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Evaluating the Cleaning Program Efficacy in ICU Ward of General Hospital Using Visual and Microbial Approaches

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Background & Aims of the Study: Hospital infectious is one of the major causes of mortality among the hospitalized cases. The interior environment status of hospitals has the important rule in microbial transmission. Translocation of the infectious agents may be essentially due to contacts between patients and contaminated interior environment. This work was performed to assess the hygienic circumstances of Shahid-Beheshti Hospital located in Kashan.

Materials & Methods: This cross-sectional study was carried out during 10 weeks which was based on two approaches including environmental observations relied on a checklist and a sampling program. The samples were taken to determine the ACC, staining, catalase, coagulase, menthol fermentation (MSA) and DNase. Data analysis was performed using SPSS 18 with McNamara nonparametric approach.

Results: Based upon the observation checklist, 184 cases (92%) among the pre-cleaned objects were reported as "contaminated". Also, 160 cases (80%) from post-cleaned objects were reported as "contaminated". Whereas, the findings obtained from microbial tests reported that, 169(84.5%) and 138(69%).14.5 sampling points were contaminated with *Staphylococcus aurous*, respectively. Results revealed that the hygienic status of the hospital objects and surfaces was improved by cleaning program. The effectiveness of cleaning program was verified both via visual (P<0.001) and microbial method (P<0.001).

Conclusions: Despite of high levels of microbial counts and some observed dirty which were remained after the cleaning program; it seems that routine cleaning programs are useful approaches for surface cleaning. Applying the standard protocol for cleaning practices and implementing a precise monitoring system can be useful to reduce the infection transmission risk and cross contamination. The Hospital Infection Control Council (HICC) has the major rule to achieve the mentioned hygienic targets.

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Background

Hospital infection is one of the major causes of mortality among hospitalized cases (1). Studies have proved the relationship between contaminated environment in hospitals and microbial transmitted infections (2). Extended infectious agents translocation is essentially due to contact between environment and patients (3). Common Environments in the hospitals and health care facilities are divided in two groups

including semi-domestic level and medicine tools and medicine equipment (4). The contamination of inanimate environments as the table beside the bed, ward-robes and handles beside the patient contain dangerous pathogens of hospital infections to methicillin-resistant Staphylococcusaureus, vancomycin that can be alive for a long time on the environment and transfer the disease (5).

In addition, to empirical visuals, epidemiological studies proved that environmental surfaces can be effective in transferring respiratory and gastric infections (6). Appropriate hygienic condition in hospitals is among the major measures to control the hospital infectious (2). Although the purpose is not creating a sterile environment in the hospital but removing pollutants, dirty, dusts and pathogens is required to reduce the transmission risk of infectious agents from the hospital environment to the patients (7). On the other hand, the presence of sensitive hosts is the main reason to have the specific considerations in the hospital environment regarding to infection control (8). During the recent decade, controlling the pathogens of health-care centers is one of the main issues in epidemiology studies (9). Recently, five experiments showed that the hygiene environment reduces 40% the transmission risk of staphylococcal resistance to methicillin and vancomycin (10). The role of contaminated environment in transmission of infectious is due to preparation the opportunity for microbial colonization (11). Various studies have focused on the role and importance of keeping the hygienic condition in the hospital control the pathogen infections (12). The level of contamination in hospitals are reduced after performing the cleaning practice which has been approved via comparing the samples before and after the cleaning (7) For instance, an experiment was showed that the average microbial loading was reported 2.89±0.89 cfu/Ml before cleaning program which was reduced to 1.05±0.18 cfu/mL after it (8). To control the transmission of pathogens in hospital environments, keeping the appropriate health condition is recommended (13).

Hygienic considerations can be achieved if the hospital environment has been kept in clean and dust-free condition. 90% of microorganisms are hidden inside the dust particles so; the first aim of routine cleaning is removing the dusts and dirty (14). Proper surveillance of hospital hygiene is necessary and monitoring the efficacy of cleaning program is the essential element of health care management in the hospital (15). Hygiene is an effective and cost-benefit measure to reduce the hospital infections that should be done scientifically. The standard approaches for visual monitoring are available which can be applied as an indirect measure for microbial evaluation of hospital environment (16). In Iran, some studies have been investigated the microbial contamination of hospital inanimate environment (17-19) but, the role of cleaning program on hospital hygiene was no considered.

Aims of the study: this study was performed to determine the health condition and the environmental hygienic characteristics of in Beheshti Hospital in Kashan, a city located in Esfahan province.

