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Major Article

Prevalence and risk factors of health care–associated infections in a limited resources country: A cross-sectional study



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Background: The aim of this study was to determine the prevalence of health care–associated infections (HAI) in our university hospitals (UH) and to delineate the risk factors associated with HAI.

Methods: We conducted a cross-sectional study in the 2 UH of Sfax, Tunisia on July 2017, including all patients hospitalized for at least 48 hours. It was a 1-day pass per department and a 1-week prevalence survey per UH.

Results: Of 752 patients eligible for the study, the total number of HAI was 82, representing an overall prevalence of HAI of 10.9%. Respiratory tract infections were the most prevalent HAI (36.6%). In multivariate analysis, intrinsic risk factors independently associated with HAI were immune-suppression (adjusted odds ratio (AOR) = 2.8; $P < .001$), diabetes (AOR = 2.2; $P = .008$), and malnutrition (AOR = 2.2; $P = .019$). Extrinsic risk factors were endotracheal intubation (AOR = 17; $P = .01$), transfer to another department (AOR = 9; $P = .019$), parental feeding (AOR = 7.2; $P = .014$), tobacco use (AOR = 6.3; $P = .004$), as well as surgical wound class contaminated or dirty (AOR = 6.3; $P = .002$), and peripheral venous catheter (AOR = 4.7; $P = .006$).

Conclusions: Our study highlighted the magnitude of the HAI problem threatening the quality of care in Southern Tunisia. A wise identification of HAI risk factors may help health care workers to ascertain the avoidability of these infections.

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Health care–associated infections (HAI) represent a major public health problem worldwide, leading to an increase in health care costs.¹ Their occurrence continues to escalate at an alarming rate, especially in the developing countries. As compared to developed countries, prevalence of HAI in the limited resources countries are 2 times higher than in Europe and 3 times higher than in the United States.²

HAI originally referred to nosocomially acquired infections that are typically not present or incubating at the time of admission.³

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More often, they lead to an increase in hospital stay and higher morbidity and mortality rates because they affect hospitalized patients whose immune systems are often weak. Moreover, the rise in HAI incidence and the abuse of antimicrobial agents in hospitals resulted in germ selection and emergence of resistant strains of microorganisms, which have a heavy economic and medical burden. Epidemiologic surveillance represents a central axis in prevention strategies and has become an integral feature of infection control in all hospitals. In most countries, prevalence surveys constitute one of the most common methods adopted for epidemiologic surveillance, allowing to follow the HAI frequencies and their epidemiologic particularities.⁴ In the developing countries, accurate estimates of the burden of HAI remain challenging because of the lack of national and regional surveillance programs and data. In Tunisia, according to the first national survey conducted in 2005, the prevalence of hospital HAI was 13.2%.⁵ In light of the current knowledge gap in the local area, our study aimed to determine the prevalence of HAI in the university hospitals (UH) of Southern Tunisia, to describe the distribution of isolated microorganisms according to anatomic infectious sites and to delineate the risk factors associated with HAI.

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METHODS

Study design and settings

We conducted a cross-sectional study in the 2 UH of Sfax from July 3 to July 10, 2017. It was a 1-day pass per department and a 1-week prevalence survey per UH.

The governorate of Sfax is situated in the coastal region of Southern Tunisia. It contains 2 UH: Hedi Chaker UH (HCUH) and Habib Bourguiba UH (HBUH). HCUH is an 889-bed tertiary-level teaching hospital, with 16 hospital medical departments. It is divided into adult departments, which contain general medicine departments (hematology and other general medicine departments), gynecology and obstetrics, as well as adult psychiatric units, and pediatric departments, which are composed of general medicine, neonatology, neuro-pediatric, pediatric surgery, and pedopsychiatric departments. HBUH includes mainly 15 surgical departments, with a hospital capacity of 562 beds. This UH is composed of surgery, intensive care, and general medicine departments (neurology, oncology, and radiotherapy).

