ORIGINAL PAPER

Assessing the efficiency of floor disinfection on bacterial decontamination in sanandaj governmental hospitals

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Date of submission: 30 Aug 2017, ***Date of acceptance:*** 30 Jan 2018

ABSTRACT

Despite regular disinfection and decontamination of the hospital floors and surfaces, resistant pathogens from the hospital surfaces and their transmission to humans have been reported recently. The resistance of pathogens to the disinfectant agents or failed disinfection techniques have put the routine floor and non-critical surface disinfection done in hospitals into question with regard to their effectiveness. In this study, 112 samples were collected using cotton swabs which were immediately placed in a broth agar media. The collected samples were cultured in broth agar and eosin methylene blue media. We determined the bacterial load on the ward floors and patient rooms before and after disinfection and assessed the effectiveness of the used method and decontamination agents in cleaning the floors. The results showed that disinfection did not have a significant effect on the hospital surface decontamination, and the disinfection process did not change the colony count in the different wards of the hospital (P-value < 0.05).

Keywords: Hospital; Disinfection; Effectiveness; Floor; Contamination

Introduction

Despite the efforts of the healthcare system and the modern healthcare technologies, nosocomial or hospital-acquired infection (HAI) is a major complication of hospitalization.[1-3] HAIs remain an important source of morbidity and mortality with an estimated 1.7 million infections and 99,000 deaths annually in the United States.[4] Various microorganisms have been reported as HAI pathogens, including patients' endogenous flora and pathogens colonizing hospital environments. Twenty to forty percent of the HAIs are attributed to transmission of the pathogens to patients by the hands of healthcare personnel.[5] A recent study showed that methicillin-resistant *Staphylococcus aureus* (MRSA) contaminated nurses gloves who touched inanimate objects near patients colonized by MRSA.[6, 7] Another study found that vancomycin-resistant enterococci (VRE) were transferred to gloved hands nearly half of the time after contact with bed rails and bedside tables of colonized patients.[8]

There is convincing evidence in the literature that environmental contamination plays an important role in the transmission of healthcare-associated pathogens.[9-11] Nevertheless, evidence has shown that disinfection of the environmental surfaces is a critical intervention for reducing HAIs.[12, 13] In recent years, a number of studies have demonstrated that environmental cleaning interventions can improve the thoroughness of cleaning and reduce contamination of

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Citation: Kohzadi Sh, Ramazanzade R, loqmani H, Shakib P, Ghaderzadeh H, Khasi B, et al. Assessing the efficiency of floor disinfection on bacterial decontamination in sanandaj governmental hospitals. J Adv Environ Health Res 2018; 6(1): 44-51

surfaces.[14] Routine disinfection processes, based on cleaning the surfaces, are suggested to help control the spread of pathogens in hospitals.[9, 10, 15, 16] MRSA is the most threatening pathogen that colonizes the hospitals. It can survive in the dust for up to a year and can be isolated from the floor, radiators, furniture, lockers, and equipment.[17] Mechanical floor cleaning removes organic soil and dirt that can be a nidus for bacterial growth; indeed it removes some of the resident flora.[9, 18] But the problem is that within a few hours later, the floor gets contaminated with new microbes. This implies that using a chemical decontaminant with a long-lasting effect is necessary to keep the floors clean of microbes. Cleaning is routinely monitored by visual audit in Iran. A visually clean ward, based on a completed obligated duty, is not a reliable assessment of the infection risk for an individual patient in that ward. Visual assessment will not be a valid and scientific method in these conditions. Floor decontamination is done routinely in Sanandaj hospitals with towels and diluted chemical agents, but there is no data on the effectiveness of this method for decontamination with regard to its financial burden.

Hence, the aim of this study was to determine the bacterial load on the ward floors and patient rooms before and after disinfection and to assess the effectiveness of the used method and decontaminant agents in cleaning floors.

