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Nosocomial Infections in Six Major Hospitals in Sana'a Capital City and in Some Governorates in Yemen

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Abstract

Nosocomial infections (NIs) and antimicrobial resistances are spread worldwide. This study was carried out in six major hospitals in some governorates in Yemen to determine the risk factors, incidence rates, nosocomial infections causative agents and antimicrobial resistance. A total of 384 patients, whose ages range between <1 to 90 years old, were taken in consideration for this study. Moreover, patients case definition and phenotypic identification methods for microbial isolates and antimicrobial sensitivity tests were based on standards methods.

Findings are that the overall incidence rate for nosocomial infection was 65.4 cases in every 100 patients; however, the highest rate was in the intensive care units with a rate of 68.2 cases in every 100 patients and the overall mortality rate was 9.2 in every 100 nosocomial patients. Risk factors for nosocomial infection were; staying in hospitals for long time, surgical operation, antibiotics and devices used. The highest incidence rates were as 33.1% for Nosocomial Urinary Tract Infections (NUTIs). The common isolated pathogens were *C. albicans* (86.1%) and *E. coli* (66.7%) of NUTIs while, *Acinetobacter* spp. (69.7%) and *S. aureus* (16.8%) were from Nosocomial Surgical Site Infections (NSSIs). The highest resistant percentages of isolated bacteria were 79.8% to ampicillin, and 78.9% to ceftazidime of broad spectrum antibiotics and the highest resistant percentage to narrow spectrum antibiotics for Gram-positive (G +ve) bacteria was 85.7% to methicillin. In conclusion, incidence and mortality rates for nosocomial infections and antibiotics resistant percentages were very high in Yemen.

Keywords: Nosocomial infections; NUTIs; NSSIs; Antimicrobial resistant; Nosocomial pneumoniae infection; Nosocomial blood stream infection.

Introduction

Nosocomial infections (NIs) refers to an infection caused by an infectious agent/s or its toxin/s occurring to patients at the hospital was not present or incubating at the time of admission [1]. Eighty percentage of common NIs includes of NUTIs, NSSIs, Nosocomial Pneumonia Infection (NPNEU), Nosocomial Bloodstream Infection (NBSIs) and other sites of NIs comprises 20% of all NIs [2]. Urinary Tract Infection (UTI) is the invasion of tissues by one or several microorganism species, inducing an inflammatory response and signs includes at least one of the following:fever more than 38°C, urinary urgency, polyuria, burning sensation a positive urine culture is a significant bacteriuria 10^5 colony forming units per mL (CFU/ml) of urine and the patient's flora [3].

NSSIs occurs either incision or organ/space. Incision SSIs are divided into superficial incision SSI and deep incision SSI. Organs/spaces SSIs involves any part of the anatomy other than incised body wall layers that opened during an operation [4]. And, signs include of purulent discharge around the wound or an area of drain or cellulite from the wound. The infection is acquired during the operation itself; either exogenously or endogenously from the flora on the skin or in the operative site [5]. American Thoracic Society (ATS) and World Health Organisation (WHO) guidelines defined the NPEUN as a Lower Respiratory Tract Infection (LRTI) that appears during or after the hospitalization of the patient occurs more than 48 h [6]. The diagnostic criteria are fever, cough, purulent sputum and progressive infiltration in X-ray and Gram stain for sputum showing more than 25 white blood cells per low field and bacteria. Sputum, tracheal or bronchoscopic aspirates are often cultured [5]. Nosocomial BSI is defined as the demonstration of the pathogen in the patient bloodstream who has been hospitalized for more than 48 h [7]. It must meet at least one of the following criteria including the patient who has a pathogen isolated from one or more blood cultures and this isolate is not related to another site of infection, fever more than 38°C, chills, or hypotension [5]. Results of culture are necessary to confirm the diagnosis of NIs [5].

The highest frequencies of NIs reported by WHO were from hospitals in Eastern Mediterranean Region 11.8% and South-East Asia 10% [6]. Multiple risk factors increases of NIs spread includes hospital type, size, low patients immunity, increasing of medical procedures, invasive techniques are potential routes of infection and antibiotics resistant bacteria transmission among hospital populations and poor Infection Control Practices (ICPs) facilitates of infection transmission to hospital and community populations [7].