Data collection

We have adopted the protocol of the national survey conducted in 2005 in Tunisia in public and private health structures, to ensure the comparability with other UH either in Tunisia or with other countries.⁷ This protocol was validated by a comity of experts in hygiene and preventive health from the National Observatory of New and Emerging Diseases in Tunisia. The study was performed using an anonymous questionnaire completed by 2 trained teams in each department pass. Finished questionnaires have been daily validated to ensure data completeness. Standard information was collected from medical and nursing records, microbiology reports, radiograph reports, temperature charts, prescribing records, and, when necessary, through discussion with clinical staff and hygiene referents. Collected data were related to patients' general characteristics, clinical profiles, exposure to indwelling invasive devices or a surgical procedure within 30 days, insertion of implants within 12 months prior to the survey, and antibiotic treatment prescribed on the day of the survey. As proposed by McCabe, patients were classified according to the severity of their underlying conditions into 3 categories: non-fatal disease (expected survival >5 years), ultimately fatal disease (expected survival 1–4 years), and rapidly fatal disease (expected death within 1 year).⁶ Relative to the profile of patients undergoing surgery, we recorded American Society of Anesthesiologists (ASA) grades that ranged from 1–6,⁷ and the surgical wound class (clean, clean/contaminated, contaminated and dirty), based on the bacterial load of the surgical wound.⁸

To check for inter-observer variation, each team visited the same wards on the same day, unaware of the results of the other team, then collected data were compared between the teams. Patients who were seen by only 1 team (1% of the total participants) were excluded from analysis.

Inclusion criteria and case definition

Patients of any age who were hospitalized for at least 48 hours were included. Patients undergoing a same-day treatment or surgery, those seen at outpatient departments, outpatient dialysis, and emergency rooms were ruled out. An HAI was considered prevalent when the patient had a clinically and/or microbiologically confirmed infection at the time of the survey. The definition of HAI was based on the criteria of the Centers for Disease Control and Prevention (CDC), the National Nosocomial Infection Surveillance (NNIS), and the National Healthcare Safety Network (NHSN) systems.² HAI patients were those who had signs and symptoms that met 1 of the CDC definitions, or

had 1 or more signs or symptoms included in a CDC definition, and/or still receiving antibiotic treatment for HAI on the day of the survey.⁸ The diagnosis of HAI was first suspected by the investigators and then confirmed by medical staff including expert doctors and hygiene referents in each department, who verified the diagnosis criteria for each patient. An active HAI at admission within 48 hours of a patient transferred from another UH would be considered to be acquired in the other UH. Risk factors of HAI were divided into 2 groups: intrinsic risk factors including age, sex, and underlying diseases, and extrinsic factors, such as invasive medical procedures.

Statistical analysis

All statistical analysis were performed using SPSS Statistics software version 20 (IBM Corporation, Armonk, NY). The results of quantitative variables were presented as mean \pm SD or median and interquartile range (IQR). Those of qualitative variables were presented as numbers and percentages. For categorical variables, we used the χ^2 test in independent samples. The measure of association was performed using the odds ratio (OR) and its 95% confidence interval (CI). To define the independent risk factors predictive of HAI, we carried out a multivariate analysis using logistic backward stepwise regression (adjusted OR [AOR]; 95% CI; *P*). The difference between the groups was considered significant when *P* < .05.

RESULTS

Patients' characteristics

Overall, 752 patients hospitalized in 26 departments within the 2 UH were eligible for this study. Of these patients, 501 (66.6%) cases were admitted to HCUH and 251 (33.3%) cases were hospitalized in HBUH. The study population consisted of 377 men (50.1%). The median age was 41.6 years (IQR = [26–61 years]). There were 422 patients aged between 15 and 59 years (56%). In total, 317 patients had an extreme age (≤ 18 years or ≥ 60 years) (42%). The median hospital stay was 8 days (IQR = [4–17] days). It was significantly higher in HBUH (*P* = .047). We found associated comorbidities such as diabetes and immune-suppression in 109 (14.5%) cases and 101 (13.4%) cases, respectively. Antibiotic treatment was used in 371 (49.2%) cases, in which 73 (20%) cases were indicated for infection prophylaxis. For patients undergoing a surgery, the main surgery wound class was clean surgery (49.6%), followed by clean/contaminated surgery (23.4%) (Table 1).