Materials & Methods

The study was performed in ICU ward of Beheshti Hospital in Kashan, the central part of Iran during 2011. There was no previous information or any sensitivity study in the staff as a common process to prevent any behavior change and error. Some inanimate surfaces in ICU with maximum contact with the hand of hospital staff, patients, patient's relatives and visitors were selected as sampling points. Consequently, 10 locations were selected inside the ICU including the table beside the patient bed, switch light, basin handle, nursing station,

receiver, room handle (interior section), chair, patient bed, refrigerator handle, the floor of the rooms (higher traffic routs).The study was performed in a period of 10 weeks and two times in each week, before and after the daily cleaning. The selected locations were monitored by visual and microbial methods. Visual discrimination method currently is used for monitoring the health condition of environment and efficacy of hygienic processes in various countries such as Canada, England, Ireland, Scotland and Wels (7-9-15-16).In this study, the standard check-list relies on instruction of hygiene was used for infection control used by supervision committee on infection diseases of Canada (20). The results were reported as clean (acceptable hygienic condition) and contaminated (unacceptable hygienic condition).

Sampling strategy was based on using a wet swab with sterile solution of normal saline. The sampling practice was performed by pressuring the swab to the wall of lab tube so, the extra liquid was received and then, about 10 cm^2 of the selected surface was exposed to the contact with swab. The swabbing was based on a zig-zag pattern. Then, the swab was put in tube contained one millimeter sterile normal saline. Then, sample was transferred to the laboratory. In laboratory, the tube is put in the sugar for 10 seconds and after that we prepared 100 micro liter of the solution by sterile sampler head in plate of Blood Agar culture. The cultured sample was put for in incubator for 48 hours at 37 °C. In the next step, the colonies form on the medium surface was measured by colony counter and results were reported as CFU/cm^2. According to the literature (7, 16, 21), the locations contains the microbial loading more than $2.5CFU/cm^2$ were reported as contaminated (unacceptable hygiene) and the locations contain microbial loading less than $2.5CFU/cm^2$ were reported as clean (acceptable hygiene).

According to the similar studies (5,8,9), *S.aureus* belonged to the opportunist pathogens, is one of the most prevalent microorganisms in hospital infections. So, the identification of *S.aureus* can be considered as the sign of contaminated condition (unacceptable hygiene). The Gramstaining method, catalase, coagulase, menthol fermentation (MSA) and DNase were used to identify the *S.aureus.*

All sampling and analyzing apparatus were treated with the autoclave equipped with the indicator class 6 to verify the sterilization process. Finally, the obtained data were analyzed using the McNemare nonparametric method by SPSS software version 18.

Results

In this study, 400 checklists were completed for 10 kinds of surface. 150 locations were contaminated before and after the cleaning operation, 34 locations were contaminated before cleaning and then, reported as “clean”, after the operation. 10 locations were denoted as “clean”, before the cleaning program, but reported contaminated after it. 6 locations remained clean both before and after the cleaning program. Consequently, 92% of the sampling points were contaminated before the cleaning program, and there were 82% of the sampling points that remained “contaminated "after the cleaning program So, there was a significant difference between the impacts of cleaning program, before and after the process (P<0.001).

Among the 200 coupled samples, 8 locations were reported clean before and after the cleaning program. Also, 115 locations were remained contaminated before and after the cleaning program and 23 locations were

Reported as "clean" before the cleaning program but were known as "contaminated" after it. 54 locations were "contaminated" before the cleaning program and were clean after it. Totally, 84.5% of the locations were contaminated before the cleaning program, while it was reduced to 69% for the locations after cleaning (P<0.001). 6 locations were remained contaminated to *S.aureus* before and after the cleaning program. 155 locations were denoted as free of *S.aureus* both before and after cleaning, 23 locations were contaminated with it before cleaning and after cleaning were without it and 16 locations were without *S.aureus* before cleaning and after the cleaning program. 14.5% of the locations were contaminated before cleaning whereas it reduced to 11% after the cleaning program but the difference was not significant (p>0.05). In visual evaluation, 184 (92%) of the locations before and 160 (80%) of the locations were contaminated after the cleaning program. While in microbial method with the number of colonies 169 (84.5%) of the locations before and 138 (69%) of the locations after cleaning and *S.aureus*29 (14.5), 22(11) % of the locations were contaminated before and after cleaning. The comparison of frequency distribution of locations status with three methods of observation, the number of colonies and *S.aureus*are can be illustrated in Fig. 1.

For obtained samples before the cleaning program, the frequency of Gram-positive bacteria, Gram-negative bacteria and those whiteout any reaction to the staining were reported 61.5%, 51%, 3%, respectively which were reported 51%, 47% and 2%, respectively, after the cleaning program. The frequency of bacteria regarding to their reaction status after the Gram-staining are presented in Table 1.