Several global and regional studies had been performed in NIs, ICPs and Antimicrobial Resistant (AMR) was conducted by Centres for Disease Control and Prevention (CDC) and WHO [8]. There were no governmental policies or planes for NIs and ICPs surveillance programs in different Health Care Settings (HCS) in Yemen by the Ministry of Health and Population. Limited studies were conducted in Yemen were directed in one subject, one health care setting or one department [9-12]. A few data were available on the impact of Hospital Acquired Infections (HAIs) in low and middle-income countries [13]. Yemen, is one of them. So, this study aimed to determine the incidence rate of NIs in major hospitals in Sana'a city and some governorates in Yemen by common

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types of NIs, long staying in hospital and location of the patient, risk factors for NIs, the spectrum of NIs causative pathogens and the overall percentages of antibacterial and antifungal resistant.

Materials and Methods

This study was carried out from December 2010 to December 2013 in six major hospitals, three of them were in Sana'a city are Al-Jumhori Teaching Hospital, Al-Thowra General Hospital, and Al-Kuwait University Hospital. And other hospitals in Dahmar, Amran and Hadramut governorates were from Al-Wehdah University Hospital, Amran General Hospital, and Iben Siena Hospital respectively.

A total of 384 patients aged <1-90 years old (236 males and 148 females) were enrolled in this study. Case definitions for NIs occurrence were based on CDC and WHO criteria [1,7]. According to CDC and Healthcare Infection control practices advisory committee (HICPAC) criteria in 2003 this study focused on high-risk units such as Intensive Care Units (ICUs) including of Neonatal ICUs (NICUs), Surgical ICUs (SICUs), Medical ICUs (MICUs), Myocardial Medical ICUs (MMICUs), Burn Units (BUs), Operating Theatres (OTs) and haematology wards and of non-ICUs were Surgical Wards (SWs), Medical Wards (MWs). According to CDC criteria, all-inclusive patients were without any infection signs based on administration records at the date of admission that confirmed by laboratory culture results and clinically by doctor's investigation to patients [14].

A total of 964 specimens were collected from patients with an acquired infection after hospitals admission from 48-72 hours or more were urine, pus, body fluid aspiration, sputum or sputum suction blood specimens. Specimens collection, transportation were based on the guidelines of CDC and WHO standards [14,15]. Microbiological identification of isolated growth was according to CDC and WHO standards methods [16,17]. All culture media, antibacterial and antifungal discs were purchased from OXOID Company. All bacterial and fungal isolates were subjected to antimicrobial susceptibility test by using of Kirby-Bauer disk diffusion by and Epsilometer test (E. test) methods [18,19].

Study design

In this study, patients' demographic characters were observed, the frequency of NIs, incidence, infection types, patients' location in hospitals wards, the period of staying in hospitals. Type of this study was a prospective cohort study, while the incidence rates estimated as overall incidence rates by sex, NIs types, NIs patients location in hospitals and in unites or words and period of staying [20].

Statistical analysis

Statistical Package for Social Sciences version 20 was used for the presentation and statistical analysis of the results. Statistical tests for means of significance included:McNemar's test, Chi-square (χ^2) for nominal versus nominal variables or ordinal versus nominal variables, Fisher exact test, and Relative Risk (RR) were used for data analyses to assess 2 × 2 table for bi-variables. The significance level selected was Probability Value (P) ≤0.05 and appropriate of 95% Confidence Intervals (CIs.) was calculated for incidence proportional data for the remaining risk factors.

Results and Discussion

Nosocomial infections associated with antimicrobial resistance are spreading worldwide and significant causes of morbidity and mortality in hospitalized patients in developing and developed countries but the highest burden was in developing countries [21]. Of total 384 patients, 236 (61.5%) were males and 148 (38.5%) were females aged from ≤ 1 to ≥ 60 years old. Of total patients in Capital Sana'a City hospitals were 114 (29.7%) from Al-Jumhori Education hospital, 100 (26%) from Al-Thawrah General hospital and 40 (10.4%) from Al-Kuwait University hospital. While 50 (13%) of patients were from Al-Wehdah Educational Hospital in Dhamar governorate, 40 (10.4%) from Amran General Hospital in Amran governorate and 40 (10.4%) were from Iben Siena hospital in Hadramut governorate (Table 1). The crude rate of NI was 251 (65.4%). Of total NI patients 157 (66.5%) were males which was higher than females 94 (63.5%) in this study. Also, observed by other studies [22,23]. Moreover, age and sex were with no significant association with NIs occurrence. Similarly, it is observed by Health Protection Scotland and National Services Scotland [24]. However, disagreed by two studies [12,24,25].

Allegranzi and Pittet reported that "In developed countries NIs rates were between 5% and 10% of patients and the risk of NIs are ranged from 2-20 times higher than developed countries and the proportion of patients infected can exceed 25%" [26]. Also, this study agreed the previous study and Yemen is one of developing countries which the crude rate of NIs occurrence was high 65.4% which is higher than the rate of NIs in hospitalized patients in developed countries that were ranged from 5-15% and from 9-37% in ICUs patients evaluation written by WHO (Table 1) [27]. The highest rate of NIs was in Al-Thawrah General Hospital 74% with significant association p ≤ 0.03 and these patients were under risk of NIs by RR 1.2 times more than others.

