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Investigating the Microbial Contamination of the Hands of Healthcare Staff and Medical Equipment in Different Wards of Hospital in Zahedan, Southeastern Iran

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ABSTRACT

Background: Nosocomial infections are one of the serious problems in medical centres that can lead to the death of patients. Contamination of medical devices and surgical equipment is known as one of the main causes of the spread of these infections.

Methods: In this study, 442 medical and non-medical devices of Ali Ebne Abi Taleb Hospital in Zahedan) medical and non-medical devices that have more contact with the patient (were collected over two years and every month according to the schedule.

Results: The most contamination was related to the hands and nails of the personnel, where 26 cases were positive with coagulase-negative *Staphylococcus*. Then, suction with *Pseudomonas aeruginosa* contamination was positive in 15 cases, followed by stethoscope and sialic lamp in the operating room, each of which were positive in 11 cases. *Staphylococcus* was the most common organism in all departments and was isolated mostly from patients' beds, staff's hands and nails, and stethoscopes.

Conclusion: To reduce the level of contamination and prevent the spread of hospital infections, it is necessary to observe hygiene principles such as hand washing, regular disinfection of equipment, and use of standard guidelines to prevent infections.

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Introduction

Nosocomial infections are a widespread problem in current healthcare that infect between 4 and 10% of hospitalized patients annually (1, 2). Nosocomial infections occur in cases where a patient is admitted to a hospital or medical care unit within 48-72 h or 3 days. Patients hospitalized in the intensive care unit (ICU) are at a higher risk of contracting nosocomial infections. Reports indicate that 1 out of every 10 patients is exposed to nosocomial infection (3).

Microbial contamination in hospitals, particularly in warm spaces, such as surgery rooms, increases nosocomial infection, prolongs patient hospitalization, delays wound healing, and raises care costs Current estimates show that nosocomial infections charge the UK National Health Service £1 billion a year, equivalent to 1% of the total budget allocated to hospitals. Nosocomial infections are often caused by environmental organisms and are associated with a wide range of infected hospital equipment, indicating the high risk of nosocomial infection following equipment contact (4).

Cleaning protocols for equipment used in critical situations increase the carrying possibility of many microorganisms. Additionally, frequent cleaning of the equipment has been reported in several studies on the contamination of medical stethoscopes (1). Better cleaning and disinfection of environmental surfaces have been addressed in healthcare facilities. Careful cleaning and disinfection of environmental surfaces, daily and at patient discharge, are among effective infection prevention programs. In addition, disinfectants must be used appropriately to achieve the effects of interest. There is controversy about the disinfection of environmental surfaces. Some experts believe that microorganisms can only be eliminated physically using a detergent solution. However, some believe that manual disinfection of surfaces using available disinfectants is sufficient and there is no need for newer approaches (5).

On the other hand, infections acquired from the ICUs are among the causes of mortality worldwide. Infections caused by multidrug-resistant (MDR) bacteria are a worrying healthcare problem and a challenge for physicians dealing with critically ill patients. Infection of non-living surfaces in ICUs has been identified in the spread and cross-transmission of pathogens among critically ill patients. Medical devices such as urinary catheters, intravenous lines, and ventilators are particularly prone to contamination. They can damage epithelial barriers or impede host defenses, making patients more susceptible to infections. It is estimated that over 850,000 device-related infections occur annually in the U.S (6).

The infection may occur through transferring microorganisms contaminating the hands of healthcare workers or direct contamination of microorganisms in the environment near the patient's bed. MDR bacteria occur as surface-contaminating microorganisms, common medical equipment, and surfaces. Evidence shows that the most common bacteria in operating room infection is *Staphylococcus aureus*, which accounts for 40% of the infection, followed by *Enterobacter* and *Escherichia coli* (4).

It is important to examine infected medical equipment and devices that directly contact the patient, as well as the hands and nails of the personnel, and to determine the type of contaminating organism. Therefore, the microbial contamination level of medical equipment in different hospital wards in Zahedan was investigated in this study.

