



Nosocomial Infections Pathogens Isolated from Hospital Personnel, Hospital Environment and Devices

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ABSTRACT

Background: Nosocomial infections has always been a major problem for health care and lead to increases in morbidity and mortality in hospitalized patients. The aim of this study was to determine the contamination of personnel and hospital environment and device with nosocomial infections pathogens.

Methods: Wet swab was used to sampling from the hospital personnel and equipment in different wards of a hospital in Isfahan, Iran. Culture and isolation of strains were done according to the standard microbial methods. Identification was based on gram staining, microbial and biochemical tests.

Results: Overall 236 samples; 123 and 113 samples were collected from 91 hospital personnel and hospital environment and devices respectively. *S. aureus* was isolated from 14.2%, 15.3% and 5.4% of personnel hands, uniform and throat respectively. The cases of Enterobacteriaceae were isolated from personnel hands, uniform and throat as 13.9%, 4.3% and 3.27% respectively. *P. aeruginosa* was isolated from personnel hands (4.3%), uniform (6.5%) and throat (6.5%).

Conclusion: *S. aureus*, Enterobacteriaceae and *P. aeruginosa* were the most prevalence bacteria that isolated from the personnel hands, uniforms, throats and hospital environment and devices. Personnel hands were the most contaminated part considering both the numbers and diversity in isolated organisms. Contamination of the hospital personnel and hospital environment and devices have a main role in dispersion of the nosocomial pathogens in hospital environment. With a good hygienic administration and an excellent healthy management planning in hospitals can be inhibit the dispersion of nosocomial pathogens in hospitals environment.

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Introduction

Medical facilities of hospitals considered as a double-edged sword. Many of medical equipment that are used to control the disease may also cause the fundamental problems in medicine that are called nosocomial infections (1). Various hospital infections that patients is affected by them in hospital environment and usually the signs and symptoms are appeared 48 hours after admission (1, 2). There are two sources of nosocomial infections: a) the infections that the hospitalized patients acquire them from the hospital environment. b) Transferred by individuals who traffic to hospital or are working there. According to studies, almost half of all hospital infections are in the first batch. Most of nosocomial infections are caused by opportunistic pathogens (3).

Nosocomial infections are known as infectious diseases that affected infants and hospitalized patients during their stay in the hospital and their symptoms appeared before leaving the hospital. Diseases that appeared in patients after 48-72 hours of hospitalization regarded as nosocomial infections. Nosocomial infections are a risk for the spread of infection in society. *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* are the most dangerous biological agents in nosocomial infections. In recent years, other pathogenic species of the bacterial genera such as *Enterobacter*, and *Serratia* have been reported in some epidemic nosocomial infections (4) Bacterial transmission among patients take place through various ways such as manometer cuff, thermometer, stethoscope and latex gloves in hospitals (5). Mostly, the surface of stethoscopes, including potentially pathogenic microorganism that is able to be transferred to human skin. Commercial Inflating cuff, have direct contact with the skin of patients and intermittently, may be used for different patients, therefore, it is appropriate location for replacement of nosocomial pathogens. These pathogens might directly contact the host, or it might contact the host via an indirect route involving inanimate objects, called fomites, and/or living organisms,

called vectors. A piece of computer hardware, or a vector, such as a health care worker, becomes contaminated with a microbe and then serves as a reservoir for transmitting the microorganism to the host by possible forms of contact. These pathogens can be easily transmitted from one patient to another by means of the medical devices and can cause nosocomial infections (6, 7, 8). According to the medical devices which can have an important role in spread of nosocomial pathogens, confirming the nosocomial infections acquisition through contaminated instruments and inaccessibility is necessary. Thus, it is necessary to study the prevalence of nosocomial pathogens in hospital environment, since the effects of such infections, including fatalities and economic costs, are significant. So, the aim of this study was survey prevalence of nosocomial infections agents from personnel and hospital environment in Iran.

