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Prevalence of Nosocomial Bacterial Infections and their Patterns of Antibiotics Susceptibility among Hospitalized Patients: A Seven-Year Retrospective Study

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ABSTRACT

Background: Nosocomial infection (NI) is a major public health challenge among patients having surgical sites infections (SSIs), blood stream infections (BSIs), and urinary tract infections (UTIs). These illnesses, if not perfectly treated, may cause a high rate of morbidity and mortality.
Objective: This study aimed to evaluate the profiles of resistance to antibiotics of pathogenic bacteria involved in nosocomial SSIs, UTIs, and BSIs.
Methods: This retrospective descriptive study involved hospitalized patients enrolled in hospitals at Mukalla city, Hadhramout, Yemen for 7-years period (2014-2020). Clinical samples of UTIs, SSIs and BSIs were collected. Bacterial isolates were identified by the standard procedures of sampling culture and biochemical methods. Standard disc diffusion (Kirby-Bauer) method was performed for antimicrobial susceptibility testing. The variables of sex, age, and type of infection were obtained from study population.
Results: Of 653 hospitalized patients, 326 (49.9%) tested positive for bacterial infection. Of these (58.0%) were UTIs, (29.1%) SSIs and (12.9%) BSIs. In terms of bacterial strains distribution, (47.9%) were Gram-positive, and (52.1%) were Gram-negative bacteria. The majority of bacterial isolated from UTIs were *Escherichia coli* (48.6%) followed by *Staphylococcus aureus* (21.6%), and the most bacterial isolated from BSIs were *Staphylococcus aureus* (50.0%) followed by *Escherichia coli* 19.0%. Moreover, *Staphylococcus aureus* (55.7%) and coagulase negative staphylococci (CoNS) (17.8%) were the most prevalent bacteria identified in SSIs. Bacterial isolated showed a significant of antibiotics resistance.
Conclusions: Treatment of bacterial NI must be verified by bacterial culturing and the antibiotics susceptibility to select the effective drug and prevent antibiotics resistance development.

Keywords: Health care associated infections, Urinary tract infections, Antimicrobial resistance patterns; Bacterial isolates, Hospital.

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INTRODUCTION

Nosocomial infections (NIs) also called Health care associated infections (HAIs) are commonly diseases cases that follow hospital admissions that lasted about 48–72 hours, and still stay a worldwide health problem and one of the important cause of antibiotics resistance among hospitalized patients (1). Bacteria are commonly the prominent cause of NIs, and the hospitals transmission occurs by the cross-contamination of hands contaminated of patients by health care staffs in which frequent contact with patients or by the contamination of objects (2,3). The most frequent kinds of NIs are surgical site infections (SSIs), urinary tract infection (UTIs), bloodstream infections (BSIs), gastroenteritis, and respiratory system (4).

The essential pathogenic bacteria contributed with NIs are *Staphylococcus aureus, Streptococcus pneumoniae,* coagulase negative staphylococci (CoNS), *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Haemophilus influenzae, Enterococci* and Acinetobacter (5-7). The emergence of bacterial resistance to antibiotics has become a major public health challenge, establishing a new burden on modern medical care in hospitals (8). The most common antibiotic-resistant pathogens are *S. aureus, P. aeruginosa, Klebsiella* spp., Enterococci spp., and Enterobacter spp. (9,10).

A recent annually report of World Health Organization (WHO) indicates about hundreds of millions of individuals acquired NIs including the most developed countries. This report showed that 15 of patients out of every one hundred will be acquire at least one NI in developing countries, while 1 out of every 10 infected patients will be die because the NIs. The report found that while the real burden in underdeveloped nations is still unknown, the risk of NIs is global and affects all healthcare facilities and systems globally. NIs occurrence cases is 2–3 times higher in developing countries compared to developed countries (11).

In this study, NIs defined as onset >48 hours after admission, exclusion of pre-admission cases. The significance of understanding the causative bacterial pathogens and antibiotic sensitivity profile is underscored by the high prevalence of NIs in patients with UTIs, SSIs, and BSIs. In our knowledge, there are no accurate statistical information on the prevalence of NIs, their adverse health effects, and financial complications in Yemen. Also, data on NIs are lacking in Hadhramout governorate; hence this study was carried out to estimate the incidence of NIs and characterize the bacterial pathogens and antibiotics resistance profiles over a 7-years period as a first step to reduce NIs at Mukalla city Hospitals, Hadhramout, Yemen.