Materials and Methods

In this cross-sectional descriptive study, the population included various medical and non-medical equipment and devices at Ali-Ebne Abi Taleb Hospital in Zahedan City. Microbial culture samples of 442 items from different hospital equipment were prepared in a targeted manner, and the samples were collected every month for two

years according to the schedule. The samples were obtained from the electroshock pedal, suction, monitoring device, oxygen chamber, EKG device, endoscopy device, Ambu bag mask, laryngoscope blade, stethoscope, scialytic lamp, drug trolley, hands and nails of personnel from various hospital wards, (36 samples from NICU, 66 samples from emergency (general and burns), 48 samples from ICU (general, heart, and burns), 58 samples from the endoscopy ward (adults and pediatrics), 23 samples from the burn ward, 60 samples from the operating room (general, burns, and heart), 36 samples from the gynecology and obstetrics ward, 32 samples from the internal ward (infectious and general internal), 30 samples from the surgical ward (children, general). The samples were prepared from different levels of medical and non-medical devices having more contact with the patient. They were soaked in the TSB (Trypticase-Soy-Broth) liquid medium using sterile swabs, which were then soaked in a thioglycolate medium by an expert and incubated at 37 °C for 24 h. Then, the swabs were examined for the growth of anaerobic microorganisms. The infection criterion was microbial growth in the prepared samples. Finally, the data were analyzed using statistical tests and SPSS software.

Results

In this study, 442 samples were collected from Ali-Ibn Abitaleb Hospital in Zahedan, including the electroshock pedal, suction, monitoring device, oxygen chamber, EKG device, endoscopy device, Ambu bag mask, laryngoscope blade, stethoscope, scialytic lamp, drug trolley, the hands and nails of the staff. Out of 442 samples taken, 36 samples were obtained from the NICU and newborns, 66 samples from the emergency ward (general and burns), 48 samples from the ICU (general, heart, and burns), 58 samples from the endoscopy ward (adults and pediatrics), 23 samples from the burn ward, 60 samples from the operating room (general, burn, and heart), 36 samples from the gynecology and obstetrics ward, 32 (7.1%) samples from the internal ward (infectious, general, and internal), 30 samples from the surgical ward (pediatrics and general) (Table 1). According to Figure 1 and Table 2, the most infection belongs to the hands and nails of the personnel, with 26 positive cases and coagulase-negative staphylococci (CoNS), followed by suction with *Pseudomonas aeruginosa* contamination in 15 positive cases and then stethoscope and the scialytic lamp in the operating room, each with 11 positive cases.

Table 1. Distribution of the relative frequency of the examined units based on the ward.

Department	%	number
Emergency	14.93	66
NICU/Neonate	8/14	36
ICU	10.48	48
Endoscopy	13.18	58
Burn	5.42	24
Operation room	14.93	66
Gynecology	8.14	36
Internal	12.21	54
Surgery	6.78	30
Transplant	2.71	12
Dialysis	2.71	12

S. aureus and CoNS) 36 (54.5%) samples, *E. coli* (10 samples), fungi (12 samples), *P. aeruginosa* (7 samples), and *Klebsiella* (1 sample) were positive. *Staphylococcus* was the most common organism in all wards and was mostly isolated from patients' beds, staff's hands and nails, and stethoscopes. *E. coli* was the most prevalent organism isolated from the endoscope in the endoscopy ward. *P. aeruginosa* was the most contamination in the suction. (Table 2). The samples were mostly from the emergency ward and operating room (66 cases) and the endoscopy ward (58 cases), and the rest of the samples were from other internal, ICU, CCU, hematology, burns, surgery, transplantation, dialysis, and women wards (Table 1). Out of all