Materials and Methods

Sampling and analysis

A cross-sectional study was carried out from January to May 2015, in two government hospitals in Sanandaj, Iran. There are 29 wards in both the hospitals. Due to financial constraints, only four samples were taken from each ward of the two hospitals, one from the beginning of each ward and the other one from a randomly chosen room, before and after disinfection. A preset area of 1 × 1 m at the foot end of the first bed in the room was used as the location of sampling. Therefore, a total of 112 samples were collected. The sampling time was immediately before disinfection and 30 minutes later, using cotton swabs placed immediately in a broth agar media. Sample collection was done over 4 months. The collected samples were cultured in broth agar and eosin methylene blue media, and different microorganisms were identified using routine laboratory tests. Comparison of the bacteria colony count before and after disinfection was performed using a colony count machine. In both hospitals, disinfection is done by diluting the used chemical agents in a plastic bucket and rubbing the floor surfaces with a towel drenched in the diluted agent and let to dry. The disinfectant agent used by hospital A was MICROZED GP-H (surface disinfectant cleaner, Saziba company, Iran). It has a broad efficacy against gram-negative and gram-positive bacteria, mycobacteria, viruses, fungi, yeast, and mold, according to the agent's catalogue. The disinfectant agent used by hospital B was DesNet. The data collected were entered into SPSS software (Ver. 20), and it was analyzed using t-test and Wilcoxon test.

Results and Discution

Microbial load before and after decontamination in hospital A

Altogether, 58 samples were collected from hospital A before and after disinfection. As shown in Fig. 1, before decontamination, *S. aureus*, coagulase-negative staphylococci, *E. coli*, *Klebsiella*, *Bacillus* spp., and fungi were found in 37.9%, 27.17%, 17.1%, 0%, 10.25, and 20.5% of the samples, respectively, and only 3.4% of the samples collected in hospital A were without any bacteria. However, after decontamination, *S. aureus*, coagulase-negative staphylococci, *E coli*, *Klebsiella*, *Bacillus* spp., and fungi were found in 37.9%, 20.37%, 6.9%, 6.9%, 10.3%, and 17.2% of the samples, respectively, and only 17.2% of the samples were without any bacteria. As tabulated in Table 1and Table 2, the results of the t-test analysis showed that the bacterial diversity and colony count did not change before and after the disinfection process in hospital A (P-value < 0.05).

The presence of bacteria varied among the different wards. Fig. 2 shows the bacterial

species frequency in the different wards before disinfection. The most common bacteria observed in the different wards was *S. aureus*, and the least common was *Klebsiella*. The results showed that before decontamination, *S. aureus* was found in 100% of the samples taken from pulmonary, female internal and neurology wards and in half of the samples from ear, nose, and throat (ENT), burn, dialysis, and coronary care unit (CCU) wards. After decontamination, *S. aureus* was found in 50% of the samples taken from pulmonary, cardiology (female), burns, gastrointestinal (GI), dialysis, surgery, and oncology wards and 100% of the samples from infectious disease and neurology wards (Fig. 3).

Table 1. Bacterial diversity before and after disinfection in A hospital (T-test)

State	Frequency	Mean	Standard deviation	T	P
Before disinfection	29	3.55	3.03	0.752	0.458
After disinfection	29	2.93	2.57		

The total frequency of *S. aureus* and *Bacillus* spp. did not change before and after decontamination in hospital A. The frequency of *E. coli*, coagulase-negative staphylococci, and fungus decreased by 10.2%, 6.8%, and 3.3%, respectively, but the frequency of *Klebsiella* increased by 6.9%.

Table 2. colony count before and after disinfection in A hospital (T-Test)

State	Frequency	Mean	Standard deviation	T	P
Befor disinfection	29	3.13	1.88	0.747	0.461
After disinfection	29	2.72	2.01		

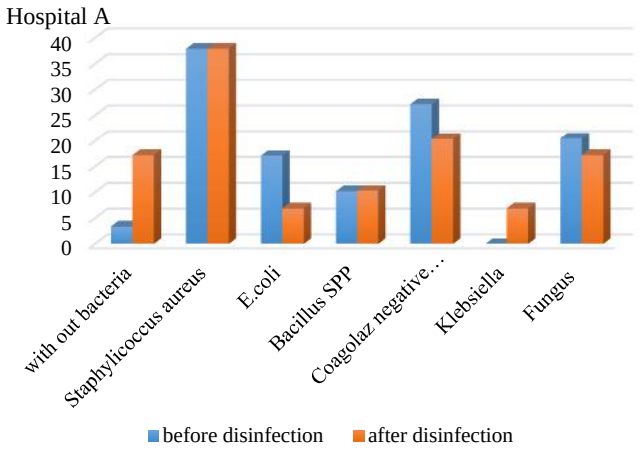

Fig. 1. Bacterial species in hospital A samples before and after disinfection

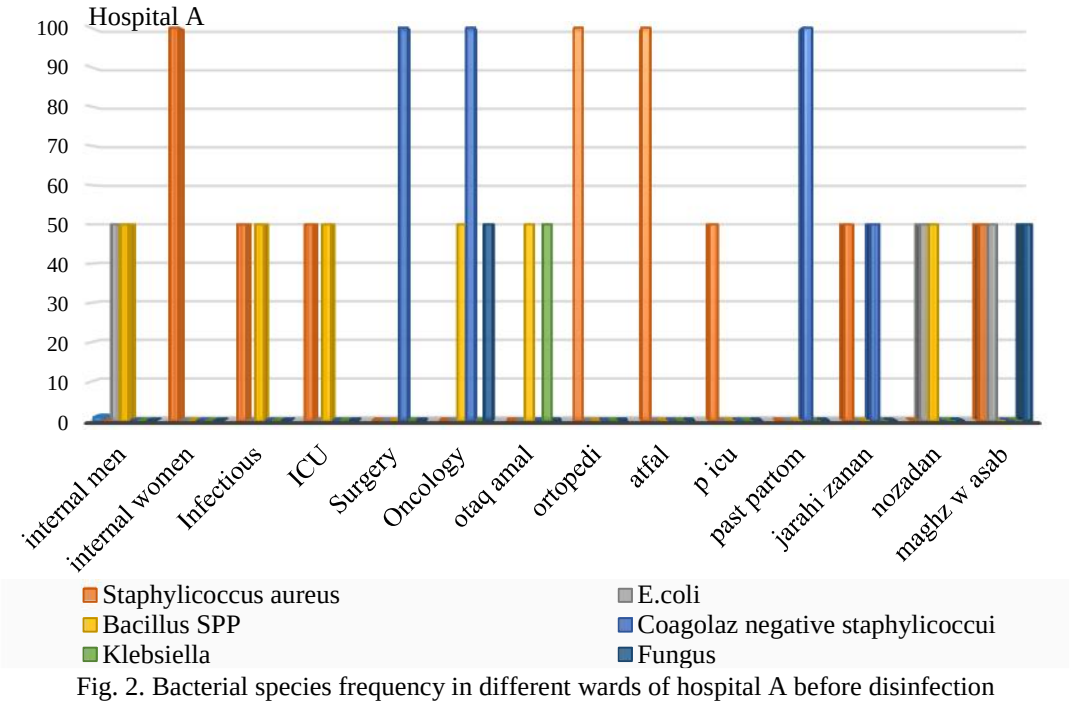

Fig. 2. Bacterial species frequency in different wards of hospital A before disinfection

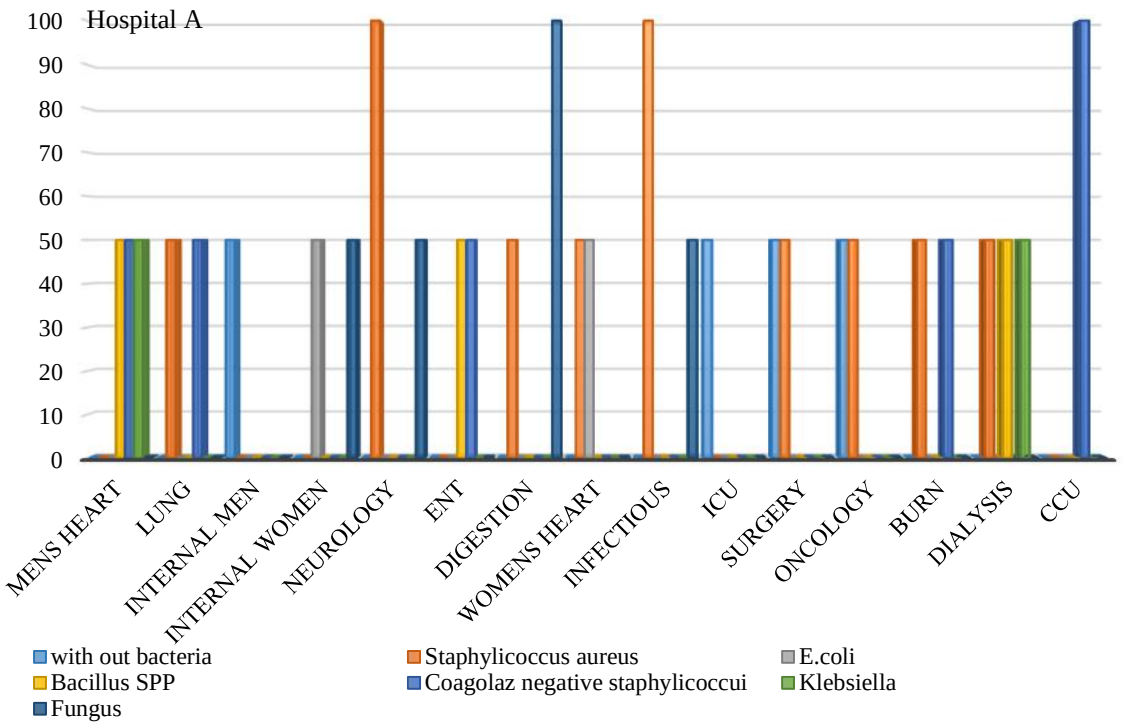

Fig. 3. Bacterial species frequency in different wards of hospital A after disinfection

Microbial load before and after decontamination in hospital B

Altogether, 54 samples were taken from hospital B before and after disinfection. Before disinfection, *S. aureus*, coagulase-negative staphylococci, *E. coli*, *Klebsiella*, *Bacillus* spp., and fungi were found in 40.7%, 29.6%, 7.4%, 3.7%, 22.2%, and 7.4% of the samples, respectively, taken from hospital B, and none of the samples were without any bacteria (Fig. 4). After disinfection, *S. aureus*, coagulase-negative staphylococci, *E. coli*, *Klebsiella*, *Bacillus* spp., and fungi were found in 14.8%, 37%, 33.3%, 7.4%, 3.7%, and 0% of the samples, respectively, and no sample was clean.

As shown in Table 3, there was no significant difference in the bacterial diversity before and after disinfection in hospital B (P-Value < 0.05).

The presence of bacteria varied among the different wards. Fig. 5 shows the bacterial species frequency in the different wards before disinfection. The most common bacteria found in the different wards was *S. aureus*, and the least common was *Klebsiella*. The results showed that before disinfection, *S. aureus* was found in 100% of the samples taken from internal medicine (female), pediatrics, and orthopedic wards and in half the samples from infectious disease, intensive care unit (ICU), pediatric ICU, surgery (female), and neurosurgery wards. After disinfection, it was observed in 50% of the samples taken from internal medicine (female), infectious disease, oncology, and neonatal wards and 100% of the samples from the operation room (Fig. 6). On the other hand, the total frequency of *S. aureus*, *Bacillus* spp., and fungi decreased by 25.9%, 18.5%, and 7.4%, and coagulase-negative staphylococci, *E. coli*, and *Klebsiella* increased by 7.4%, 25.9%, and 3.7%, respectively.

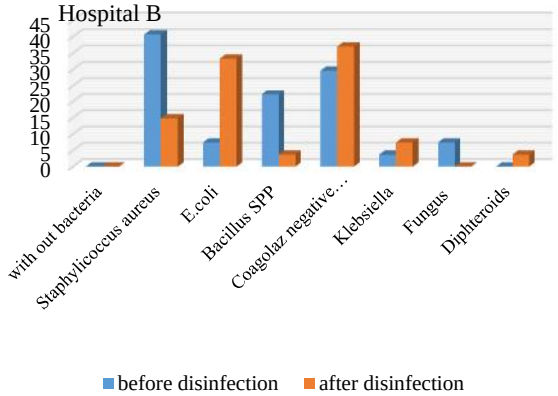

Fig. 4. Bacterial species in samples taken from hospital B before and after disinfection

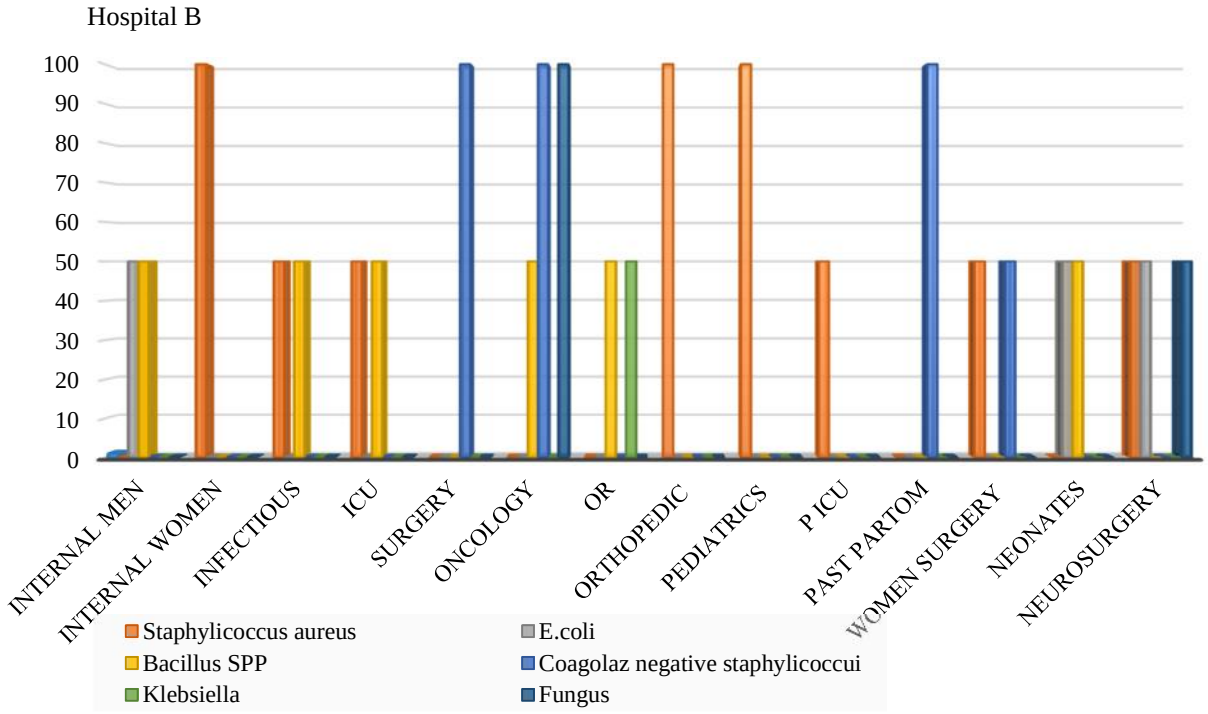

Fig. 5. Bacterial species frequency in different wards of hospital B before disinfection

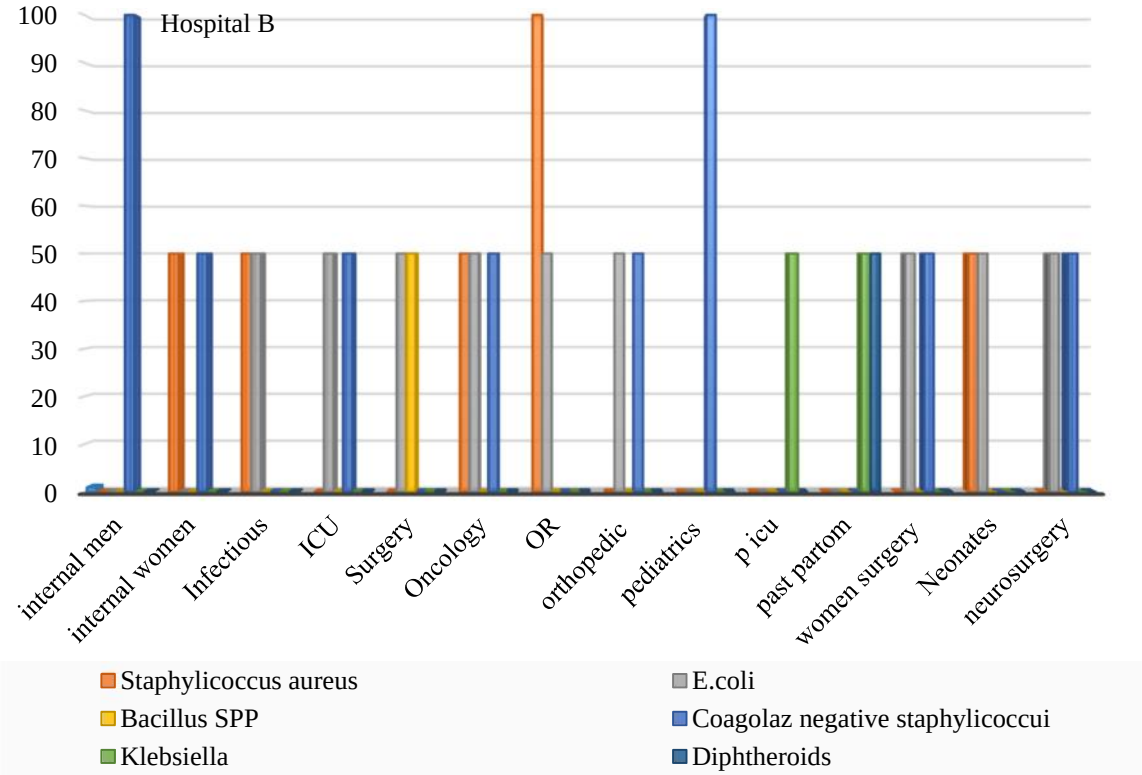

Fig. 6. Bacterial species frequency in different wards of hospital B After disinfection

Table 4 shows that the colony count did not change following the disinfection process in the different wards of the hospital (P-value < 0.05).

Table 5 compares the number of samples before and after disinfection based on the colony count. Disinfection success rate did not show a

significant correlation with the colony count,although, sterile cultures increased from 4 to 7 after disinfection.

Table 3. Bacterial diversity comparing before and after disinfection
in hospital B (Wilcoxon Test)

State	Frequency	Mean Rank	Z	P
Before disinfection	27	11	-0.891	0.373
After disinfection	27	912.93		

Table 4. Colony count before and after disinfection in hospital B (T-Test)

State	Frequency	Mean	Standard deviation	T	P
Before disinfection	27	3.92	0.95	-1.80	0.83
After disinfection	27	4.37	0.68		

Table 5. Number of samples before and after disinfection based on colony count

Colony count	Frequency of samples before Disinfection	Frequency of samples after Disinfection
abortive	4	7
10	1	1
102	7	4
103	15	11
104	12	13
102-103	13	17
103-104	4	3
Total	56	56