Participating departments and HAI prevalence

Of all eligible patients, 76 cases had at least 1 HAI (10%). The total number of HAI was 82, representing an overall prevalence of HAI of 10.9% (95% CI = [8.6%–13.1%]). HAI prevalence was 9.4% (95% CI = [6.8%–12%]) in the medical UH at HCUH, whereas it achieved 13.9% (95% CI = [9.6%–18.1%]) in the surgical UH at HBUH.

In HCUH, adult general medicine departments included 234 patients, in which 26 patients developed an HAI (11.1%), whereas in pediatric departments, the prevalence of HAI in general medicine achieved 19.14%. HBUH, surgical departments embedded 189 patients, with a HAI prevalence of 10% (Table 2).

Of all HAI, 52 infections were microbiologically documented (63.4%). *Pseudomonas aeruginosa* was the most common microorganism associated with HAI, accounting for 15.4% of all documented infections. HAI distribution by anatomic site revealed that respiratory tract infections were the most prevalent HAI (36.6%), in which *Aspergillus fumigatus* and *Acinetobacter baumannii* were respectively the most frequently isolated microorganisms (33.2% and 22.2%). Urinary tract infections were at the second range of HAI, with a prevalence of

Table 1
Patient characteristics

Variables	Total	HCUH	HBUH	P value
Total (N, %)	752 (100)	501 (66.6)	251 (33.4)	-
Sex (N, %)				.028
Male	377 (50.1)	237 (47.3)	140 (55.8)	
Female	375 (49.9)	264 (52.7)	111 (44.2)	
Age (median, IQR, years)	41.6 [26-61]	36.5 [21.8-54]	55.4 [34-66.4]	.09
Age categories (years)				<.001*
≤18	135 (18)	115 (23)	20 (8)	
18- <60	422 (56)	291 (58)	131 (52.2)	
≥60	195 (26)	95 (19)	100 (39.8)	
Length of stay (median, IQR, days)	8 [4-17]	9 [4-19]	7 [4-14]	.047
Transfer to another department	19 (2.5)	7 (1.4)	12 (4.8)	.005
Immunosuppression	101 (13.4)	70 (14)	31 (12.4)	.54
Neutropenia	35 (4.7)	32 (6.4)	3 (1.2)	.001
Malnutrition	73 (9.7)	56 (11.2)	17 (6.8)	.05
Obesity	42 (5.6)	31 (6.2)	11 (4.4)	.3
Tobacco use	154 (20.5)	108 (21.6)	46 (18.3)	.3
Diabetes	109 (14.5)	73 (14.6)	36 (14.3)	.9
Dyslipidemia	43 (5.7)	24 (4.8)	19 (7.6)	.12
Hypertension	116 (15.4)	72 (14.4)	44 (17.5)	.26
Antibiotic treatment	371 (49.3)	222 (43.3)	149 (59.3)	.005
Curative	298 (80)	168 (75.6)	130 (87.2)	-
Prophylactic	73 (20)	54 (24.4)	19 (12.8)	
Surgery 30 days prior to the study date	141 (18.8)	65 (13)	76 (30.3)	<.001
Invasive medical devices				<.001
Indwelling urethral catheter	87 (11.6)	31 (6.2)	56 (22.3)	<.001
PVC	378 (50.3)	227 (45.3)	151 (60.2)	<.001
CAC	6 (0.8)	0 (0)	6 (2.4)	.001
CVA	37 (4.9)	20 (4)	17 (6.8)	.09
Tracheostomy	6 (0.8)	0 (0)	6 (2.4)	.001
Endo-tracheal intubation	28 (3.7)	12 (2.4)	16 (6.4)	.007
Parenteral feeding	24 (3.2)	10 (2)	14 (5.6)	0.008
Mechanical ventilation	30 (4)	12 (2.4)	18 (7.2)	0.002

NOTE. Bold values are statistically significant ($P < .05$).

CAC, central arterial catheter; CVA, central venous catheter; HBUH, Habib Bourguiba University Hospital; HCUH, Hedi Chaker University Hospital; IQR, interquartile range; N, number; PVC, peripheral venous catheter.

* $P < .001$ significantly different between the 3 age categories in each pair comparison.

