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Healthcare-Associated Infections among Patients in a Large Burn Intensive Care Unit: Incidence and Pathogens, 2008–2012

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Burn injuries are a common source of morbidity and mortality in the United States, with an estimated 450,000 burn injuries requiring medical treatment, 40,000 requiring hospitalization, and 3,400 deaths from burns annually in the United States.[1] Patients with severe burns are at high risk for local and systemic infections.[2] Furthermore, burn patients are immunosuppressed, as thermal injury results in less phagocytic activity and lymphokine production by macrophages.[2] In recent years, multidrug-resistant (MDR) pathogens have become major contributors to morbidity and mortality in burn patients.[3]

Since only limited data are available on the incidence of both device- and nondevice-associated healthcare-associated infections (HAIs) in burn patients, we undertook this retrospective cohort analysis of patients admitted to our burn intensive care unit (ICU) from 2008 to 2012.

This study was conducted at University of North Carolina (UNC) Hospitals, an 806-bed tertiary care facility, using surveillance data collected over 5 years (2008–2012). The ICU of the UNC Jaycee Burn Center is a 21-bed unit dedicated to the care of severely ill patients with burns or extensive exfoliating skin conditions. Patients are housed only in single rooms, and “burn-wound” precautions are used for all patients (ie, hand hygiene, gloves, and gowns prior to entering the room). Comprehensive hospital-wide surveillance for all HAIs that included all Centers for Disease Control and Prevention (CDC)–defined sites was performed in accordance with CDC criteria by 5 infection preventionists and 3 full-time faculty

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members.[4] All surveillance data were entered into an electronic database. Incidences of central line–associated bloodstream infections (CLABSIs), ventilator-associated pneumonia (VAP), and catheter-associated urinary tract infections (CAUTIs) were calculated as infections per 1,000 device-days. Incidences of non-device-associated bloodstream infections (BSIs), pneumonia, urinary tract infections (UTIs), and other infections were calculated as infections per 1,000 patient-days. Denominator data were collected following CDC criteria.[5] MDR gram-negative bacilli were defined throughout the study period as pathogens susceptible to less than or equal to 1 class of clinically relevant antibiotics, as described by the Clinical and Laboratory Standards Institute standards for susceptibility testing.

The most common sites of HAIs occurring among burn patients were respiratory tract (44.44%; $n = 120$), urinary tract (21.85%; $n = 59$), other (21.11%; $n = 57$), bloodstream (11.85%; $n = 32$), and surgical site infections (0.74%; $n = 2$; Table 1). Of note, tracheobronchitis accounted for 44% of all respiratory infections. Almost all UTIs (86%) and BSIs (91%) were device associated. Traditional surgical site infections were uncommon and accounted for less than 1% of all HAIs.

The most common pathogens among our burn ICU patients were the nonfermentative gram-negative bacilli *Pseudomonas aeruginosa* and *Acinetobacter* spp. (Table 2). Overall, gram-positive cocci accounted for only 19.8% ($n = 68$) of our top 21 pathogens. Yeast accounted for 6.6% ($n = 24$) of pathogens; filamentous fungi were uncommon. *Clostridium difficile* infections (CDIs) were also uncommon; the rate of CDI was 0.28 per 1,000 patent-days. Of note, during the study time period, CDI was our fourth most common healthcare-associated pathogen at UNC (hospital-wide rate, 0.56 per 1,000 patient-days).

MDR pathogens comprised a high percentage of strains: MDR *Acinetobacter* spp. (90.8%), methicillin-resistant *Staphylococcus aureus* (59.5%), MDR *P. aeruginosa* (33.8%), MDR *Stenotrophomonas maltophilia* (21.1%), MDR *Serratia marcescens* (18.8%), vancomycin-resistant *Enterococcus* spp. (13.0%), and MDR *Escherichia coli* (7.7%).

Infections in severely burned patients remain a major cause of morbidity and mortality.[2,3] Our rates of device-facility infections are well below that reported by the National Healthcare Safety Network (NHSN) for the year 2012, even though our rates included the entire 5-year period from 2008 to 2012 and our rates have been falling with time.[6] Specifically, our rates compared with the NHSN-reported pooled mean rates (per 1,000 device-days) for burn ICUs were as follows: CLABSI, 1.92 versus 3.4; CAUTI, 2.31 versus 4.7; and VAP, 4.16 versus 4.4. Our device utilization rates compared with NHSN-reported pooled mean rates were as follows: central lines, 0.42 versus 0.48; urinary catheters, 0.62 versus 0.50; and ventilators, 0.40 versus 0.27.[6] Thus, our low device-associated infection rate was not due to lower device use. Surgical site infections (ie, 2) meeting the NHSN definitions were very low, although another 19 infections were classified as skin infections. This low rate, in part, is likely related to the difficulty of diagnosing skin infections using surveillance definitions in this population.

A limitation of the NHSN is that nondevice-associated HAIs are not reported. For the 3 major body sites (blood, lungs, and urinary tract), the great majority of HAIs were in fact device associated. However, tracheobronchitis was almost as common as VAP. Importantly, more than 20% of HAIs fell into the "other" category. Of interest, the rate of CDIs was quite low, despite the frequent use of antibiotics in this patient population. The overall rate of HAIs among our patients was 7.56 per 1,000 patient-days.