METHODOLOGY

Samples Collection

This retrospective descriptive (record review) study was carried out on hospitalized patients with clinical diagnosis of UTIs, SSIs and BSIs at the Hospitals of Mukalla city, Hadhramout, Yemen. The patients had undergone urine, wound discharges and blood sampling, then transported with proper transport media to the department of medical microbiology at the national centre of public health central laboratories in Mukalla, Hadhramout, Yemen and processed. Criteria of NIs were matched to definitions of the centre for disease control and prevention (CDC) (12).

A total of 653 samples were collected between 2014-2020, with data from hospitalized patients analysed for bacterial identification and antibiotics sensitivity.

Identification of Bacterial Culture

All samples collected were inoculated into blood agar and MacConkey agar (Oxoid, Ltd., UK). The plates were incubated at 37°C overnight. Each plate was examined after 24 hours of incubation, and the negative plates were incubated for another 24 hours. Bacterial species were identified by the colonies features, Gram stain and divers biochemical tests reaction according to standard methods (13).

Antibiotics Susceptibility Testing

In accordance with the requirements of the Clinical and Laboratory Standards Institute (CLSI), the isolates were tested for in vitro antibiotic susceptibility using the Kirby-Bauer disk diffusion method (14). In briefly, the standard bacterial suspension inoculum was evenly disseminated across the Mueller Hinton agar (Oxoid, Ltd., UK) surface after being adjusted to a turbidity of 0.5 McFarland standard, then incubated overnight at 37°C. Disks of antibiotics (Bioanalyse, USA) of co-trimoxazole (26 µg), amikacin (30 µg), ciprofloxacin (5 µg), doxycycline (30 µg), ceftriaxone (30 µg),

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ciprofloxacin (5 µg), cefadroxil (30 µg), nalidixic acid (30 µg), lincomycin (15µg), azithromycin (15 µg), cefuroxime (30 µg), kanamycin (1000 µg), amoxicillin (30 µg), and cephalexin (30 µg) were applied on Mueller Hinton agar plates. The inhibition zone diameter was measured and interpreted as sensitive, intermediate sensitive or resistant according to the standard criteria (14). The reference strains of *Escherichia coli* ATCC 25922 and *Staphylococcus aureus* ATCC 25923 were used as quality control strains measure for the criteria of phenotypic identification and antibiotics sensitivity testing.

Ethical Approval

This research was authorized by the Research Ethics Committee of Faculty of Sciences, Hadhramout University, Yemen (Ethical approval no. 2/2021). Databases were used to gather clinical and laboratory management data about the patients. The study was consistent with the principles of the Helsinki Declaration.

Data Analysis

The data were analysed using Statistical Package for Social Sciences (SPSS) software (version 24; IBM SPSS Inc., New York, USA). The descriptive statistics were computerized, and the variables of sex, age and bacterial species were obtained from the study population. The tables show the frequency of isolated NIs bacteria. Also, the percentage of antibiotics resistance was compared. Chi-square test values <0.05 for the categorical variables were considered significant.

RESULTS

Incidence of Nosocomial Infection in UTIs, SSIs and BSIs Patients

In this study, 653 urine, wound discharges and blood samples obtained from UTIs, SSIs and BSIs patients were processed. As presented in (Table 1), (49.9%) of patients were bacterial growth positive, while (50.1%) were negative. Among the isolated bacterial species, (47.9%) was Gram-positive bacteria, while (52.1%) was Gram-negative bacteria. This study showed a high frequency of NIs in females compared to males (51.2%). Also, most cases in age group 31-40 years were observed (19.6%). A large number of participants were admitted to urology ward (58.0%), followed by general surgery (29.1%), and medical wards (12.9%).

Table 1: Characteristics of NIs among UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Characteristics	**No. (%)**
No bacterial growth	327(50.1)
Bacterial growth	326(49.9)
Gram positive bacteria	156(47.9)
Gram negative bacteria	170(52.1)
Gender	
Male	159(48.8)
Female	167(51.2)
Age groups	
Less than 10 years	36(11.0)
10-20 years	35(10.7)
21-30 years	41(12.6)
31-40 years	64(19.6)
41-50 years	51(15.6)
51-60 years	40(12.3)
More than 60 years	59(18.2)
Wards distribution	
Medical	42(12.9)
General surgery	95(29.1)
Urology	189(58.0)

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In this study, statistical analysis showed a significant correlation between bacterial nosocomial infection prevalence and gender (P=0.01), while the correlation was not significant between the types of NIs and the age groups (P = 0.253) (Tables 2 and 3).

Table 2: Correlation between gender and NIs among UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Type of NI	**Gender No. (%)**			**χ2 value**	**P-value**
	Male	Female	Total		
SSI	63 (9.6)	32 (4.9)	95 (14.5)	16.548	0.01
BSI	18 (2.8)	24 (3.7)	42 (6.5)		
UTI	78 (11.9)	111 (17.0)	189 (28.9)		
Total	159 (24.3)	167 (25.6)	326 (49.9)		

Key: NI; Nosocomial infections, SSI; Surgical site infections, BSI; Bloodstream infections, UTI; Urinary tract infections

Table 3: Correlation between age groups and NIs among UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Type of NI	**Age groups No. (%)**								**χ2 value**	**P-value**
	>10	10-20	21-30	31-40	41-50	51-60	<60	Total		
SSI	11(1.7)	12(1.8)	13(2.0)	18(2.7)	18(2.7)	10(1.5)	13(2.0)	95(14.5)	14.797	0.253
BSI	8(1.2)	7(1.1)	8(1.2)	5(0.8)	5(0.8)	4(0.6)	5(0.7)	42(6.5)		
UTI	17(2.6)	16(2.5)	20(2.1)	41(6.3)	28(4.3)	26(4.0)	41(6.3)	189(28.9)		
Total	36(5.5)	35(5.4)	41(6.3)	64(9.8)	51(7.8)	40(6.1)	59(9.0)	326(49.9)		

Key: NI; Nosocomial infections, SSI; Surgical site infections, BSI; Bloodstream infections, UTI; Urinary tract infections

As given in (Table 4), the distribution of NIs types at Mukalla hospitals 189(58.0%) were *UTIs*, followed by 95 (29.1%) SSIs and 42 (12.9%) *BSIs*. Bacterial species which appertain to 9 genera, were identified by 326 positive cultures. E. coli (48.6%), followed by *S. aureus* (21.6%) were the most common bacteria identified in *UTIs.* The most common pathogenic bacteria in SSIs were *S. aureus* (55.7%), followed by CoNS (17.8%) and *E. coli* (13.7%). The most common bacteria in circulatory infections were *S. aureus* (50.0%), followed by *E. coli* (19.0%) and CoNS (11.9%).

Table 4: Isolation rates of bacterial agents considering nosocomial UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Bacterial isolates	**UTIs No. (%)**	**SSIs No. (%)**	**BSIs No. (%)**	**Total No. (%)**
S. aureus	41(21.6)	53(55.7)	21(50.0)	115(35.3)
CoNS	15(8.0)	17(17.8)	5(11.9)	37(11.3)
E. faecalis	2(1.1)	1(1.1)	1(2.4)	4(1.2)
E. coli	92(48.6)	13(13.7)	8(19.0)	113(34.7)
K. pneumoniae	7(3.7)	0(0.0)	0(0.0)	7(2.1)
P. aeruginosa	6(3.2)	7(7.4)	1(2.4)	14(4.3)
Proteus spp.	10(5.3)	3(3.2)	2(4.8)	15(4.6)
Citrobacter spp.	9(4.8)	0(0.0)	1(2.4)	10(3.1)
Enterobacter spp.	5(2.6)	1(1.1)	3(7.1)	9(2.8)
Serratia spp.	2(1.1)	0(0.0)	0(0.0)	2(0.6)
Total	189(58.0)	95(29.1)	42(12.9)	326(100.0)

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Profile of Antibiotics Resistance of Bacterial Isolates