World health organization was classified as the exogenous risk factor related to NIs occurrence into minimal, medium and high levels [6]. Most patients in this study were undergoing of high level includes of Mechanical Ventilation Intubation Devices (MVDs) intubation 266 (69.3%), catheterizations including of 266 (69.3%) of patients were with Intravascular Catheters Devices (IVCDs) and 80 (20.8%) were with Urinary Catheters (UCs), 255 (66.4%) were with surgical operations and 307 (80%) of patient were under antibiotics used; all these risk factors were in significant association with overall NIs and common types of NIs occurrences (Table 2). Also, agreed by other studies [6,28]. The previous conditions were common risk factors for NIs occurrence because those patients were exposed to several invasive procedures, devices, long time hospital staying for medication and antibiotics used. Also, observed by other studies [29,30].

Antibiotics used in this study had the highest risk factor for NIs occurrence because those patients were under risk of NIs by RR (1.9) times more than other patients and the risk was ranged from [1.4-2.5 times of 95% Confidence Interval (CI). P ≤ 0.001]. The antibiotic used is one of major factor responsible for changes or increase in resistance rate especially in a high prescribed group of antibiotics [31]. Resistance typically emerges first in the healthcare setting before the community and drug-resistant bacteria have become the source of 70% of NIs occurrence [2]. The rate of antibiotics used in this study was lower than the rate in Jordan 94% [32], in Iran 99% [33] and in Turkish was 90% [34]. However, was higher than some studies in different countries were 78% in Saudi Arabia [35] and 25% in German [36].

The overall incidence rate in ICUs patients was higher than non-ICUs patients (68.2 per100 patients [1.1-1.5 of 95% of CI.] versus 59.4 per100 patients [0.7-0.9 of 95% of CI.]) both with significant association NIs occurrence p ≤ 0.001 (Table 3). Also, shown by WHO [8] and, the incidence rate of NIs in ICUs patients was higher than the occurrence rate observed by WHO, in European multicentre study in ICUs was 51 per 100 patients [8]. And, in other high-income countries were 30 per

Variables		Positive NIs (n=251)		RR	CI 95%	χ^2	p
		No.	%				
Sex							
Male	(n=236)	157	66.5	1.1	0.9-1.3	0.36	0.54
Female	(n=148)	94	63.5	1	0.7-1.2	0.36	0.54
Age groups							
≤ 1-9	(n=50)	36	72	1.4	0.8-2.43	1.12	0.29
10-19	(n=65)	39	60	0.7	0.5-1.3	0.99	0.31
20-29	(n=54)	36	66.7	1.1	0.6-1.8	0.05	0.82
30-39	(n=39)	22	56.4	0.7	0.4-1.3	1.5	0.22
40-49	(n=43)	30	69.8	1.2	0.7-2.3	0.41	0.52
50-59	(n=43)	26	60.5	0.8	0.5-1.4	0.45	0.5
≥ 60	(n=90)	62	69	1.2	0.8-1.7	0.64	0.42
Hospital							
Al-Thawrah General Hospital	(n=100)	74	74	1.2	1.02-1.4	4.5	<0.03
Amran General Hospital	(n=40)	29	72.5	1.1	0.9-1.4	1	0.3
Al-Kuwait University Hospital	(n=40)	27	67.5	1.1	0.8-1.3	0.09	0.7
Al-Wehadah Educational Hospital	(n=50)	34	68	1.1	0.1-1.1	0.18	0.6
Al-Jumhori Educational Hospital	(n=114)	68	59.7	0.8	0.7-1.1	2.3	0.1
Iben Sena Hospital	(n=40)	19	47.5	0.7	0.5-1.0	6.3	<0.01
Crude rate	n=384	251	65.4				

Mean age=43, 6 ± 24.4 years old
RR: Risk occurred if relative risk is more than 1 χ^2: Chi-square=3.8 or more is significant
CI: Confidence interval 95% P: Probability value ≤ 0.05 or less is significant

Table 1: Association between nosocomial infections occurrence and patients sex, ages, locations in major hospitals in Sana'a Capital City and in some governorates in Yemen.