Our data demonstrated that the most common pathogens were *P. aeruginosa*, *Acintetobacter* spp., and *S. aureus*. Our frequency of infections due to *Acinetobacter* spp. was elevated in the study time period by an outbreak due to a clonal strain of *Acinetobacter*. Burn centers in Turkey,[7] China,[8] and Bulgaria[9] have reported the same top organisms comprising the top 3 pathogens in burn patients. As with our bacterial strains, a high frequency of MDR strains has been reported for *S. aureus*, *Enterococcus* spp., *P. aeruginosa*, and *Acinetobacter* spp.[10]

In conclusion, infections in our burn ICU were lower than the mean rates reported by NHSN. Most major site infections are device associated. Infections due to *C. difficile* are uncommon. Nonfermentative gram-negative bacilli constitute a large proportion of HAIs. MDR pathogens are common in this patient population. Additional analyses of our HAIs in our burn population are currently under way to further evaluate the interventions that have led to our low rate of HAIs and determine the risk factors for specific HAIs.

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Table 1

Number and Frequency of Healthcare-Associated Infections (HAIs), Burn Intensive Care Unit, 2008–2012

HAI	No. (%)	Denominator	Frequency
CLABSI	29 (10.74)	15,103 device-days	1.92 per 1,000 device-days
BSI	3 (1.11)	35,698 patient-days	0.0840 per 1,000 patient-days
VAP	60 (22.22)	14,425 device-days	4.16 per 1,000 device-days
HAP	7 (2.59)	35,698 patient-days	0.197 per 1,000 patient-days
Tracheobronchitis	52 (19.26)	35,698 patient-days	1.46 per 1,000 patient-days
Sinusitis	1 (0.37)	35,698 patient-days	0.0280 per 1,000 patient-days
CAUTI	51 (18.89)	22,122 device-days	2.31 per 1,000 device-days
UTI	8 (2.96)	35,698 patient-days	0.224 per 1,000 patient-days
SSI,[a] superficial	0 (0.00)	…	…
SSI,[a] deep	1 (0.37)	…	…
SSI,[a] organ space	1 (0.37)	…	…
Other: venous infection	20	35,698 patient-days	0.560 per 1,000 patient-days
Other:[a] open burn SSI	10	…	…
Other: *Clostridium difficile*	10	35,698 patient-days	0.280 per 1,000 patient-days
Other: burn wound cellulitis	9	35,698 patient-days	0.252 per 1,000 patient-days
Other: peritonitis	2	35,698 patient-days	0.056 per 1,000 patient-days
Total	270 (100)	35,698 patient-days	7.56 per 1,000 patient-days

NOTE. Single other cases of burn wounds were impetigo, burn infection, necrotizing fasciitis, conjunctivitis, cutaneous infection, and sinusitis (incidence, 0.0280 per 1,000 patient-days). BSI, bloodstream infection; CAUTI, catheter-associated urinary tract infection; CLABSI, central line–associated bloodstream infection; HAP, healthcare-associated pneumonia (nonventilated); SSI, surgical site infection; VAP, ventilator-associated pneumonia; UTI, urinary tract infection.

[a]Denominator (ie, number of surgeries) not available.

Table 2

Pathogens Isolated from Selected Healthcare-Associated Infections, Burn Intensive Care Unit Patients, 2008–2012

Pathogen	Total (%)	CLABSI	BSI	VAP	HAP	Tracheobronchitis	CAUTI	UTI
Pseudomonas aeruginosa	65 (17.8)	2		25	3	14	6	
Acinetobacter spp.	64 (17.5)	10		18		7	7	
Staphylococcus aureus	37 (10.1)	3	2	15		13		
Enterococcus spp.	23 (6.3)	5		1			9	1
Gram-negative bacilli (not specified)	20 (5.5)	1		4	1	4	1	
Stenotrophomonas maltophilia	19 (5.2)			4	1	10	1	
Enterobacter cloacae	14 (3.8)	2		5		3	1	1
Escherichia coli	13 (3.6)	1			1		4	3
Candida spp.	12 (3.3)	1					7	
Clostridium difficile	10 (2.7)							
Klebsiella pneumoniae	10 (2.7)			2		2	3	
Candida albicans	9 (2.5)	1					6	2
Enterobacter aerogenes	8 (2.2)			2		3	1	
Proteus mirabilis	6 (1.6)	1				2	3	
Coagulase-negative staphylococci	5 (1.4)	2						
Enterobacter spp.	4 (1.1)			2				
Mucor	4 (1.1)			1				
Enterobacter-Klebsiella group	3 (0.8)			1		2	1	
Streptococcus pneumoniae	3 (0.8)							
Candida glabrata	3 (0.8)		1				3	
Serratia marcescens	3 (0.8)	3		3	1	2	3	
Other[a]	21 (5.7)	1		4		7	1	1
Total	365 (100)	36	3	89	7	68	57	8

NOTE. The total number of pathogens is larger than the total number of infections since some infections had multiple pathogens isolated. BSI, bloodstream infection; CAUTI, catheter-associated urinary tract infection; CLABSI, central line–associated bloodstream infection; HAP, healthcare-associated pneumonia (nonventilated); SSI, surgical site infection; VAP, ventilator-associated pneumonia; UTI, urinary tract infection.

[a]Includes 2 isolates of Fusarium spp., Haemophilus influenzae, Haemophilus sp., and Morganella morganii and single isolates of Absidia sp., Acremonium sp., Aspergillus fumigatus, Burkholderia sp., Citrobacter diversus, diphtheroids, Lactobacillus sp., mixed flora, Moraxella catarrhalis, orophyngeal flora, Streptococcus anginosus, and Streptococcus viridans group.