Materials and Methods

Study design and sampling

Overall, 236 samples; 123 samples from 91 personnel and 113 samples from hospital environment and devices were collected in a 3 month period. The personnel samples were taken from hands, uniforms and throats of personnel members and crews who have been working in different ward of hospital. Sampling from the personnel was performed in situation that they were working in their workplace. It was wanted from them not to change their gowns or wash their hands and also sampling was performed from hospital environment and equipment in different ward of selected hospital such as ICU Trauma, Cardiac Care Unit, men's orthopedic, skin, Lung, ICU, neurology, gastroenterology, surgery for men, Rheumatology, surgery for baby, surgery for women, gynecology and urology.

Isolation and identification of Microbes

Sampling Swabs were kept in TSB medium and were transferred to medical microbiology laboratories, and incubated for 24 h at 37 ° C. The samples cultured on blood agar, TSB broth, EMB agar, MAC agar, Cetrimid agar, Pyocyanin agar and Sabro Dextrose Agar (SD) mediums in order to isolate a diverse range of microorganisms. Then, additional biochemical tests, such as oxidase, catalase, urease, carbohydrate utilization tests, motility and staining technique such as gram staining and Albert's staining and also other tests as it have been cited in manual practical microbiology were used.

Results

Among the total of personnel samples (n=91), 87% and 13% were women and men, respectively, who aged between 22-54 years. It was shown that in all personnel, at least one of the three sampling sites (hand, uniform and throat) were contaminated with nosocomial infections pathogens such as *S. aureus*, *P. aeruginosa*, *E. coli*, *Klebsiella*, *Enterobacter*, *Citrobacter* and B hemolytic streptococci and also other common microorganism. *S. aureus* was isolated from 14.2%, 15.3% and 5.4% of hand, uniform and throat of personnel respectively. Coagulase-negative staphylococci were the highest isolated microorganism in hand and uniform of hospital personnel with 32.9 and 20.8% abundance respectively. This organisms were isolated from 10.9% of throat in hospital personnel. The *Corynebacterium* species were isolated from ca. 1, 3.2 and 3.2% of hand, uniform and throat respectively. The bacillus form bacteria were detected on hand, uniform and throat of personnel as respectively 4.3, 6.5 and 14.2%. *Streptococcus* species especially β -streptococcus were detected on hand (4.3%), uniform (2.1%) and throat (ca. 1%) of hospital personnel. The abundance rate of Enterobacteriaceae on hand, uniform and throat of personnel were respectively as (*Klebsiella* (3.2%), *Enterobacter* (2.1%), *E. coli* (4.3%), *Serratia* (ca.

1%) and *Citrobacter* (3.2%)), (*Klebsiella* (0%), *Enterobacter* (3.2%), *E. coli* (1.09%), *Serratia* (0%) and *Citrobacter* (0%) and (*Klebsiella* (1.09%), *Enterobacter* (0%), *E. coli* (0%), *Serratia* (ca. 1%) and *Citrobacter* (ca. 1%). Fungi were isolated as 8.7% and 2.1% from uniform and throat of personnel. Fungi were not detected on personnel hands (Figure 1).

Twenty one percent of personnel had both contaminated uniform and hands with nosocomial infections pathogens. It was shown that 4.3% of personnel who were working in Cardiac Care Unit, surgery for baby and men's orthopedic wards of hospital, had all together contaminated uniform, throat and hands simultaneously with nosocomial infections pathogens.

Many types of bacteria and fungi were isolated from 111 samples of the tools, equipment and hospital environment, while, any organism was not isolated from mineral water and hand sterilizing liquid. *Staphylococcus aureus*, Coagulase-negative staphylococci, *Pseudomonas aeruginosa*, *Streptococcus* spp., *Klebsiella*, *Bacillus*, *Corynebacterium* spp., *Enterobacter*, *Escherichia coli*, *Serratia*, *Citrobacter* were the most prevalence organism isolated from equipment and hospital environment (Table 1). As table 1 shows, Suction pumps, ventilator, table, clothes, beds, stretcher and patient's room were the most contaminated cases with nosocomial pathogens. Other isolates were environment microflora and were not pathogenic microorganism.

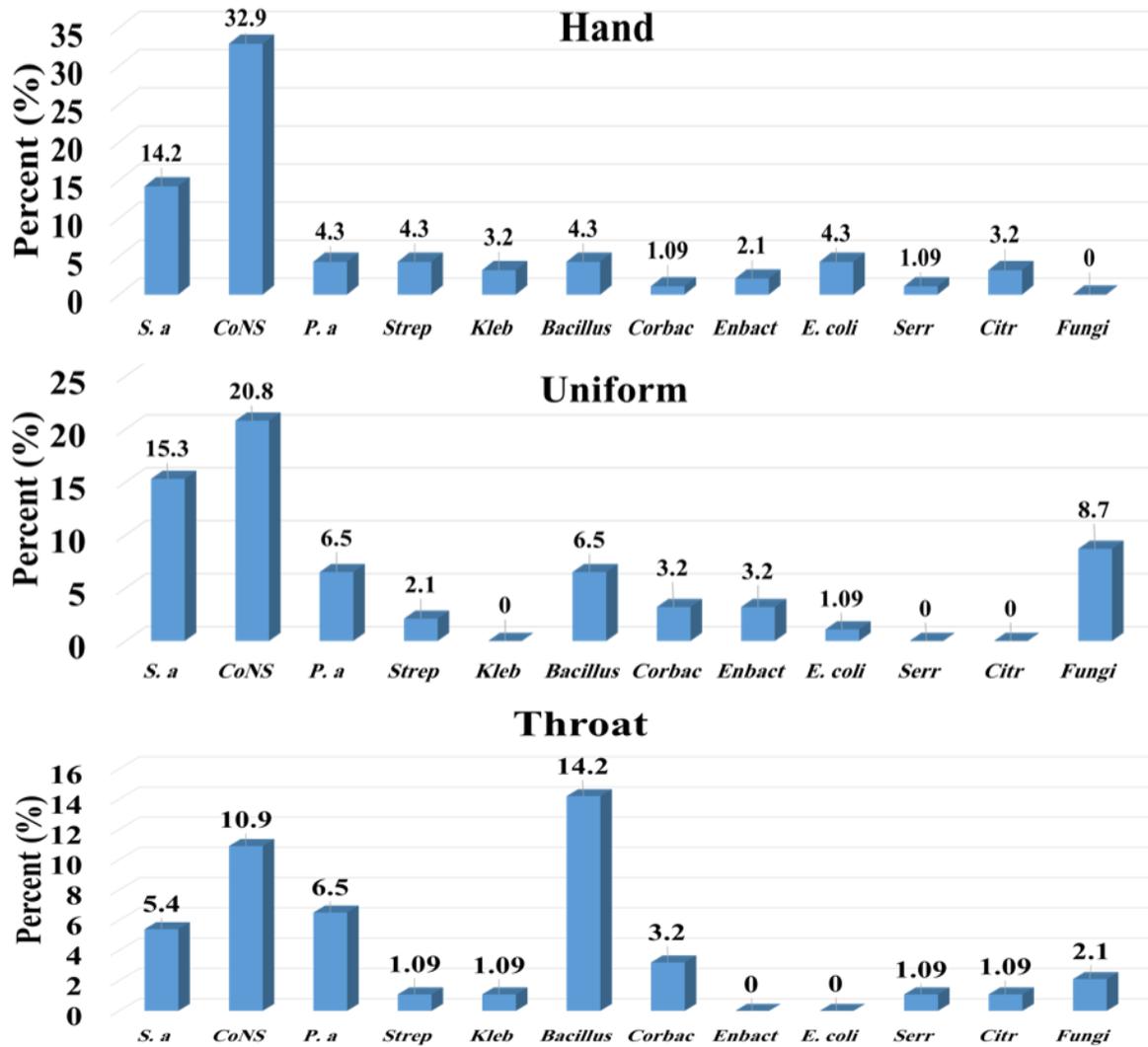


Figure 1. The prevalence of microorganism on hand, uniform and throat of hospital personnel. CoNS; Coagulase-negative staphylococci, S. a; *Staphylococcus aureus*, P. a; *Pseudomonas aeruginosa*, Strep; *Streptococcus* spp. Kleb; *Klebsiella*, Corbac; *Corynebacterium* spp. Enbact; *Enterobacter*, Serr; *Serratia*, Citr; *Citrobacter*.

Table 1. The prevalence of microorganism on equipment, tools and hospital environment.

Hospital environment and equipment	Isolated Microorganisms
Suction pump	<i>S. aureus</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>E. coli</i> , <i>Serratia</i> , <i>Fungi</i>
Ventilator	<i>S. aureus</i> , <i>CoNS</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Citrobacter</i> , <i>Enterobacter</i> , <i>E. coli</i> , <i>Serratia</i> , <i>Fungi</i>
CPR device	<i>S. aureus</i> , <i>Serratia</i> ,
Manometer	<i>S. aureus</i> , <i>Klebsiella</i> , <i>Fungi</i>
Masks and oxygen capsule	<i>S. aureus</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Bacillus</i> , <i>Corynebacterium spp.</i> <i>Diplococcus</i> , <i>Fungi</i>
Table , clothes , beds, stretcher and rooms belong to the patients	<i>S. aureus</i> , <i>CoNS</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Citrobacter</i> , <i>Klebsiella</i> , <i>Bacillus</i> , <i>Fungi</i>
Injections table and drug trays	<i>S. aureus</i> , <i>CoNS</i> , <i>Klebsiella</i> , <i>Bacillus</i> , <i>Fungi</i>