Exposed extrinsic risk factors	Patients Total "n"	Positive NIs (n=251)		RR	CI 95%	χ2	p
		No.	%				
Antibiotic used	(n=307)	221	72	1.9	1.4- 2.5	29.7	≤ 0.001
Intravascular catheters devices (IVCDs)	(n=266)	193	72.6	1.5	1.2-1.8	19.8	≤ 0.008
Mechanical ventilation intubation devices (MVDs)	(n=266)	193	72.6	1.5	1.2-1.8	19.8	≤ 0.008
Surgical operation	(n=186)	141	75.8	1.4	1.2-1.6	17.4	≤ 0.003
Urinary catheter (UC)	(n=80)	63	78.8	1.3	1.1-1.5	8	≤ 0.004
Surgical procedures before one month	(n=69)	51	73.9	1.2	1-1.4	2.7	0.09
Length of inpatients staying in hospitals / **Patient day Number of Day X total "n"**	**Patients Total "n"**	**Positive NIs (n= 251)**		**RR**	**CI 95%**	**χ2**	**p**
		No.	%				
Three days	3 × 105=315	(n=105)	47	44.8	0.6	0.5-0.8	27.1	≤ 0.002
Seven days	7 × 137=959	(n=137)	94	68.6	1.1	0.93-1.3	0.99	0.3
Fourteen day	14 × 51=714	(n=51)	40	78.4	1.3	1.1-1.5	4.4	≤ 0.03
Twenty one day	21 × 44=924	(n=44)	36	81.8	1.3	1.1-1.5	5.9	≤ 0.01
Twenty eight day	28 × 47=1316	(n=47)	34	72.3	1.1	0.9-1.4	1.15	0.1
Total patient day	4228						

RR: Risk occurred if relative risk is more than 1 χ^2: Chi-square=3.8 or more is significant
CI: Confidence interval P: Probability value ≤ 0.05 or less is significant

Table 2: The potential extrinsic risk factors exposed and length staying associated with nosocomial infections occurrence among patients from different selected hospitals.

100 patients. Moreover, it was higher than the occurrence rate in low-income countries for NIs in ICUs patients were 35.2% and 34.7 per 100 patients respectively shown by WHO and Allegranzi et al. [8,37].

The highest incidence rate of NIs in ICUs was in Burn unite patients 96 per 100 patients, however, in non-ICUs, it was in Medical wards 68.6 per 100 patients both were a significant association with NIs ($p \leq 0.008$ and $p \leq 0.005$ respectively) (Table 3). The incidence rates of NIs in Burn Unite patients was higher than the incidence rate reported by Qader, and Muhamad in Iraq it was 83 per 100 patients [38], and in Iran, it was 34.7 per 100 patients by Javanbakht et al. [39]. In this study the overall incidence rate of NIs in SICUs patients was 81.6 per 100 patients which are higher than studies in Taiwan which was 14.7 per 100 patients [40] and in Kuwait; it was 10.6 per 100 patients [41]. The incidence rate of NIs in Medical wards patients in this study was higher than Medical wards in Hungary were 25.6 per 100 patients [29] and in India; it was 21.5 per 100 patients [42].

The highest incidence rate of NIs occurrences types per 100 patients was in NUTIs patients 33.1% followed by NSSIs, NPNEUs, were (32%, 16.1%) respectively (Table 4). The incidence rates and incidence density for NUTI were 33.1 per 100 patients and 30.1 per 1000 patient days respectively were higher than the incidence densities for NUTI was 4.1 per 1000 patients days in developed countries estimated by Edwards et al. [43]. However, it was lower than the incidence density for NUTIs in developing countries from 31 studies incidence densities were varied between 1.7 and 44.6 per 1000 catheter-days summarized by Allegranzi et al. [37]. The second incidence rate in this study was for NSSI 32 per 100 patients and incidence density was 29.1 per 1000 inpatient days was higher than the incidence rate 5.6 per 100 patients in developed

Patients location in Hospital units/ward (n= 384)		Nosocomial infection Incidence rates (n=251)		RR	CI 95%	χ^2	*p*
		No	%				
ICUs Patients	n=261	178	68.2	1.3	1.1-1.5	9.9	≤ 0.001
Non-ICUs patients	n=123	73	59.4	0.8	0.7-0.9	9.9	≤ 0.001
ICUs patients units types							
Burn unit	n=25	24	96	1.5	1.7-9.8	11.1	≤ 0.008
SICUs	n=49	40	81.6	1.4	1.2-1.8	11.03	≤ 0.008
MICUs	n=21	16	76.2	1.2	0.9-1.5	1.2	0.28
Neonatal ICUs	n=32	22	68.8	1.2	0.8-1.2	0.18	0.67
Mixed ICUs	n=119	71	59.7	0.9	0.7-1.1	2.5	0.11
MCICUs	n=15	**5**	33.3	0.5	0.24-1.03	7.1	≤ 0.007*
Non-ICUs patients types							
Medical wards	(n=51)	35	68.6	3.1	1.9-4.9	26.5	≤ 0.005
Surgical wards	(n=72)	38	52.8	0.8	0.6-1.1	2.4	0.12

*Fisher t-test: when the value of cell less than 5; SICU: Surgical Intensive Care Units; MICU: Medical Intensive Care Units; MCICU: Myocardial Intensive Care Units

Table 3: Nosocomial infections incidence rates in ICUs and non-ICUs patients from different hospitals departments.