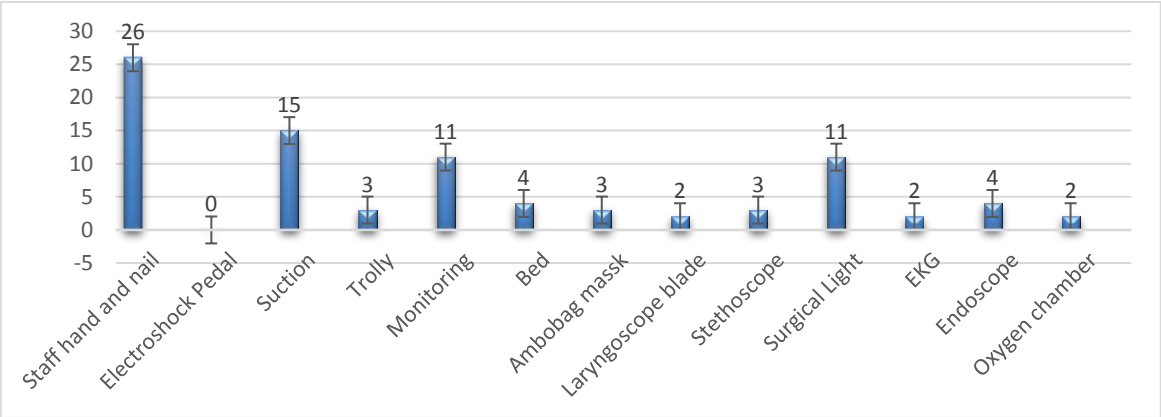

Fig 1. Relative and absolute frequency distribution of positive microbial culture samples from medical devices and personnel's hand.

442 cultured cases, 80 (18%) and 361 (81.8%) cases were respectively positive and negative for bacterial growth.

Table 2. Distribution and abundance of different types of isolate bacteria based on sampling levels.

	Staphilococcus	*E. coli*	Fungi	*Pseudomonas*	*Klebsiella*
Monitoring	6	0	2	1	0
trolley	2	0	2	0	1
Hands and nails of personnel	26	0	0	0	0
Laryngoscope	3	0	0	0	0
endoscope	0	5	0	2	0
stethoscope	3	1	1	0	0
Patient's bed	4	0	0	0	1
Amboba g	2	1	3	0	0
ECG	2	0	0	0	0
Suction	2	5	4	6	0
cuff	1	0	0	0	0

Discussion

Nosocomial infections are regarded as a serious problem in the world. Antibiotic resistance of pathogens associated with hospital environments is an important therapeutic challenge for physicians. Infectious diseases are globally ranked second in the death of patients (7). Since most isolated bacteria and fungi are opportunistic and given the special conditions of patients during surgery and anesthesia predisposing them to infectious diseases, these microorganisms can be dangerous for patients. Approximately 40,000 hospitalized patients annually decease from nosocomial infections worldwide, more than 25% and 15% of which are attributable to healthcare processes in developing and developed countries, respectively. Infection with microorganisms, such as *P. aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *E. coli*, are among the causes of hospital infections. Patient prolonged hospitalization in ICUs increases the cost of care in hospitals (8). Research indicates that a high percentage of patient-care equipment is contaminated. For example, a study at Arba Minch General Hospital found that 71.7% of inanimate objects and patient-care equipment sampled showed bacterial contamination, with notable pathogens including *Staphylococcus aureus* and *Klebsiella* spp (9).

Studies indicate that a high percentage of medical equipment, especially in ICUs, is contaminated with various bacteria. For example, a study in Golestan province showed that 33.1% of infections were observed in ICUs, and the highest level of contamination was reported in laryngoscopes and ECG sensors (8). In another study in Uganda, 88% of medical equipment was contaminated with different bacteria (10).

In our study, however, frequencies of 2% and 11% were recorded for *Pseudomonas* and CoNS, respectively. The findings of this research revealed higher infection rates in the emergency, operating room, and internal (infectious) wards. Higher contamination in the emergency seems to result from the various numbers of different patients. In this study, CoNS was the most isolated organism, followed by *E. coli* and fungi. Additionally, hand hygiene is of particular importance to prevent the transmission of microorganisms and reduce the spread of infection. This issue received more attention during the global Coronavirus pandemic. In the months following the initial outbreak, international public health campaigns and physician education were focused on hand washing and disinfection. Hand drying is also important in controlling the spread of microorganisms (11). As shown in Table 2, the highest contamination was reported from the hand and nail samples of personnel (26 cases), all of which were CoNS. The importance of this issue is reflected in preventing the spread of microorganisms from one patient to another, leading to contamination and treatment-resistant nosocomial infections over time. MDR P. aeruginosa is among the factors of nosocomial infection, which prolongs hospitalization and increases mortality (12). In the present study, according, this pathogen was isolated from the suction (n=6), endoscope (n=2), and monitoring device (Table 2) (1).