Hospital corridor and floor sweep	<i>S. aureus</i> , <i>Enterobacter</i> , <i>E. coli</i> ,
Uncovered injection syringe	<i>S. aureus</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> ,
Thermometer	<i>CoNS</i> , <i>P. aeruginosa</i> and other <i>Non-fermenters</i> ,
Hand Washing Liquid	<i>P. aeruginosa</i> and other <i>Non-fermenters</i> ,
Dishes Sink	<i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Fungi</i>
Bathtub and Shower	<i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Citrobacter</i> , <i>Bacillus</i> , <i>E. coli</i> ,
Patient Toilets and Basins	<i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Klebsiella</i> , <i>Bacillus</i> , <i>Fungi</i>
Hospital crew Boots	<i>P. aeruginosa</i> and other <i>Non-fermenters</i> , <i>Bacillus</i>
Tap	<i>Klebsiella</i> , <i>Bacillus</i> , <i>Enterobacter</i> , <i>E. coli</i> , <i>Fungi</i>
Food Distribution Table	<i>Bacillus</i> ,
Patient's Refrigerator	<i>Bacillus</i> , <i>Fungi</i>
Serum Bar	<i>CoNS</i> , <i>Klebsiella</i> , <i>Bacillus</i> , <i>Fungi</i>
Distilled Water	<i>Bacillus</i>

Larinescope Blade	<i>Bacillus</i>
Earphone	<i>Enterobacter, Fungi</i>
Monitoring System	<i>Providencia, Fungi</i>
Portable Photography.	Positive-oxidase & Positive-Fermentation bacteria (O+F+), <i>Fungi</i>
Hand sterilizing liquid	No organism
Mineral water favorite for patients	No organism
Echo System	<i>Fungi</i>
Patient's Dossier	<i>Fungi</i>

