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Bacterial contamination of intensive care units, Sana'a City, 2019, Yemen

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Abstract

Background: Contamination of intensive care unit (ICU) is one of nosocomial infection risks that increase the costs of care and predispose ICU patients to higher mortality rates. The aims are to identify bacterial contamination and determine the pathogen isolates from the ICUs of Sana'a city hospitals.

Method: A descriptive cross-sectional study in the ICUs of eight hospitals was conducted. Sterile swabs moistened in sterile normal saline were used for collecting two samples from seven ICU sites at each hospital. All were subjected to microbiological cultures at the national reference lab.

Result: Out of 112 collected swabs, 87 (78%) yielded positive bacterial growth, and 109 bacterial strains; 62% (68) gram-positive and 38% (41) gram-negative bacteria were isolated. Coagulase-negative staphylococcus, Staphylococcus aureus accounted for 28% (30) and 21% (23) while Klebsiella and Pseudomonas species accounted for 13% (14) and 13% (14) of all bacterial isolates, respectively. 40 (37%) strains, 24 (22%), and 15 (14%) strains of isolated bacteria were from patient beds/bedside tables, floors, and walls, respectively.

Conclusion: The High level of contamination in the patient's surroundings necessitates the implementation of strict quality standards of hygienic manners and effective cleaning of inanimate surfaces by infection control units at hospitals and periodic monitoring by health authorities.

Keywords: Bacterial contamination; Intensive care units; Yemen.

Abbreviations: CONS: Coagulase-negative staphylococci; HCAIs: Health care-associated infections; HCWs: health care workers; ICUs: Intensive care unites; IPCs: infections prevention and control; MDR: multidrug resistant.

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Introduction

Health care-associated infections (HCAIs) are infection that patients acquire while receiving treatment for medical or surgical conditions. HCAIs can lead to a prolonged hospital stay, long-term disability, and increased resistance of microorganisms to antimicrobial agents [1]. HCAIs are the most frequent adverse event in healthcare delivery, affecting 7 to 10% of patients worldwide [2]. According to WHO of every 100 hospitalized patients at any given time, there are 7 in developed countries and 10 in developing countries acquire at least one HCAI. In low and middle-income countries the frequency of ICU-acquired infection is at least 2-3 fold higher than in high-income countries [3]. Acquisition of infection in ICUs is 5-10 times higher than other hospital wards and approximately 30.0% of ICU patients having at least one infection [1,4,6]. Bacterial contamination of ICUs is one of the major risk factors to spread of HCAIs among ICU patients, which increase the costs of care particularly in case of infection by multidrug resistant bacteria and predispose patients (especially those with an underline disease, impaired immunity and with invasive procedures) to higher mortality rate [5,7]. In Yemen, surveillance systems for HCAIs is not activated. During 2011-2016, three studies related to HCAIs have been conducted. A study carried out in six hospitals, three in Sana'a and three in other governorates, revealed incidence of nosocomial infection among 65.4 cases / 100 patients [8]. Another study at Al-Gamhorea Hospital in Aden city showed high bacterial contamination in operation theaters [9]. The last one was at Al Thawra hospital in Sana'a city revealed poor infections prevention and control (IPCs) practice of ICU medical staff [10]. Still there is a gap in the information related to ICUs contamination. The aims of this study are to determine the level of bacterial contamination in ICUs, Identify the pathogen isolates from ICU environment and recommend appropriate preventive measures.

Materials and methods

Study area, design and period: A hospital-based cross-sectional study was conducted in the main Sana'a city hospitals during 5th -15th December 2019.

Sampling: Seven inanimate surfaces/ sites at each ICU were swabbed including; patient's bed, bedside table, floor, wall, Knop door, IV stand and masks of O_2 supply. Two samples from each site were collected to give 112 samples from the eight hospital.

Sample collection, handling, and transport: Sterile swab moistened in sterile normal saline were used to collect samples for targeted sites. The swabs were inoculated directly on MacConkey agar, Blood agar and Sabouraud Dextrose agar. All samples were transported to National Center of Public Health Laboratories for microbial examination. Bacterial culture and identification: The inoculated plates were incubated at 37 °C for 18-24 hours. Bacterial isolates from culture-positive plates were identified microscopically based on Gram reaction and colony characteristics. Biochemical tests were performed for the final identification. Oxidase, Kligler Iron agar, Sulphate Indole Motility, Simmon's Citrate and Urease tests were used to identify Gram-negative bacilli. Catalase, Coagulase and DNAase tests were used for Gram-positive cocci. The identification of staphylococcus based on Blood agar hemolytic characteristics. Data analysis: Data were entered into Microsoft Excel 2013, imported and analyzed using Epi Info version 7.2. Descriptive statistics were computed and tables were used to summarize results

Table 1: Distribution of positive bacterial growth cultures, isolates and gram characteristics by sites of intensive care units, Sana'a city, Yemen, 2019.