Type of nosocomial infection	**Male** (n=236)		**Female*** (n=148)		**Total** (n=384) 392*	
	No.	%	No.	%	No.	%
Nosocomial UTIs	71	55.9	56**	44.1	127	33.1
Nosocomial SSIs	82	66.7	41**	33.3	123	32
Nosocomial NPNEUs	39	62.9	23	37.1	62	16.1
Nosocomial Other RTIs	18	47.4	20	52.6	38	9.9
Nosocomial BSIs	10	66.7	5	33.3	15	3.9
Crude mortality rate	16	59.3	11	40.7	27	7.1

*8 cases with double or triple of NIs. (8 patients of 41 Females were with double infections (NSSI followed by NUTI). So, (56-8=48 real cases were with single infection of NSSIs) (48+41+23+20+5+11=148 total enrolled femals in this study)

Table 4: Incidence rates of common nosocomial infection types occurrences according to patients sex in major hospitals of Sana'a Capital City and in some governorates in Yemen.

countries observed by Allegranzi et al. [37]. However, it was similar to the incidence rate of NSSI 30.2% in Brazil in a university hospital of surgical unit and 30.9% of paediatric patients NIs in Nigeria [8]. Raja'a et al. reported "at Al-Kuwait University Hospital, Sana'a that the overall incidence rate for NSSI was 2.2%" which was lower than this study [10].

The third incidence rate was for NPNEU 16.1 per 100 patients was within the range of NPNEU incidence rates from 15 to 20 per 100 patients shown by one study (Table 4) [44]. However, it was lower than the incidence density for NPNEU observed by a Systematic review in low and middle-income countries in a period between (1995-2010) was 23.9 per 1000 ventilator day [8]. And, the rates of NUTIs, NSSIs, NPNEU NBSIs, among males were higher than females which was agreed by one study however, disagreed by another study (Table 4) [23,24].

The highest mortality rate was 23 (9.2%) in nosocomial patients was with significant association $p \leq 0.02$ (04-8.4 of 95% CI. $\chi^2=5$) and the highest mortality rate was in ICUs patients (Table 5) which was lower than the mortality rate in developed countries were ranged from 12-80% observed by WHO [8]. In this study, the highest rate of NIs type was for NBSIs 26.7% which is significantly associated with mortality rate $p \leq 0.01$ (1.7-10.8 of 95% CI $\chi^2=9.2$), similarly shown by WHO [8].

All NIs were mainly caused by 300 (89.3%) of pathogenic bacteria and fungi isolates were *C. albicans* 36 (10.7%) (Table 6). These findings were agreed by Hidron et al. [45]. The total frequency of bacterial isolates 188 (56%) were Gram-negative (G -ve) bacteria was higher than the frequency 112 (33.3%) of G +ve isolates in this study which is similar to Satyavani et al. [46]. On contrast by Ahmed study, it is observed G +ve bacterial isolates mostly associated with NIs occurrence [47]. Moreover, Peleg and Hooper, reported that "G-ve bacteria were responsible for more than 30% of all NIs" [48] which were lower than this study. Also, G-ve bacteria were associated with 32% of NSSIs, 30.3% of NUTIs, 29.8% of NPNEUs, 4.8% of NBSIs and 3.2% of nosocomial of other Respiratory Tract Infections (RTIs) (Table 6). Nosocomial SSIs were caused by 55 (49.1%) of G +ve bacteria followed by 39 (34.8%) of NUTIs but with low frequencies for another type of NIs (Table 6). Similarly, observed by Saleem et al., that "G +ve bacteria were the most common bacteria associated with NSSIs" [22]. Of total G +ve bacteria 61.8% of NSSIs was commonly caused by *S. aureus* in this study was higher than 57.8% reported by Saleem et al. [22].

Of total G-ve bacterial isolates, 23 (69.7%) of *Acinetobacter* spp were mainly isolated from NSSIs patients in this study was higher than the percentages 13% and 53.3% of *Acinetobacter* spp isolates estimated respectively by two studies [22,41]. Also, of total Gram -ve bacteria isolates 55% of *K. pneumoniae* were mainly associated with the NPNEUs (Table 6).This finding was higher than 11% of *K. pneumoniae* associated with the development of NPNEUs by Tablan et al. [49]. While, 66.7% of *E. coli* isolates were mainly associated with the development of NUTIs (Table 6) was higher than the study by Hidron et al. [45]. In this study the overall NIs associated with 10.4% of *C. Albicans* isolates were from ICUs patients. This result was higher than 8.8% *Candida* sp. isolates associated NIs observed by one study [8].

Most of the pathogenic isolates in this study in Yemen were with high resistant percentages to common antibiotics and antifungal used and the overall antibiotic resistant percentages by all bacterial isolates were ranged from 7.2%-85.7% and for fungal isolates were ranged from 5.6%-55.6% (Table 7). Similarly, in developing countries antibiotics resistance percentages were higher than the resistance percentages commonly used antibiotics in developed countries [42]. The overall

resistant percentage of bacterial isolates to broad-spectrum antibiotics was ranged from 24.4%-79.8%. The highest resistance percentage was to ampicillin 79.8% and the lowest one was to norfloxacin 24.4%. Ampicillin is one of extending spectrum antibiotics had the highest resistance percentage to bacterial isolates (Table 7). Similarly, was determined 78% by Sharif et al. [50] However, was higher than the resistant percentage ranged from 36-37.4% observed by Karlowsky et al. [51] and lower than 97%, and 86% respectively shown by other studies [45,52].

The overall resistant percentages for Gram -ve bacterial isolates to narrow-spectrum antibiotics were ranged from 31.1%-63.3% which was the highest resistant percentage to piperacillin 63.3% (VII). Similarly, high resistant percentages to piperacillin were 57.6% in Egypt and 61.1% in Saudi Arabia [53], however, it was lower than the resistant percentage to piperacillin were ranged from 68.4%-100% found by Bayram and Balci [54]. The highest resistant percentage to narrow-spectrum antibiotics by Gram +ve bacteria was to methicillin 85.7%. Similarly, was found by ECDC [55]. However, was lower than the resistant percentage to methicillin 98.6% shown by Mehta et al. [56]. And, it was higher than the resistant percentage 15.9% found by Zhanel et al. [57-59].

The overall oxacillin resistant percentages for Gram +ve bacterial isolates were 64% (Table 7) which was lower than 82.1% estimated by one study [60]. According to oxacillin resistant for *S. aureus* and other *Staphylococcus* spp. the following antibiotics classes were resistant due to co-resistant to another antibiotic in the same class and other classes such as penicillin, βeta-lactams/β-lactamase inhibitor combinations, cephem, and carbapenems are in vitro appear sensitive but clinically are not effective and should not be reported sensitive [61]. Beta-lactam/β-lactamases inhibitor combinations, third-generation cephalosporin, quinolones, and carbapenems are used for initial empirical therapy in critically ill patients for a high range of pathogenic bacteria to be covered. These are leading to selective resistant organisms, particularly to third-generation of cephalosporin and quinolone; however, penicillin, clindamycin, and vancomycin are preferred for treatment of Gram +ve bacterial infections [62]. The resistant percentage to ampicillin/sulbactam was 59% which is higher than 17.7% of resistant percentage estimated by Kaye et al. because ampicillin/sulbactam was

Variable chracters		Dead (n=27)		RR	CI 95%	χ^2	*p*
		No.	%				
Type of inpatients							
Nosocomial patients	(n=251)	23	9.2	3	1.04-8.4	5	≤ 0.02
Non-nosocomial patients	(n=133)	4	3	0.34	0.12-1	5	≤ 0.02*
Death / Type of nosocomial infections							
Nosocomial BSIs	(n=15)	4	26.7	4.3	1.7-10.8	9.2	≤ 0.01*
Nosocomial UTIs	(n=127)	17	13.4	3.5	1.6-7.3	11.7	≤ 0.006
Nosocomial PNEUs	(n=62)	7	10.9	1.8	0.8-4.11	2.1	0.2
Nosocomial SSIs	(n=123)	11	8.9	0.2	0.1-0.33	56.4	≤ 0.001
Nosocomial Other RTIs	(n=38)	3	7.9	1.2	0.4-3.6	0.05	0.8*
*Fisher t-test: when the value of cell less than 5		**Some patients had double or triple NIs					

Table 5: Mortality rates and risk of nosocomial infections among patients and common types of nosocomial infections in hospitals.