Discussion

A nosocomial infection also called “hospital acquired infection that is a major challenge to patient safety. Pathogens such as *Pseudomonas aeruginosa* and other Nonfermenters, *Staphylococcus aureus* and Enterobacteriaceae especially *Escherichia coli*, *Klebsiella* and *Entrobacter* have important roles in nosocomial infections. Permanent presence of these pathogens in hospital environment depend on the infection source and the mediating factors that cause the spread of nosocomial infection pathogens. The importance of mediating factors in spread of nosocomial pathogens in hospital environment are personnel, equipment, device and the accessories which is used to support patients. In our study, *S. aureus* was isolated from 14.2%, 15.3% and 5.4% of personnel hands, uniform and throat respectively. As the data showed, hands and uniforms were more contaminated with *S. aureus* than throat in personnel, this represents that, hands and uniforms in hospital personnel likely will have an important role in prevalence of *S. aureus* in hospital environment. This data is conforming with results of khalili et al. that has reported *S. aureus* is isolated from 19.2 and 15.9 percent of hospital personnel noses and nails, respectively (9).

The cases of Enterobacteriaceae such as *Escherichia coli*, *Klebsiella*, *Entrobacter*, *Serratia* and *Citrobacter* were isolated from personnel hands, uniform and throat as 13.9%, 4.3% and 3.27%, respectively. As results highlighted, hands

were more contaminated with Enterobacteriaceae in hospital personnel. *P. aeruginosa* as an important nosocomial pathogen was isolated from personnel hands (4.3%), uniform (6.5%) and throat (6.5%). In this cases, uniforms and throat in hospital personnel were equally contaminated with *Pseudomonas aeruginosa* and presumably have a similar role in the prevalence of this organism in hospital environment. In overall, in examined hospital, personnel hands were more contaminated with *S. aureus* and Enterobacteriaceae, their uniforms were more contaminated with *S. aureus* and *P. aeruginosa* and throat of hospital personnel were more contaminated with *Pseudomonas aeruginosa* and other non-fermentative. According to the data, microbial diversity among isolated microorganisms from hands of hospital personnel was higher than ones of uniforms and throat. This likely is related to the touching of different things by hospital personnel. We found that the uniforms of personnel were more contaminated with fungi than their hands and throat. In conclusion of hospital personnel study, we suggested a way to diminish significantly the prevalence of nosocomial infection pathogens if the patient and personnel wash their hands and uniforms regularly.

Dimitra Petroudi in his study (Greece 2009) exhibited that adequate hand washing after patients examining has an important role in decreasing of translocation of nosocomial infection pathogens in hospital environment (6).

Staphylococcus aureus as a virulent nosocomial pathogen was isolated from many devices and

hospital equipment such as suction pumps, ventilator, table, clothes, beds, stretcher and patient's rooms. These things could facilitate the translocation of *S. aureus* among high risk hosts. Other nosocomial pathogens such as *Pseudomonas aeruginosa* and Enterobacteriaceae (e.g. *Escherichia coli*, *Klebsiella*, *Serratia* and *Citrobacter*) were isolated with different percent from devices, equipment and hospital environment. Isolation of Enterobacteriaceae from hospital devices and personal stuff of patients, disclose this fact that the hospitalized patients have a poor own hygiene. These nosocomial pathogens on hospital device and personal stuff of patients can be translocated by hospital personnel or due to direct use in other patients. Our results showed the contamination of hospital personnel with Enterobacteriaceae. This might be related to the proximity of hospital personnel and hospitalized patients. Anton and his colleague in United States (2010) in their report pointed to the isolation of about 70% gram-negative bacteria especially Enterobacteriaceae from intensive care units (ICUs) (4).

In our study, *Pseudomonas aeruginosa* is another virulent pathogen that was isolated from both hospital device and personnel. This bacteria is an environment bacteria and easily can translocate with hospital carrier device and personnel among high risk patients.