The antibiotics susceptibility patterns of nosocomial bacterial isolates were evaluated and the greater number of antibiotics were investigated (Table 5). The antibiotics resistance patterns for each bacterial isolates by type of NIs shown in (Table 6). All bacterial isolates showed high and varying resistance to azithromycin (48.2%), cefuroxime (35.8%), co-trimoxazole (35.7%), amikacin (35.1%), and ceftriaxone (30.8%). There was a higher antibiotics sensitivity in some studied antibiotics such as amoxicillin (91.5%), cefadroxil (86.4%), kanamycin (83.2%), ciprofloxacin (80.1%) and cephalexin (78.4%), nalidixic acid (79.1%), lincomycin (76.2%), and doxycycline (75.8%). Gram-negative bacterial isolates had presented greater resistance to azithromycin, co-trimoxazole, ceftriaxone, amikacin and cefuroxime. Gram-positive bacteria reported resistant to azithromycin, co-trimoxazole, cefuroxime and amikacin (Table 7).

Table 5: Sensitivity and resistance percentages of bacterial isolated from nosocomial UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Antibiotics	Tested isolates	Sensitivity (%)	Resistance (%)
Co-trimoxazole	322	207(64.3)	115(35.7)
Azithromycin	326	169(51.8)	157(48.2)
Amikacin	322	209(64.9)	113(35.1)
Ceftriaxone	315	218(69.2)	97(30.8)
Cephalexin	296	232(78.4)	64(21.6)
Ciprofloxacin	326	261(80.1)	65(19.9)
Cefuroxime	324	208(64.2)	116(35.8)
Cefadroxil	317	274(86.4)	43(13.6)
Doxycycline	326	247(75.8)	79(24.2)
Kanamycin	322	268(83.2)	54(16.8)
Lincomycin	324	247(76.2)	77(23.8)
Amoxicillin	305	279(91.5)	26(8.5)
Nalidixic acid	320	253(79.1)	67(20.9)

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Table 6: The antibiotics resistance patterns for bacterial isolates by type of NIs among UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Bacterial species	**Type of NIs**	**Antibioticcs resistance patterns**		
		Sensitive (%)	Resistance (%)	Total (%)
S. aureus	SSI	99(54.4%)	83(45.6%)	182(100%)
	BSI	26(43.3%)	34(56.7%)	60(100%)
	UTI	53(49.1%)	55(50.9%)	108(100%)
CoNS	SSI	39(63.9%)	22(36.1%)	61(100%)
	BSI	0(0.0%)	5(100%)	5(100%)
	UTI	19(47.5%)	21(52.5%)	40(100%)
E. faecalis	SSI	0(0.0%)	1(100%)	1(100%)
	BSI	0(0.0%)	0(0.0%)	0(0.0%)
	UTI	1(16.7%)	5(83.3%)	6(100%)
E. coli	SSI	21(58.3%)	15(41.7%)	36(100%)
	BSI	10(45.5%)	12(54.5%)	22(100%)
	UTI	135(38.9%)	212(61.1%)	347(100%)
K. pneumoniae	SSI	0(0.0%)	0(0.0%)	0(0.0%)
	BSI	0(0.0%)	0(0.0%)	0(0.0%)
	UTI	9(47.4%)	10(52.6%)	19(100%)
P. aeruginosa	SSI	13(33.3%)	26(66.7%)	39(100%)
	BSI	4(80.0%)	1(20.0%)	5(100%)
	UTI	11(47.8%)	12(52.2%)	23(100%)
Proteus spp.	SSI	5(55.6%)	4(44.4%)	9(100%)
	BSI	2(50.0%)	2(50.0%)	4(100%)
	UTI	8(33.3%)	16(66.7%)	24(100%)
Citrobacter spp.	SSI	0(0.0%)	0(0.0%)	0(0.0%)
	BSI	1(25.0%)	3(75.0%)	4(100%)
	UTI	6(20.7%)	23(79.3%)	29(100%)
Enterobacter spp.	SSI	2(66.7%)	1(33.3%)	3(100%)
	BSI	2(20.0%)	8(80.0%)	10(100%)
	UTI	7(53.8%)	6(46.2%)	13(100%)
Serratia spp.	SSI	0(0.0%)	0(0.0%)	0(0.0%)
	BSI	0(0.0%)	0(0.0%)	0(0.0%)
	UTI	5(50.0%)	5(50.0%)	10(100%)

CoNS: Coagulase-negative Staphylococci; NI; Nosocomial infections, SSI; Surgical site infections, BSI; Bloodstream infections, UTI; Urinary tract infection

Table 7: Antibiotics susceptibility patterns of bacterial isolated from nosocomial UTIs, SSIs and BSIs patients at Mukalla hospitals, Hadhramaut/Yemen during 2014-2020.