Isolated pathogens	NUTIs (n=127)	NSSIs (n=123)	NPNEU (n=62)	NBSIs (n=15)	Other RTIs (n=38)	Total numbers and percentages (%)
	Yes (n=117*)	Yes (n=111**)	Yes (n=57**)	Yes (n=15)	Yes (n=13)	
K. pneumoniae	7 (11.7)	18 (30)	33 (55)	2 (3.3)	0	60 (17.9)
S. aureus	14 (25.5)	34 (61.8)	4 (7.3)	2 (3.6)	1 (1.8)	55 (16.4)
E. coli	30 (66.7)	4 (8.9)	7 (15.6)	2 (4.4)	2 (4.4)	45 (13.4)
Enterococcus spp.	19 (54.3)	12 (34.3)	0	2 (5.7)	2 (5.7)	35 (10.4)
Acinetobacter spp.	4 (12.1)	23 (69.7)	3 (9.1)	1 (3.03)	2 (6.1)	33 (9.8)
P. aeruginosa	13 (43.3)	7 (23.3)	7 (23.3)	1 (3.3)	2 (6.7)	30 (8.9)
S. epidermidis	6 (42.9)	5 (35.7)	0	2 (14.3)	1 (7.1)	14 (4.2)
Enterobacter spp.	2 (25)	4 (50)	1 (12.5)	1 (12.5)	0	8 (2.4)
S. pyogenes	0	2 (33.3)	4 (66.7)	0	0	6 (1.8)
Citrobacter spp.	0	2 (33.3)	2 (33.3)	2 (33.3)	0	6 (1.7)
P. mirabilis	0	2 (40)	3 (60)	0	0	5 (1.5)
S. saprophyticus	0	1 (100)	0	0	0	1 (0.3)
Nocardia spp.	0	1 (100)	0	0	0	1 (0.3)
S. Paratyphi group (B)	1 (100)	0	0	0	0	1 (0.3)
Isolated Gram-negative G -Ve pathogenic bacteria 188 (56%)						
Total Gram Negative bacteria	57 (30.3)	60 (32)	56 (29.8)	9 (4.8)	6 (3.2)	188 (56)
Isolated Gram-positive G+Ve pathogenic bacteria 112 (33.3%)						
Total Gram positive bacteria	39 (34.8)	55 (49.1)	8 (7.1)	6 (5.4)	4 (3.6)	112 (33.3)
Isolated pathogenic fungi 36 (10.7%)						
C. albicans	31 (86.1)	2 (5.6)	0	0	3 (8.3)	36 (10.7)
Total isolates	127 (37.8)	117 (43.8)	64 (19.1)	15 (4.5)	13 (3.9)	336 (100)
*Had 127 strains because of double infection		**Had 117 strain because of double infection				
***Had 64 strains because of double infection		n: number; 0: not isolated				

Table 6: Common pathogenic isolates from nosocomial infections patients in different major hospitals in Sana'a capital city and in some governorates in Yemen.

Antibiotic name		Resistant		Total (n=300)
		No.	%	
Broad spectrum of Antibiotics				
Ampicillin		237	79.8	297
Ceftazidime		236	78.9	299
Cefdroxil		232	77.9	298
Cefapime		231	77.3	299
Cefurixime		224	74.9	299
Cefotaxime		221	73.9	299
Cefaxime		220	73.6	299
Ceftizoxime		216	72.2	299
Cefoxtine		210	70	300
Cefazoline		207	69.7	297
Cefatrixone		167	58	288
Nitrofurans		207	69.7	297
Ciprofloxacin		179	68.6	261
Ofloxacin		47	37	127
Norfloxacin		31	24.4	127
Sulphamethoxazole/Trimethoprime		189	66.2	299
Azirhromycin		178	59.9	297
Doxycyclin		169	59.5	284
Tetracycline		155	52	298
Ampicillin/Sulbactam		177	59	300
Amoxicillin-Clavulanic Acid		167	58	288
Pipracillin/Tazobactam		147	49	297
Fosfomycin		48	57.1	84
Gentamicin		153	51.2	299
Amikacin		72	40.9	176
Chloramphenicol		64	52	123
Imipenem		98	33	297
Narrow spectrum of antibiotics used For Gram-negative bacteria				
Pipracillin		105	63.3	166
Aztroneome		113	63.1	179
Mezlocillin		110	58.5	188
Colistin Sulphate		51	46.8	109
Nalidixic Acid		14	31.1	45
Narrow spectrum of antibiotics used For Gram-positive bacteria				
Methicillin		60	85.7	70
Oxacillin	Penicillin -stable penicillin	71	64	111
Cloxacillin	Penicillin -stable penicillin	59	53.2	111
Erythromycin	Macroloides	50	45.1	111
Penicillin-	Penicillin	38	34.2	111
Vancomycin	Glycopeptides	31	28	111
Clindamycin	Lincosamides	28	25.2	111
Linzolid	Oxazolidinones	13	11.7	111
Rifampicin	Ansamycins	8	7.2	111
Antifungal agents	**Antifungal classes**	**No.**	**%**	**Total n =36**
Fluconazole	Azoles-Triazole group	20	55.6	36
Nystatin	Polyenes group	11	30.6	36
Clotrimazole	Azoles-Imidazole group	10	27.8	36
Ketoconazole	Azoles-Imidazole group	7	19.4	36
Itraconazole	Azoles-Triazole group	6	16.7	36
Amphotericin -B	Polyenes group	2	5.6	36