ICU sites	Positive cultures	Total isolates		Gram positive		Gram Negative	
	No.	No.	%	No.	%	No.	%
Patient's Beds/ Bedside table	32	40	37%	25	63%	15	37%
Floors	16	24	22%	11	46%	13	54%
Walls	13	15	14%	10	67%	5	33%
Masks of O_2 supply	11	12	11%	6	50%	6	50%
IV stands	8	9	8%	8	89%	1	11%
Knop doors	7	9	8%	8	89%	1	11%
TOTAL	87	109	100%	68	62%	41	38%

Table 2: Frequency of Bacteria isolates by type, intensive care units, Sana'a city, Yemen, 2019.

Isolates	No.	Percent
Gram Positive	**68**	**62%**
Coagulase-negative staphylococci	30	28%
Staphylococcus aureus	23	21%
Bacillus species	11	10%
Enterococcus species	4	4%
Gram Negative	**41**	**38%**
Klebsiella species	14	13%
Pseudomonas species	14	13%
Acinetobacter species	13	12%

Results

Out of 112 samples collected from adult ICU of eight hospitals, 87 (78%) yielded positive bacterial growth, and 109 bacterial isolates were identified: 40 (37%) from patient's bed/ bedside tables, 24 (22%) from floors. The lowest number 7 (9%) of bacterial isolates from knop doors. From the total 109 bacterial isolates, 68 (62%) were Gram-positive and 41 (38%) Gram-negative. Lower number of Gram-negative bacteria was isolated from all ICU sites except Masks of O_2 supply and floor where 50% and 54% of isolated bacteria were Gram-negative, respectively. Table 1 shows the distribution of positive bacterial growth cultures, isolates and Gram characteristics by sites of intensive care units, Sana'a city, Yemen, 2019.

Seven types of bacterial isolates were identified, Coagulase-negative staphylococcus (CoNS) and Staphylococcus aureus (S.aureus) were predominant accounting for 28% (30) and 21% (23) all bacterial isolates, while Klebsiella species and Pseudomonas species from Gram-negative accounting for13% (14), 13% (14) of all bacterial isolates, respectively. Table 2 shows Frequency of Bacteria isolates by type, intensive care units, Sana'a city, Yemen, 2019.

CoNS followed S.aureus were predominantly isolated from surfaces of bed/bedside tables, walls, Knob doors and IV stands.

Table 3: Distribution of bacterial isolates by sites & types of Bacteria, intensive care units, Sana'a city, Yemen, 2019.

ICU sites	CoNS	S. aureus	P.spp	K.spp	Acinetobacter	Bacillus spp	Enterococcus	Total Isolates
Bed/bedside table	9(23%)	10(25%)	5(13%)	8(20%)	2(5%)	4(10%)	2(5%)	40(37%)
Floor	3(13%)	4 (17%)	7(29%)	3 (13%)	3(13%)	2(8%)	2 (8%)	24(22%)
Wall	5(33%)	3(20%)	2(13%)	1(7%)	2(13%)	2(13%)	0(0%)	15(14%)
Masks O_2 supply	4(33%)	2(17%)	0(0%)	1(8%)	5(42%)	0(0%)	0(0%)	12(11%)
IV stand	5(56%)	2(22%)	0(0%)	0(0%)	1(11%)	1(11%)	0(0%)	9(8%)
Knop door	4(44%)	2(22%)	0(0%)	1(11%)	0(0%)	2(22%)	0(0%)	9(8%)
Total	30(28%)	23(21%)	14(13%)	14(13%)	13(12%)	11(10%)	4(4%)	109(100%)

CoNS: Coagulase-negative staphylococci. S.aureus; Staphylococcus aureus. P.spp; Pseudomonas species. K.spp: Klebsiella species.

Klebsiella mainly isolated from patients' bed/bedside tables while Pseudomonas and Acinetobacter species were predominantly isolated from floor and masks of O_2 supply, respectively. Table 3 shows Distribution of bacterial isolates by sites & types of Bacteria, intensive care units, Sana'a city, Yemen, 2019.

Discussion

Bacterial contamination of ICUs is one of the major factors that increase the incidence of nosocomial infections and have bad effect on patient and hospital management [5,7].