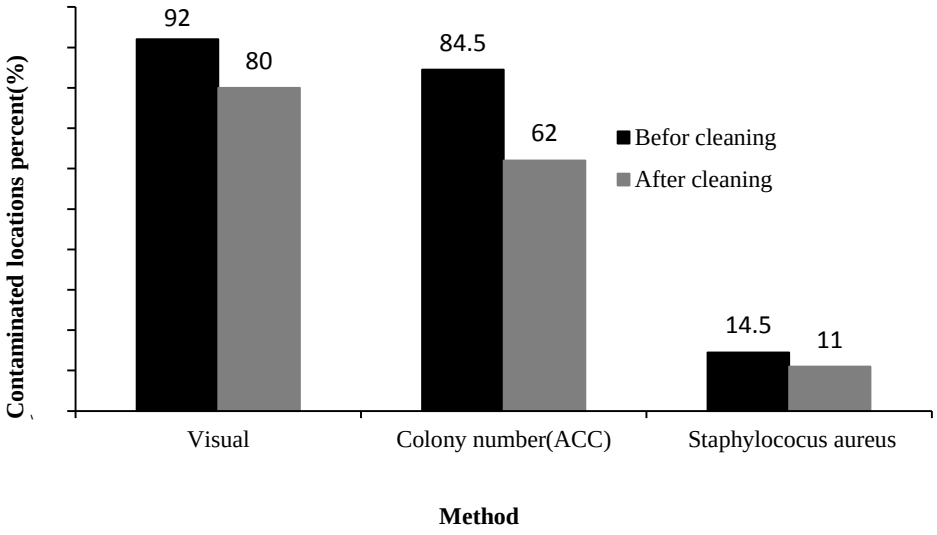

Figure 1) Frequency distribution of the location status regarding to three used methods (visual, colony number and S.aureus) before and after the cleaning program

Discussion

Results showed that the numbers of contaminated locations, both in visual and microbial methods, were reduced after the cleaning program. The reducing rate was 12% in the visual method and it was 15.5% for the microbial method which was obtained by the colony counting. Also, the presence of *S.aureus*

was about 3.5% reduced after the cleaning program. It can be concluded that, the Frequency of contaminated locations remained in high levels, even after the cleaning program.

Table 1) Frequency distribution of microorganisms based on the Gram-staining before and after the cleaning program

Cleaning Program	Gram positive coccinumber (%)	Gram negative coccinumber (%)	BacilGram positive number (%)	BacilGram negative number (%)	The lack of reaction to Gram staining number (%)
Before cleaning	72 (36)	49 (24.5)	51(25.5)	22 (11)	6 (3)
After cleaning	64(32)	54(27)	38 (19)	40(20)	4 (22)
Total	136 (34)	103(25.75)	89 (22.25)	66 (15.5)	10 (2.5)

Various studies showed that the cleaning program can be effective to reduce the frequency of contaminated locations but the different levels of reducing amounts have been reported (7,22). An indoor experiment inferred that the contaminated locations after the cleaning program were reduced about 3.3%, 4.2% via visual and microbial method, respectively (7). It should be noted that, the former study had the small sample size. Kuper et al. studied on 27 locations in interior and surgery wards in England and Waels hospitals. They reported the contaminated locations as 20% and 10.75% for before and after the cleaning program, respectively, using visual method. Also, according to the microbial method, the contaminated locations were reported as 77 and 75% for before and after the cleaning program (22). In the current study, the contaminated locations before and after cleaning in visual method were 92% and 80%, respectively and in microbial method were 84.5% and 69%, respectively. High amounts of contaminated locations can be due the various factors such as lack of an appropriate plan of cleaning as on some sampling methods, the cleaning was not considered or it was not completed as standard. On points that are not cleaned continuously, the microbial load average is higher considerably compared to other points (8). The lack of training program for the staff and the health-care related personnel's is a major influencing factor. Various studies denoted that improving the daily cleaning program is beneficial to increase the health level and also the contaminations due to the pathogens presence in health centers are reduced (9).

In Iran, some studies of microbial contamination of equipment and hospital environment are reported. Aslani et al. in a study done in Shahre Kord hospital of Hajar on various equipment of the hospital, of total 137 cultivations, 125 cases (91.2%) were positive in terms of bacterium growth and 12 cases (8.8%) were negative (17). In a study, the contamination of ICU was 31.5% and CCU 33.9% (18). In these studies, the judgment was bacterium growth and there was no the other index for judgment about health condition of sampling surface and sampling was done without considering cleaning plan and dependent factors. The study on 1440 samples of infants and 1568 samples of maternity wards showed that except dispensable equipment that were sterile with autoclave, other equipment in

the first period were in high rank between 80-100% and contamination in the second period after cleaning the equipment did not have any difference with the first period (19). The average percentage of contamination in operation room of Imam Khomeini Hospital and Mobasher Kashani of Hamedan before cleaning was 78.4% and after cleaning 33.4% that had significant difference in reducing the contamination (P<0.04) (23). In this study, by visual method (P=0.001) and microbial (P=0.000) in the reduction of contamination after cleaning had significant difference. On the other hand, the studies showed that health standards in monitoring the efficiency of cleaning and risk monitoring of contact locations and evaluation of the risk of suffering from hospital infections are useful (21).