17.1%. *Escherichia coli* and *Klebsiella pneumoniae* were the most predominant pathogens in the cytobacteriological exam of urine (36.3% and 27.3%, respectively). As for surgical site infections, their prevalence was 14.6% of all HAI; they were bacteriologically documented in 11 (91.6%) cases. *Pseudomonas aeruginosa* and *Staphylococcus aureus* were the most common organisms causing a surgical site infection (18%) (Table 3).

Table 2
The prevalence of HAI according to ward specialty and university hospital

University hospital/ward specialty	All enrolled patients	Number of HAI	Prevalence of HAI (%)
Total patients	752	82	10.9
HCUH (Total)	501	47	9.4
Adult departments	398	32	8
General medicine	234	26	11.1
Hematology	28	9	32.14
Other general medicine departments	206	17	8.25
Gynecology and obstetrics	66	4	6.06
Adult psychiatric unit	98	2	2
Pediatric departments	103	15	14.5
General medicine	47	9	19.14
Neonatology	36	2	5.6
Neuro-pediatrics	8	2	25
Pediatric surgery	8	2	25
Pedopsychiatric	4	0	0
HBUH (Total)	251	35	13.9
Surgery	189	19	10
Intensive care	21	13	62
General medicine (neurology, oncology, radiotherapy)	41	3	7.3

HAI, health care-associated infections; HBUH, Habib Bourguiba University Hospital; HCUH, Hedi Chaker University Hospital.

Risk factors

Intrinsic risk factors

Comparison of risk factors associated with HAI using univariate analysis revealed that the intrinsic factors increasing the risk of HAI were neutropenia (OR = 3.35; $P = .005$), immune-suppression (OR = 2.84; $P < .001$), diabetes (OR = 2; $P = .016$) and extremes of age (OR = 1.9; $P = .007$). HAI were equally distributed between men and women (OR = 1.25, $P = .34$). Moreover, McCabe index (OR = 4; $P < .001$), ASA grade ≥ 2 (OR = 2.5; $P = .039$), and malnutrition (OR = 2.2; $P = .022$) were significantly associated with HAI. Subsequent to multivariate analysis, 3 variables have been proved as independent intrinsic risk factors of HAI occurrence: immune-suppression (AOR = 2.8; $P < .001$), diabetes (AOR = 2.2; $P = .008$), and malnutrition (AOR = 2.2; $P = .019$) (Table 4).

Extrinsic risk factors

Univariate analysis showed that transfer to another department (OR = 8.9; $P < .001$), surgery 30 days prior to the study date (OR = 3.3; $P < .001$), and surgical wound class contaminated or dirty (OR = 2.6; $P = .023$), as well as tobacco use (OR = 1.8; $P = .026$) were found to be significantly more frequent in patients with HAI. As for invasive care exposures, urethral catheter (OR = 3.8; $P < .001$), peripheral (OR = 2; $P = .004$) and central venous catheter (OR = 9.4; $P < .001$), as well as parenteral feeding (OR = 8.6; $P < .001$) were statistically associated with HAI. Furthermore, respiratory tract invasive exposures such as tracheostomy (OR = 18.7; $P < .001$), endotracheal intubation (OR = 12.5; $P < .001$), and mechanical ventilation (OR = 12.6; $P < .001$) were significantly predictive of HAI. Of these several factors, multivariate analysis showed that endotracheal intubation (AOR = 17; $P = .01$), transfer to another department (AOR = 9; $P = .019$), parental feeding (AOR = 7.2; $P = .014$), tobacco use (AOR = 6.3; $P = .004$), as well