Bacterial spp.	**Total isolates**	**Pattern**	**Antibiotics susceptibility patterns No. (%)**												
			COT	AZM	AK	CTR	CN	CIP	CXM	CFR	DO	K	L	AML	NA
S. aureus	115	S	76(66.1)	60(52.2)	82(71.3)	87(75.7)	93(80.9)	92(80.0)	75(65.2)	101(87.8)	90(78.3)	97(84.3)	94(81.7)	107(93.0)	97(84.3)
		R	39(33.9)	55(47.8)	33(28.7)	28(24.3)	22(19.1)	23(20.0)	40(34.8)	14(12.2)	25(21.7)	18(15.7)	21(18.3)	8(7.0)	18(15.7)
CoNS	37	S	24(64.9)	28(75.7)	20(54.1)	28(75.7)	27(73.0)	29(78.4)	28(75.7)	31(83.8)	32(86.5)	29(78.4)	25(67.6)	33(89.2)	30(81.1)
		R	13(35.1)	9(24.3)	17(45.9)	9(24.3)	10(27.0)	8(21.6)	9(24.3)	6(16.22)	5(13.5)	8(21.6)	12(32.4)	4(10.8)	7(18.9)
E. faecalis	4	S	NA	3(75.0)	NA	NA	NA	3(75.0)	3(75.0)	3(75.0)	3(75.0)	NA	3(75.0)	3(75.0)	NA
		R	NA	1(25.0)	NA	NA	NA	1(25.0)	1(25.0)	1(25.0)	1(25.0)	NA	1(25.0)	1(25.0)	NA
E. Coli	113	S	70(61.9)	55(48.7)	73(64.6)	71(62.8)	89(78.8)	89(78.8)	73(64.6)	98(86.7)	82(72.6)	98(86.7)	86(76.1)	104(92.0)	86(76.1)
		R	43(38.1)	58(51.3)	40(35.4)	42(37.2)	24(21.2)	24(21.2)	40(35.4)	15(13.3)	31(27.4)	15(13.3)	27(23.9)	9(8.0)	27(23.9)
K. pneumoniae	7	S	6(85.7)	4(57.1)	5(71.4)	NA	NA	5(71.4)	4(57.1)	NA	5(71.4)	6(85.7)	5(71.4)	6(85.7)	5(71.4)
		R	1(14.3)	3(42.9)	2(28.6)	NA	NA	2(28.6)	3(42.9)	NA	2(28.6)	1(14.3)	2(28.6)	1(14.3)	2(28.6)
P. aeruginosa	14	S	9(64.3)	5(35.7)	7(50.0)	8(57.1)	11(78.6)	11(78.6)	6(42.9)	11(78.6)	9(64.3)	10(71.4)	7(50.0)	13(92.9)	8(57.1)
		R	5(35.7)	9(64.3)	7(50.0)	6(42.9)	3(21.4)	3(21.4)	8(57.1)	3(21.4)	5(35.7)	4(28.6)	7(50.0)	1(7.1)	6(42.9)
Proteus spp.	15	S	11(73.3)	7(46.7)	12(80.0)	13(86.7)	11(73.3)	14(93.3)	10(66.7)	13(86.7)	14(93.3)	13(86.7)	12(80.0)	13(86.7)	13(86.7)
		R	4(29.7)	8(53.3)	3(20.0)	2(13.3)	4(26.7)	1(6.7)	5(33.3)	2(13.3)	1(6.7)	2(13.3)	3(20.0)	2(13.3)	2(13.3)
Citrobacter spp.	10	S	6(60.0)	3(30.0)	5(50.0)	4(40.0)	NA	9(90.0)	2(20.0)	9(90.0)	5(50.0)	8(80.0)	9(90.0)	NA	6(60.0)
		R	4(40.0)	7(70.0)	5(50.0)	6(60.0)	NA	1(10.0)	8(80.0)	1(10.0)	5(50.0)	2(20.0)	1(10.0)	NA	4(40.0)
Enterobacter Spp.	9	S	5(55.6)	4(44.4)	5(55.6)	6(66.7)	NA	8(88.9)	7(77.8)	8(88.9)	7(77.8)	6(66.7)	6(66.7)	NA	8(88.9)
		R	4(44.4)	5(55.6)	4(44.4)	3(33.3)	NA	1(11.1)	2(22.2)	1(11.1)	2(22.2)	3(33.3)	3(33.3)	NA	1(11.1)
Serratia spp.	2	S	0(0.0)	0(0.0)	0(0.0)	1(50.0)	1(50.0)	1(50.0)	NA	NA	0(0.0)	1(50.0)	NA	NA	NA
		R	2(100.0)	2(100.0)	2(100.0)	1(50.0)	1(50.0)	1(50.0)	NA	NA	2(100.0)	1(50.0)	NA	NA	NA