The results of the study showed that frequency of contaminated locations in visual method was 86% while in microbial method, this frequency was 76%. Another study in 4 hospitals in England showed that in the surgery section 90% of the locations were clean by visual method while in microbial investigation; only 10% of the locations were reported as "clean" (24). As the evaluation with each of the visual and microbial methods had different results, the further studies to compare the efficiency of visual and microbial methods are recommended. Also cleaning can be an effective method to reduce the load of environment contamination. Integrated method composed of visual and microbial tests can be used as a good approach to judge regarding to the condition of cleaning process. Standardized the various instructions for the cleaning program, training the staff and monitoring the cleaning program with well-approved methods are suggested. Reorganized the infection control committee (ICC) of hospitals regarding to using the standard procedures can improve the efficacy of cleaning program in the hospital wards.

Footnotes

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Conflict of Interest:
The authors declare no conflict of interest

References

1. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health careassociated pathogens: Norovirus, Clostridium difficile, and Acinetobacter specie. Am J Infect Control 2010; 5(38):S25-33.

2. Anonymous. Standard Principles for preventing hospital-acquired infections. Standard Principles for Hospital Environmental Hygiene. JHospInfect2001 ;(47):S21–S37 available online at http://www.idealibrary.com. On IRE hi.

3. Schulster L, Raymond YW, Arduino M, Carpenter J, Donlan R, Sehulster L ,et al. Guidelines for Environmental Infection Control in Health-Care Facilities2003. Available online at http://www.cdc.gov/ncidod/hip/enviro/guide.htm.

4. Rutala WA, Weber DJ, Weinstein RA, Siegel JD, Pearson ML, Raymond YW, et al. Guideline for Disinfection and Sterilization in Healthcare Facilities 2008.available at http://www.cdc.gov/ncidod/dhqp/pdf/guidelines/Disinfection_Nov_2008.pdf.

5. Karami GH. Surface disinfection in hospital: Why and What.[4]th conference sterilization and disinfection 2010 Sep10-11, Mashhad, Iran. [In Persian]

6. Sattar SA. Microbicides and the environmental control of nosocomial viral infections. J Hosp Infect 2004 :(56); S64–S69.

7. Sherlock O, O'Connell N, Creamer E, Humphreys H. Is it really clean? An evaluation of the efficacy of four methods for determining hospital cleanliness. J Hosp Infect 2009:2(72); 140-146.

8. Al-Hamad A, Maxwell S. How clean is clean? Proposed methods for hospital cleaning assessment. J Hosp Infect 2008:4(70); 328-334 .

9. Carling PC, Briggs J, Hylander D, Perkins J. An evaluation of patient area cleaning. In 3 hospitals using a novel targeting methodology. Am J Infect Control 2006:8(34); 513-519.

10. Carling PC, Bartley M. Evaluating hygienic cleaning in health care settings: What you do not know can harm your patients. Am J Infect Control 2010:5(38); S41-50.

11. Boyce JM. Environmental contamination makes an important contribution to hospital infection. J Hosp Infect 2007:1(65) (S2); 50–54.

12. Dancer SJ. The role of environmental cleaning in the control of hospital-acquired infection. JHospInfect 2009:4(73); 378-385.

13. Andersen BM, Rasch M, Kvist J, Tollefsen T, Lukkassen R, Sandvik L, et al. Floor cleaning: effect on bacteria and organic materials in hospital rooms. J Hosp Infect 2009:1(71); 57-65.

14. Ducel G, Fabry J, Nicolle L, Girard R, Perraud M, Prüss A, et al. Prevention of hospital-acquired infections A practical guide 2nd edition2002. Available http://www.who/CSR.

15. Griffith CJ, Obee P, Cooper RA, Burton NF, Lewis M. The effectiveness of existing and modified cleaning regimens in a Welsh hospital. J Hosp Infect 2007: 4(66); 352-359 .

16. Dancer SJ. How do we assess hospital cleaning? A proposal for microbiological standards for surfacehygiene in hospitals. J Hosp Infect 2004:1(56); 10–15 .

17. Aslani Y, Sadat M, Shahram EF, