PhD;[1,2]
David J. Weber, MD, MPH;[3,4]
Emily E. Sickbert-Bennett, PhD;[3,4]
Vickie Brown, RN, MPH;[3] Mitsuo Kaku, MD, PhD;[2]
William A. Rutala, PhD, MPH[3,4]

Affiliations: 1. Gillings School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina; 2. Department of Infection Control and Laboratory Diagnostics, Internal Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan; 3. Department of Hospital Epidemiology, University of North Carolina Health Care, Chapel Hill, North Carolina; 4. Division of Infectious Diseases, School of Medicine, University of North Carolina, Chapel Hill, North Carolina.

Address correspondence to David J. Weber, MD, MPH, Division of Infectious Diseases, School of Medicine, University of North Carolina, CB 7030, 2153 Bioinformatics, 130 Mason Farm Rd., Chapel Hill, NC 27599 (dweber@unch.unc.edu).

Received March 17, 2012; accepted July 8, 2012; electronically published October 29, 2012.

Infect Control Hosp Epidemiol 2012;33(12):1276-1277

 0899-823X/2012/3312-0020$15.00. DOI: 10.1086/668423

REFERENCES

1. Klevens RM, Edwards JR, Richards CL Jr, et al. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Rep* 2007;122:160–166.
2. Centers for Disease Control and Prevention. Surveillance definition of healthcare-associated infection and criteria for specific types of infections in the acute care setting. http://www.cdc.gov/nhsn/PDFs/pscManual/17pscNosInfDef_current.pdf. Accessed March 2, 2012.
3. Dudeck MA, Horan TC, Peterson KD, et al. National Healthcare Safety Network (NHSN) Report, data summary for 2010, device-associated module. *Am J Infect Control* 2011;39:798–816.
4. Weber DJ, Sickbert-Bennett EE, Brown V, Rutala WA. Comparison of hospitalwide surveillance and targeted intensive care unit surveillance of healthcare-associated infections. *Infect Control Hosp Epidemiol* 2007;28:1361–1366.
5. Weber DJ, Sickbert-Bennett EE, Brown V, Rutala WA. Completeness of surveillance data reported by the National Healthcare Safety Network: an analysis of healthcare-associated infections ascertained in a tertiary care hospital, 2010. *Infect Control Hosp Epidemiol* 2012;33:94–96.
6. Dubberke ER, Butler AM, Yokoe DS, et al. Multicenter study of *Clostridium difficile* infection rates from 2000 to 2006. *Infect Control Hosp Epidemiol* 2010;31:1030–1037.
7. Kang J, Sickbert-Bennett EE, Brown VM, Weber DJ, Rutala WA. Relative frequency of health care–associated pathogens by infection site at a university hospital from 1980 to 2008. *Am J Infect Control* 2012;40:416–420.

The Influence of Environmental Temperature and Air Humidity on the Maintenance of Sterility of Surgical Instruments Sterilized in Different Wraps

To make reuse of surgical instruments possible, reprocessing should include careful cleaning, rigorous inspection, appropriate packaging, and sterilization. After completion of these steps, appropriate storage of the materials is critical to maintaining sterility. Many recommendations exist for the storage