Table 3
Distribution of HAI by anatomic site and isolated microorganisms

Anatomic site	HAI (N, %)		Isolated microorganisms (N, %)												
	82 (100)	10.9	HAI (Pr)	Total	Ec	Kp	Ef	Other enterobacteria	Sa	Ab	Pa	Sp	Nm	Ca	Af
All HAI	82 (100)	10.9	HAI (Pr)	52 (63.4)	5 (9.6)	5 (9.6)	3 (5.8)	6 (11.5)	3 (5.8)	6 (11.5)	8 (15.4)	4 (7.7)	2 (3.8)	4 (7.7)	6 (11.5)
Respiratory tract	30 (36.6)	4		18 (60)	0	1 (5.5)	1 (5.5)	2 (11.1)	0	4 (22.2)	3 (16.6)	1 (5.5)	0	0	6 (33.3)
Urinary tract	14 (17.1)	1.86		11 (78.5)	4 (36.3)	3 (27.3)	1 (7.1)	1 (9)	0	0	0	1 (9)	0	1 (9)	0
Surgical site	12 (14.6)	1.6		11 (91.6)	1 (9)	0	1 (9)	2 (18)	2 (18)	1 (9)	2 (18)	1 (9)	1 (9)	0	0
Eye, ear, nose, throat, and mouth	6 (7.3)	0.8		1 (16.6)	0	0	0	0 (0)	0	0	0	0	0	1 (100)	0
Bloodstream	5 (6.1)	0.66		5 (100)	0	1 (20)	0	0 (0)	1 (20)	1 (20)	2 (40)	0	0	0	0
Cardiovascular system	4 (4.9)	0.53		2 (50)	0	0	0	1 (50)	0	0	0	0	0	1 (50)	0
Skin and soft tissue	3 (3.6)	0.4		2 (66.6)	0	0	0	0 (0)	0	0	1 (50)	0	0	1 (50)	0
Central nervous system	3 (3.6)	0.4		3 (100)	0	0	0	0 (0)	0	0	0	0	0	0	0
Gastrointestinal tract	4 (4.9)	0.53		0	-	0	0	0 (0)	0	0	0	2 (66.6)	1 (33.3)	0	0
Reproductive tract	1 (1.2)	0.13		0	-	0	0	0 (0)	0	0	0	0	0	0	0

Ab, *Acinetobacter baumannii*; Af, *Aspergillus fumigatus*; Ca, *Candida albicans*; Ec, *Escherichia coli*; Ef, *Enterococcus faecalis*; HAI, health care-associated infections; Kp, *Klebsiella pneumoniae*; Nm, *Neisseria meningitidis*; N, number; Pa, *Pseudomonas aeruginosa*; Pr, prevalence of HAI among 752 patients; Sa, *Staphylococcus aureus*; Sp, *Streptococcus pneumoniae*.

as surgical wound class contaminated or dirty (AOR = 6.3; $P = .002$), and peripheral venous catheter (AOR = 4.7; $P = .006$) were independently associated with HAI (Table 5).

DISCUSSION

HAI are a serious patient safety issue in health care structures worldwide, thus, surveillance analysis is an imperative prerequisite for care quality and prevention control. Several countries have attempted to measure the burden and the determinants of HAI.² Otherwise, adherence and reliability of data are a major challenge in developing countries. In this perspective, prevalence surveys have proved their usefulness in HAI monitoring.⁹ Given their lower cost and rapidity of execution, they represent the best method to estimate the global impact and to implement prevention policy in limited resources countries.

The overall prevalence of HAI in our UH was 10.9%, which agreed with previously published studies in low- and middle-income countries: it was 10.9% in Sénégal,¹⁰ and ranged from 6.7%–28% in sub-Saharan Africa.^{11,12} A meta-analysis conducted in 2011 showed that the prevalence of HAI was globally 15.5% in low- and middle-income countries.² Otherwise, our HAI prevalence rate was substantially higher than the developed countries. It has been estimated as 7.1% in Europe,¹³ 6% in Florida,¹⁴ 3.6% in Italy,¹⁵ and 6.8% in Norway.¹⁶ At a regional level, estimated HAI rates were disparate when comparing with other UH in Tunisia: it was 14.4% in Sousse,¹⁷ and 5.4% in the central east of Tunisia.¹⁸ Possible explanations for these disparities may be differences in criteria for adopted definitions of HAI, data collection procedures, number and type of infective sites, as well as the vocation and the size of the studied UH. Moreover, the risk of HAI is dependent on the patient's immune status, infection control practices, and the prevalence of the various pathogens in the local community.³ Poor hygiene and the high cost of alcohol-based hand disinfectant, that is not available at the bed side of all patients, may also explain, in part, the higher prevalence rate of HAI in the developing countries.