The result of our study has showed an overall high contamination of ICUs inanimate surfaces /sites (78%). This result was higher than the result of studies conducted in Iraq (18%) and Ethiopia (63%) and lower than result of study conducted in Nigeria (86%) [11,13]. The difference in result might be due to the different of evaluated inanimate surfaces / sites and number of ICUs. Seven sites at eight adult ICUs of eight different hospitals were included in our study while more sites/ inanimate surfaces at one adult ICU in that studies. This high contamination in our study could be attributed to multiple factors including contamination of hospital environments, cross-transmission through hands of health care workers (HCWs) after contact with admitted patients or their clinical specimens and ineffective cleaning procedure of contaminated surfaces[14,16].

The breakdown of bacterial contamination was varied based on type of contaminated surface. Patients' beds/bedside tables were the most contaminated sites (37% of bacterial isolates). This might be due to that patients' beds / bedside table can be directly contaminated by bacteria from colonized and/or infected patients or from the hands of health professionals[17,18]. Ordinary surfaces such as floors and walls in hospital setting could be secondary reservoirs for pathogens due to inadequate decontamination, the use of ineffective disinfectants during cleaning, as well as ineffective footwear as protective measure against floor contamination [19,20]. In our study, floors and walls found to be the second contaminated sites after patients' beds / bedside tables.

In this study, CoNS and S.aureus of gram positive were more common and accounted the majority of all bacterial isolates. This result might be duet to CoNS and S.aureus are commonly found in the humans skin/hands, in addition, clothing fabrics that are continuously shed during routine activity [21,23]. Furthermore, CoNS and S.aureus were predominantly isolated from surfaces with frequently manual contact a (e.g Knob doors IV stands). This suggests that the hands of health professionals were the main vector of contamination of these surfaces[22]. On other hand, the presence of these bacteria at patients' close area may posed a risk of contamination and development of infection among hospitalized patients [16,18].

The result of this study showed that Pseudomonas spp predominantly recovered from floors. This might be due to exogenous source as Pseudomonas bacterial inhibit soil [24]. Klebsiella were mainly isolated from bed/bedside tables while Acinetobacter predominantly isolated from Masks of O_2 supply. The former pose a serious clinical concern and the later pose infection control and prevention concern, respectively [21,25].

Conclusion

In conclusion, the bacterial contamination in ICUs of Sana'a city hospitals was high. Patient's close area followed by floor and walls were the most contaminated sites of ICUs environments. Isolation of potentially clinically relevant pathogens; S.aureus, CoNS, Klebsiella and Pseudomonas form area close to patients and from surface of manual posed a serious clinical concern as they are of major causative agent of nosocomial infection, emerged as multidrug resistant pathogens (MDR). So, Surveillance systems for health care-associated infections should be activated. Health authorities should force and monitor hospitals to implement IPCs protocols in periodic base. Further studies with microbial susceptibility testing are required for more comprehensive picture. The teams of IPCs at hospitals should implement strict quality standards for effective cleaning of inanimate surfaces and hand hygiene before and after contact with patients or their close areas.

Limitation: There are some limitations in this study: it was carried out only in eight hospitals, the number of samples collected were few and the duration was short, hands of health workers, microbial susceptibility testing, medical equipment and vital areas were not investigated.

Nevertheless, the findings of this study has provided a baseline information on degree of contamination, level of hygiene and cleanliness within the ICUs at some hospitals in Sana'a city. The information could be used to formulate policy for intervention measures and to forms the working template for the hospital infection control and prevention unit.

Declarations

Ethics approval and consent to participate: As these data were collected by surveillance staff, and the use of such data is part of the national surveillance activities, the study did not require formal ethical review. Official permission to perform this study was issued from Ministry of Public Health and Population. The authors confirm that all methods were performed in

accordance with the relevant guidelines and regulations in the county. The study did not involve experiments on the human subject or human participants under the age of 18 years. No human studies are presented in this manuscript.

Consent for publication: This study does not include any identifiable human images or data and thus does not require consent to publish.

Availability of data and materials: All relevant data are presented in this paper, and more information can be provided upon reasonable request from the corresponding author.

Competing of Interest: The authors declare that they have no competing interests.

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Authors' contributions: M.A.A, conceived the study, performed data analysis and contributed in writing manuscript, I.A. and S.N collected samples and performed laboratory diagnosis, K.A., S.A. contributed to the conception and design of the study R.A. and S.M contributed in writing draft manuscript. All contributed to interpretation. The author(s) read and approved the final manuscript.

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