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CoNS: Coagulase-negative Staphylococci; S: sensitive; R: resistance; COT: Co-trimoxazole; AZM: Azithromycin; AK: Amikacin; CTR: Ceftriaxone; CN: Cephalexin; CIP: Ciprofloxacin; CXM: Cefuroxime; CFR: Cefadroxil; DO: Doxycycline; K: Kanamycin; L: Lincomycin; AML: Amoxicillin; NA: Nalidixic acid; NA: Not applicable.

DISCUSSION

Nosocomial infection and the spread of antibiotics resistant NIs is one of the major public health concerns worldwide (8,15). Increasing the antibiotics resistance among bacteria causing NIs is related with a high death rates among hospitalized patients (9,16).
In this study, culture confirmed the NIs prevalence was (49.9%), and this rate was lower than a previous study conducted in Europe (63.5%) (17) and Iran (59.8%) (18), but a higher incidence compared to a study reported in Iran (12.6%) (1), Ethiopia (6.9%) (18), Poland (39.1%) (19), Vietnam 29.5% (20) and Ethiopia 46.9% (21). High NIs prevalence in this study might be due to the inclusion of a large number of different types of specimens, all age groups, and different wards in hospitals, while some studies only focused on the adult patients, limited types of clinical samples and hospital wards. Moreover, sociodemographic and geographic variables could explain these differences.
In this study, the prevalence rate of SSIs (29.1%) was higher than a study conducted in India (23.9%) (22), but a higher incidence of SSIs showed in Gabon (44%) (23). High prevalence of SSIs in the current study may be explained by the absence of suitable general measures for bacterial infection prevention and control in local hospitals.
BSIs prevalence of (12.9%) in this study was relatively comparable with other study results conducted in Poland (14.0%) (19), Italy (16.8%) (24) and Iran (15.1%) (25), while other study showed high prevalence in Ethiopia (46.9%) (20). The finding in this study was much higher compared with another study conducted in Vietnam (4.4%) (20), this high rate of BSIs could be due to the patient's inclusion from different wards admission that increase the possibility of accepting the endogenous and exogenous infection of the bloodstream (18). Furthermore, some study mentions the postoperative infections and intensive care unit (ICU) infections (26).
The prevalence of UTIs (58.0%) in this study was much higher compared with other studies reported from Australia (21.3%) (27), China (12.3%) (28), Canada (34.8%) (29), and Gabon (26.0%) (22). The prevalence rate of UTIs is determined by the interactions of some factors such as primary disease, recurrent the infection, severity the disease, hospitalized duration, long period treatment, and invasive the urinary catheters. Moreover, the incidence of nosocomial UTIs has been increasing, and the treatment has become more difficult because of the uropathogens have increasing antibiotics resistance (30).
In our study, (51.2%) of bacterial isolates were obtained from females, while (48.8%) from males in accordance to a study conducted in Iran (54.8%) of bacterial isolates were obtained from females and (45.2%) from males without significant correlation (15). According to numerous reports, the prevalence of UTIs is higher in adult women (17.0%) than men (11.9%) and this due to the physical and anatomic situations (31). The high frequency of BSIs was observed in females 3.7% than males 2.8%, contrary to a study of Ghadiri et al. where females accounted (47.3%) (30). It was concerned to note that males (9.6%) were more susceptible to SSIs than females (4.9%). The variation in this rate of gender can differ from country to another.
The most occurrence pathogenic bacteria causing NIs in this study were *S. aureus* (35.3%) and *E. coli* (34.7%). This was higher in accordance with other studies conducted in Ethiopia (32,33), Gabon (23) and Morocco (34), but lower than a study carried out in Somalia (35) and Iran (36). This higher prevalence of S. aureus could be due to its correlation with the endogenous source as the bacterium is a member of skin and anterior nares flora of patients, surgical instruments, intravenous devices, contamination from the environment of hospital, and hands of the health professionals (37). The second most frequent of E. coli may be due to the strength influence of the endogenous contamination from the intestine and transfer from surfaces of the objects to the human in the hospital which resistance to most commonly disinfectants (38).
In this study, the bacterial resistance to antibiotics was observed. The Gram-negative *E. coli* was still the most common cause of UTI. This finding is in accordance with the other studies from different