Table 7: Overall antimicrobial resistance percentages for bacterial and fungal isolates from nosocomial patients in the major hospitals in Sana'a Capital City and in some governorates in Yemen.

overused in hospitals that are leading to high emersion of antibiotic resistant [63,64].

The resistant percentages to cephalosporin had high resistant percentages were ranged from 58% to 78.9% (Table 7). These percentages were higher than the surveillance study in developed countries during the period from 2006 to 2007 in North America in 2003, 2004 and 2006 were 50%, 63%, and 40% respectively and in Latin America during period 2000 and 2004 were 25% and 63% respectively and in Asia from

China, Japan and Singapore, Oceania (Australia) and South Africa all were 30% [45]. In this study were found higher than the resistant percentages for ESBLs isolates observed in Egypt were up to 70% [65]. And, one survey conducted by Bouchillon et al. compared data from Egypt, Lebanon, Saudi Arabia, and South Africa was with high rates 72.2% to ESBLs isolates [58]. Likewise, in Asian countries including Yemen, the highest resistant bacteria rate was 78.9% to ceftazidime, 73.9% to cefotaxime, 58% to ceftriaxone and 72.2% to ceftizoxime with overall resistant percentage was 70.8%. On the contrast study by Radji et al. determined the overall resistant percentages to ceftazidime were ranged from 30%-85.7%, ceftriaxone from 46.2-85.7% and cefotaxime from 50%-100% [59].

Extended-spectrum β-lactamases producing organisms are clinically resistant to therapy with these antibiotics despite apparent in vitro susceptibility and should be reported as resistant to other antibiotic classes due to cross-reaction resistant including all penicillin, β eta lactam/βeta-lactamase combination inhibitors, cephalosporin, monobactam, trimethoprim-sulphamethoxazole, fluoroquinolone, aminoglycoside, and tetracycline were reported by CLSI [61]. Similarly, occurred in this study. Finally, the overall resistant percentage of *C. albicans* isolates to six anti-fungal drugs were ranged from 5.6%-55.6% and the highest resistance percentages was to fluconazole 55.6% which was higher than 16.4% and 34.3% respectively found by two studies (Table 7) [66,67]. An increase of resistance percentage by *C. albicans* to triazoles like fluconazole may be due to prophylactic or therapeutic overused purposes that can significantly correlate with resistant increases for *C. albicans* isolates from patients [68].

In conclusions, in this study are incidence rates for NIs in major hospitals in Sana'a and some governorates in Yemen were very high and common types of NIs were NUTIs, NSSIs, NPNEUs, other RTIs, and NBSIs. Moreover, the incidence rate for NIs patients in ICUs was higher than the incidence rate for NIs patients in non-ICUs. Also, the mortality rate among NIs patients was high and the highest mortality rate was in NBSIs patients. However, risk factors for NIs were patients underlying diseases at admission day, Sex, old and young age groups, long staying in the hospital, antibiotic used, devices used and surgical operation. An antibiotic used was very high. No programs for antimicrobial use committee supervisions and no infection control programs in Yemen and, if that programs present were inadequate. Also, inadequate training courses for NIs prevention and outbreak diagnosis and surveillance.

High incidence rates of NIs in different selected hospitals and absent of infection control and surveillance programs to prevent or reduce these problems in hospitals and community in Yemen have alarmed that if no action today means no cure tomorrow. The national or regional health authority should design an agency to oversee the programme a ministerial department, institution, and national activities plan with help of a national expert committee to support hospitals in the prevention or reducing of NIs, AMR and to expert quality clinical laboratories results. Prevention of NIs requires a systematic IC and TQM programs, antimicrobial use committee supervisions to ensure effective economical prescribing. This is usually achieved under institutions leadership to provide the fund for ICPs purposes such as training, provision of supplies, facilities and dissemination of information, to ensure that recommended practices for NIs prevention are implemented and followed by Health workers making hospitals safe for patients, environment and community.

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