The extent of fungi contamination was significant in hospital environment and personnel uniforms, however, it isn't criteria for the prevalence of virulent fungi. In this study, detection of fungi species has not surveyed. Other organism such as Coagulase-negative staphylococci was isolated from hospital devices and significantly from personnel. *Bacillus* and *Corynebacterium* isolates were also isolated from hospital environment and personnel. Routinely, these bacteria are in environment and human skin as a micro-flora which are in some cases virulent for humans especially in immunocompromised hosts. Therefore, personnel turnover in various departments in hospital, their contact with different patients and also use of the contaminated

equipment and tools among different patients in hospital have a main role in spread of nosocomial infections pathogens.

In a study at 2008 was pointed to the Coagulase-negative staphylococci, *Staphylococcus aureus*, *Enterococcus* species, *Candida* species, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Enterobacter* species, *Acinetobacter baumannii*, and *Klebsiella* as 10 most common nosocomial pathogens (10). Ahmed Khan and his colleague confirmed the existence of nosocomial infections pathogens such as MRSA, methicillin-sensitive *S. aureus* (MSSA), Vancomycin-resistant *Enterococcus* (VRE) and multidrug-resistant *Acinetobacter* species around hospital environment (11). Guinto and his colleagues highlighted that MRSA has isolated from 96% of stethoscope. In Guinto report, *Acinetobacter* species was reported from stethoscope also (12).

According to a 44-month study (2012) on 1,103 basins from 88 hospitals in the United States and Canada that was published by Dror Marchaim and colleagues in Detroit Medical Center, Wayne State University in USA, 62.2% of basins (at least 1 basin at each hospital) were contaminated with commonly hospital-acquired pathogens especially Gram-negative bacilli. In this study Enterococci and *S. aureus* were isolated from 414 and 40 cases respectively (13). Srikanth and his colleague in their study compared and characterized the aerobic microorganisms on computer keyboards of hospital and non-hospital settings. *S. aureus* was isolated from both settings (hospital: 6 MRSA, 11 MSSA; non-hospital: 4 MRSA, 9 MSSA), in this report, Gram-negative bacilli were 33% (14). A study (2012) was conducted by University of Michigan, North Ingalls in USA showed that the vancomycin-resistant Enterococci (VRE), *Bacillus* sp. *Micrococcus luteus*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Micrococcus roseus* were the most bacteria on Nurses' uniforms (15). In a report from Anthony Pinon and his colleagues in Institute Pasteur de Lille of France highlighted that 55% of samples from

clean bed linen were contaminated before contact with the patient and all samples from dirty bed linen carried microorganisms with a mean count of 23CFU/25cm². In Anthony Pinon study is reported that the uniforms of hospital personnel were highly contaminated with staphylococci or micrococci and 6 opportunistic pathogens such as *Pseudomonas* and *Bacillus* (16). Gialluly in his research has highlighted that the *Staphylococcus aureus* is the most common pathogen on cuffs used in ICUs and those kept on nurses' trolleys (17).

Conclusion

In conclusion, contamination with *Staphylococcus aureus* is significant in hands and uniforms of hospital personnel. In this study other nosocomial pathogens such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella*, *Enterobacter*, *Serratia* and *Citrobacter* isolated from the personnel hands and uniforms as different percentage. Personnel hands were the most contaminated part considering both the numbers and diversity in isolated organisms. In this study, *Staphylococcus aureus* and other nosocomial pathogens such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella*, *Serratia*, and *Citrobacter* isolated from devices, equipment and hospital environment. We found that the contamination of hospital carrier personnel and equipment have a main role in prevalence of pathogenic organism in hospital environment. With a good hygienic administration and an excellent healthy management planning in equipment and hospital personnel can be inhibit the prevalence of nosocomial pathogenic organism in hospitals environment.

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Conflict of interest

Reza Akbari, Mehdi Fattahi Bafghi and Hossain Fazeli declare that they have no conflict of interest.

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