HAI prevalence varied according to the UH and department activities. In our survey, it was higher in HBUH (13.9%) than HCUH (9.4%). Certainly, HCUH vocation is mainly medical care, whereas HBUH is specialized essentially in surgeries, in which the use of invasive medical devices was significantly more frequent. Additionally, HAI rate was markedly higher in intensive care units (62%) than in general wards, which was consistent with previous published studies.^{19,20} Reasons could be attributed to the presence of a rapidly fatal disease, a prolonged hospital stay, and more exposure to indwelling devices for diagnostic or therapeutic indication in the intensive care units. General pediatric departments have recorded a relatively high prevalence of HAI (19.14%), which was similar to the European survey in 2012 (20.2%).²¹ A closer look revealed that this unacceptably high rate might be because of the lack of a pediatric-specific standardized quality programs, because this age group is particularly characterized by an immature immune system and a higher infection susceptibility.²² New pediatric researches in the area of HAI control practices with a focus on the importance of collaboration among pediatric hospitals are highly recommended to elucidate novel approaches to preventing HAI.²³

Similar to our results, the 3 most frequently reported HAI in literature were respiratory tract, urinary tract, and surgical site infections. They respectively accounted for 15.5%, 15.5%, and 31% in Florida,¹⁴ and represented 21%, 21.5%, and 18.4% of the total HAI in Slovenia, respectively.¹⁹

Globally, the predominant isolated microorganisms were essentially gram-negative bacilli, such as *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Escherichia coli*, and *Klebsiella pneumoniae*. This figure was at the same range of previous Tunisian and international

Table 4
Intrinsic risk factors associated with HAI: results of univariate and multivariate analysis

Risk factors	Presence of HAI (N = 76)		Absence of HAI (N = 676)		P value	Crude OR [95% CI]	Adjusted OR [95% CI]	P value
	N	%	N	%				
Intrinsic risk factors								
Male	42	55.3	335	49.6	.34	1.25 [0.83-2]		
Immunosuppression	21	27.6	80	11.8	<.001	2.8 [1.6-4.9]	2.8 [1.6-5]	<.001
Neutropenia	9	11.8	26	3.8	.005	3.35 [1.5-7.4]		
Malnutrition	13	17.1	60	8.9	.022	2.2 [1.1-4.1]	2.2 [1.1-4.3]	.019
Extremes of age*	43	56.6	274	40.5	.007	1.9 [1.18-3]		
Diabetes	18	23.7	91	13.5	.016	2 [1.1-3.5]	2.2 [1.2-3.9]	.008
Dyslipidemia	5	6.5	38	5.6	.79	1.2 [0.45-3.1]		
Obesity	2	2.6	40	5.9	.3	0.4 [0.1-1.8]		
Hypertension	11	14.5	105	15.5	.81	0.9 [0.47-1.8]		
McCabe Index					<.001			
Non-fatal disease	36	47.4	540	80	-	1		
Ultimately fatal disease	26	34.2	97	14.3	<.001	4 [2.3-6.9]		
Rapidly fatal disease	14	18.4	39	5.8	<.001	5.3 [2.6-10.8]		
ASA Score ≥ 2 (vs 0/1) [†]	22	73.3	58	52.2	.039	2.5 [1.6-1]		

NOTE. Bold values are statistically significant ($P < .05$).

ASA, American Society of Anesthesiologists; CI, confidence interval; HAI, health care–associated infections; OR, odds ratio.

*Extremes of age ≤ 18 years or ≥ 60 years.[†]ASA score calculated for 141 patients who had undergone surgery (30 cases had HAI, 111 did not have HAI).**Table 5**
Extrinsic risk factors associated with HAI: results of univariate and multivariate analysis