countries (31,39). The highest resistance rate of *E. coli* obtained from urine samples was against azithromycin, co-trimoxazole, ceftriaxone, amikacin and cefuroxime respectively. These predictable results because the antibiotics have been used as a long time in our settings.
In concern, the antibiotics resistance prevalence in Gram-positive bacterial species of *S. aureus* and CoNS was similar of Gram-negative bacteria. The prevalence of resistance was observed in *S. aureus* to the antibiotics of azithromycin, co-trimoxazole, cefuroxime and amikacin is of a particular concern. Other similar result was reported in different countries (4,34,40,41).
The greater number of antibiotics in the current study were investigated, and several antibiotics had higher sensitivity in some studied antibiotics such as amoxicillin, cefadroxil, ciprofloxacin, cephalexin, kanamycin, lincomycin and nalidixic acid. The results of Carlsen et al. study on the susceptibility of uropathogens causing NIs showed that the highest antibiotics sensitivity to ciprofloxacin was observed in E. coli, P. aeruginosa, Proteus spp., Citrobacter spp., Enterobacter spp. and K. pneumoniae isolates (42), and these results are similar with our findings. This difference could be due to the different geographical region and so in our region, the pattern of antibiotics sensitivity of bacterial isolates is different from other areas significantly. Several factors influencing the difference in antibiotics susceptibility of NIs including improper or excessive use of antibiotics treatment, endemic resistant pathogens, long hospital stays and the severity of the illness (43). Investigating the prevalence of these bacterial resistant can be useful to control NIs (44).

Strengths and Limitations of the Study

To the best of our knowledge, this is the first study to discovers the prevalence of bacterial NIs and evaluate the profiles of antibiotics resistance of bacterial pathogens among hospitalized patients with nosocomial SSIs, UTIs, and BSIs in Hadhramout, Yemen. In view of this study findings; amoxicillin, cefadroxil, kanamycin, ciprofloxacin, cephalexin, nalidixic acid, lincomycin, and doxycycline could be suggested as the preferred medications for treating NIs based on their proven high sensitivity. This study helps the researchers to further studies including different hospitals and private clinics are imperative to highlight the emergence of drug resistance among clinical bacterial NIs.
The study has several limitations; due to inadequate laboratory facilities, anaerobic bacterial NIs were not investigated, patients were not followed after hospital discharge due to difficulties in communications and follow up. It was difficult to collect some variables (e.g., length of antibiotics treatment (days), length of hospital stays, previous history of admission, as well as the identification of bacterial isolates performed taking traditional of biochemical aspect.

CONCLUSION

This study focused to report the bacterial profiles and antibiotics sensitivity patterns of NIs in UTIs, SSIs and BSIs patients to know the epidemiological surveillance in our hospitals, improving the empirical treatment, and decreasing the antibiotics resistance. NIs bacterial prevalence in this study was compared with other similar study findings. The most commonly NIs were UTIs and SSIs. *S. aureus* and *E. coli* were the most frequently causes of NIs. Most of the bacterial isolates were resistant to commonly used antibiotics. Bacterial NIs treatment and management need to support by culture isolation of bacterial pathogens and antibiotics susceptibility test.

Conflict of Interest

The authors declare that there is no conflict of interest.

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