Hospital floors can be contaminated and colonized with microorganisms by aerosols, contact with shoes, wheels, and other objects.[19] Elimination of these microbes is necessary for the control of HAIs. Chemical agents are routinely used in hospitals since many years for bacterial decontamination. However, the effect of floor surface decontamination on the prevention of infectious diseases remains unclear because of lack of supporting data and studies and different confounders for attributing a particular infection to floor contamination.[20] The aim of this study was to evaluate the efficacy of disinfection, which is performed in hospitals A and B once or twice per day routinely. Moreover, there is a large amount of data on the efficacy of different chemical agents for decontaminating surfaces, but these studies have been carried out under controlled laboratory conditions. Also, the effect of the different factors that present in a hospital milieu, like crowding of the people, the method of using the chemical agent, disinfection procedure used by the attendants, frequency ofdisinfection, and resistance of microorganisms to the chemical agents, were not considered in these studies.

The manufacturers of the chemical agents used in both the hospitals claimed a broad-spectrum efficacy, but our results did not support this claim. Persistence of microbicidal effect of these agents is an essential property when used on the hospital surfaces because of the limitation of performing decontamination process and the presence of a constant source of microbial pollution in the hospital environment.

This study showed that the chemical agents used were not effective against the pathogenic species. *S. aureus*, *Bacillus* spp., and *Klebsiella*, the major pathogenic organisms, were resistant to disinfection in hospital A.[4] Different reasons can explain this ineffectiveness of decontamination. One reason is that these pathogens are biologically resistant to decontaminants, which can be deduced from the available literature. Another explanation can be the contamination of the chemical agent during its preparation process because of the contaminated towel or bucket .[21]

Investigations have shown that the mop water becomes increasingly dirty during cleaning of floors, and mop water becomes contaminated if soap and water are used rather than a disinfectant.[19, 22] In a related investigation, the use of soap and water (80% reduction) was less effective in reducing the numbers of bacteria compared with a phenolic disinfectant solution (99% reduction).[23] However, after a few hours, the bacterial count was back to nearly the pretreatment level.[23, 24]Although a 10-minute stay on the surface is recommended for these agents to be most effective, we observed that because of the crowding and new pollution being introduced, the solution vaporizes much faster; therefore, there was not enough time for effective decontamination.

Another explanation is the crowding of

people in both the hospitals because of more than the standard number of patients and a high number of patient visitors, resulting in a high load of microorganisms on the floors. Due to the subculture in the region where the study was conducted, the relatives of patients congregate in the hospital wards during the admission and hospitalization of their family member, relative, or friend.

As observed, the structure of the hospital wards can be a factor. In both hospitals, there was just one toilet room for the entire ward which accommodates about 30–40 patients, their attendants, and visitors. Their shoes and slippers can be a source of contamination of the floors and surfaces. Further studies need to be carried out to assess the disinfection effectiveness in hospitals. Because of the numerous factors affecting this process, studying it step by step is recommended during future investigations.[25]

Conclusion

This study investigated the effectiveness of floor disinfection in the reduction of bacterial load in two hospitals in Sanandaj city, Iran. Our data shows that the bacterial diversity and colony count did not change before and after the disinfection process in both hospitals (P-value < 0.05); in some cases, the bacterial colony count even increased. On the other hand, due to the excessive use of various disinfectants and the occurrence of resistant strains, not only nosocomial infections have arisen but also problems in wastewater treatment operations. Considering the probable reasons discussed above, we suggest, for hospital managerial staff, changing the chemical agents, having more training sessions for attendants, and standardizing the patient admission capacity which would result in reduced number of visitors. For researchers, more extended studies on the association between the floor bacterial load and hospital infections and surveying the disinfection effectiveness in other hospitals are suggested.

Acknowledgment

This research work was supported by Kurdistan University of Medical Sciences, Sanandaj, Iran. The authors are thankful for the financial support and cooperation of the staffs of Tohid and Besat hospitals.

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