Risk factors	Univariate analysis				Multivariate analysis			
	Presence of HAI (N = 76)	Absence of HAI (N = 676)	P value	Crude OR [95% CI]	Adjusted OR [95% CI]	P value		
Tracheostomy	4	5.3	2	0.3	.001	18.7 [3.3-25]		
Mechanical ventilation	16	21.1	14	2.1	<.001	12.6 [5.8-27]		
Endotracheal intubation	15	19.7	13	1.9	.001	12.5 [5.7-27]	17 [3.2-90]	.01
Central venous catheter	17	22.4	20	3	<.001	9.4 [4.6-19]		
Transfer to another department	9	11.8	10	1.5	<.001	8.9 [3.5-22.7]	9 [1.8-37]	.019
Parenteral feeding	11	14.5	13	1.9	<.001	8.6 [3.7-20]	7.2 [1.4-35]	.014
Central arterial catheter	2	2.6	4	0.6	.11	4.5 [0.8-25.1]		
Indwelling urethral catheter	22	29	65	9.6	<.001	3.8 [2.2-6.9]		
Surgery 30 days prior to the study date	30	39.5	111	16.4	<.001	3.3 [2-5.4]		
Surgical wound class contaminated or dirty	13	43.3	25	22.5	.023	2.6 [1.1-6.1]	6.3 [2-20]	.002
Peripheral venous catheter	50	65.8	328	48.5	.004	2 [1.2-3.3]	4.7 [1.56-14]	.006
Tobacco use	23	30.3	131	19.4	.026	1.8 [1.1-3]	6.3 [1.7-22.3]	.004

NOTE. Bold values are statistically significant ($P < .05$).

CI, confidence interval; HAI, health care–associated infections; OR, odds ratio.

studies.^{17,18,24-26} These pathogens tend to colonize in warm and moist areas such as the inguinal and perineal area, axilla, and trunk because they have the ability to form tough biofilms around catheters.³ Moreover, we found that *Aspergillus fumigatus* accounted for 11.5% of all documented infections. Several previous studies reported that *Aspergillus* species are a main cause of HAI, as they tend to occur in patients with more significant immune-suppression and prolonged neutropenia.²² Two important points can be surmised; first, the documented infection rate could be underestimated because of the lack of adequate isolation facilities, basic equipment, and trained personnel in our UH; second, bacteriological profile should be interpreted according to the epidemiological, ecological, and environmental specificities of each country.

Many intrinsic risk factors may take part in the genesis of HAI. In literature, factors considerably linked to HAI included immune-suppression,^{17,27} diabetes, and malnutrition.^{7,28} Likewise, neutropenia,^{7,29} high McCabe Index,³⁰ and ASA grade³¹ were recognized as potential risk factors of HAI. These findings were mostly coherent with our results. Our hypothesis is that these patients with fatal underlying conditions were commonly at a terminal stage when they were highly immune-suppressed, resulting in a high susceptibility to HAI and multidrug-resistant pathogens. Otherwise, sex was not statistically associated with HAI,^{32,33} as it was shown in our study.

Extrinsic risk factors were widely described in literature. It has been reported that transmission of pathogens can occur by direct

contact with health care workers or contaminated environment.³ Several studies showed that a history of surgery 30 days prior to admission, recent exposure to invasive medical devices, and mechanical ventilator support were identified as HAI risk factors,^{17,25} which was consistent with our study. Central and peripheral venous catheters were statistically associated with HAI occurrence.¹⁹ Infection on catheters depends on its installation quality, maintenance care, and ablation delay. Similar to our results, endotracheal intubation¹⁹ and parenteral feeding³⁴ were independently associated with HAI occurrence. Furthermore, patient transfer to another department and tobacco use were statistically associated with HAI. Likewise, a previous study demonstrated that transferring patients between facilities could plausibly act as a mechanism for epidemiologic spread of nosocomial infections.³⁵ This is an important finding that may help health care professionals to address effective targeted interventions in HAI control, because it is a daily act that should be done safely if simple hygiene precautions were correctly applied. As for tobacco use, it has been reported that smoking increases function of leukocytes, including neutrophils, providing a mechanistic explanation for increased infection risk.³⁶ For these reasons, targeted prevention strategies should be implemented in our local area as a public health priority, to reduce HAI emergence and microbial acquired resistance. Next, universal standard precautions, such as handwashing with soap and water or alcohol-based disinfectant before and after seeing every patient, are essential to minimize transmission rates.

CONCLUSIONS

Our study provided an insight into the magnitude of HAI problem threatening the quality of care in Southern Tunisia. HAI prevalence was in the range of other recent studies but remained substantial in comparison with developed countries. A wise identification and an objective evaluation of HAI risk factors may help health care workers to manage these infections. Prevalence surveys suggest the development of a national infection control and monitoring system. Interventions to manage the spread of these infections require an adequate provision of a well-trained medical staff, with a focus on the importance of hand hygiene, rational use of antimicrobial combinations, and injection safety precautions.

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