Ayatollahi et al. measured the prevalence of Gram-negative bacilli in the environment and equipment of hospitals in Golestan province. They reported that the highest level of contamination with *P. aeruginosa* was found in the surgical ward, and the laryngoscope, suction, sensors, ECG, monitoring connections, telephones, and patient beds were the most contaminated samples, respectively (8). Likewise, our study indicated considerable contamination in the surgical ward, on the monitoring, laryngoscope, and the personnel's hands and nails.

Ekrami et al. isolated common aerobic bacterial pathogens from the environment of seven hospitals in Ahvaz. The most common organisms were CoNS (36.1%) and *K. pneumoniae* (8.9%), respectively. The highest infectious environments were hands, kitchen, personnel room, and equipment. Furthermore, 60% of cases produced methicillin-resistant *S. aureus* (MRSA) (13). Similar to the current study, poor hygiene of hands and high contamination of some surfaces are among the key problems at hospitals and account for the most contamination.

The most common cause of nosocomial infections is microbial contamination in the operating room and ICU. In a study in a specialized surgical hospital of Erbil City, Baban et al. found that the most common organisms were S. aureus (78.6% of Gram-positive cases), followed by *Streptococcus* (33%) and *Enterococcus* (28.6%). E. coli (19%), *P. aeruginosa* (4.8%), and *Proteus* (4.8%) were reported as common Gram-negative infections (14). Similarly, the present study documented that the highest infection rate belonged to staphylococci, which could be attributed to the normal skin flora of patients and personnel. In addition, hospital pathogens in high-risk environments (e.g., ICUs and operating rooms) are the most common source of contamination and infection due to their ability to survive longer in the hospital environment.

Belay et al. (2024) investigated microbial infection in the air, environment, and medical devices of a hospital in southwestern Ethiopia. The overall prevalence of microbial infection was

67.5%, and the highest microbial load belonged to the pediatric ward due to the high number of visitors and personnel during sampling (15). In the current study, a similar condition was observed in the emergency ward and the operating room, which can be attributed to the high number of patients in this ward and more personnel in the operating room. They also reported S. aureus (38.1%) and CoNS (33.3%) the predominant microorganisms, which corresponds to staphylococci as the most common microorganism in our study). Moreover, medical equipment in special wards, such as ICUs, is more contaminated for various reasons, e.g. close contact with vulnerable patients. In ICUs, patients usually have a weaker immune system and are exposed to nosocomial infections, resulting in fast contamination transmission from medical equipment to patients (16).

Frequent and incorrect use of equipment: Medical equipment, such as laryngoscopes and ECG sensors, are used frequently and may not be cleaned completely during the cleaning and disinfection process, which can lead to the accumulation of bacteria and other pathogens on the surfaces of these equipment. Hospital design and environment: Designing dirty and clean rooms at hospitals plays an important role in contamination control. The contamination of medical equipment may increase when hygiene and disinfection protocols are not observed correctly (17, 18).

The presence of resistant bacteria: *Acinetobacter* spp. and *P. aeruginosa* are among the bacteria that can survive on surfaces for a long time and are highly resistant to antibiotics. These features make their contamination more common in hospital environments.

Non-observance of hygiene principles by personnel: Contaminated hands of hospital staff may transfer contamination to medical equipment. Non-observance of health protocols by personnel can lead to the spread of nosocomial infections (18).In general, a combination of human factors, environmental design, and characteristics of pathogens amplify the contamination of medical equipment in special wards, such as ICUs. Strict execution of hygiene and disinfection protocols is necessary to reduce these risks.

Conclusion

It is necessary to observe hygiene principles to reduce the contamination level and prevent the spread of nosocomial infections. Furthermore, it is recommended to carry out periodical cultures to examine the contamination level. Ultimately, paying attention to the contamination of medical devices and its association with nosocomial infections requires further research and reinforcement of disinfection methods in medical centres to reduce the risks of these contaminations.

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Ethics approval and consent to participate

The authors have observed all ethical points including non-plagiarism, double publication, data distortion and data fabrication in this article. They also deny any real or material conflict of interest that may affect the results or interpretation of the article.

Conflict of interest

None.

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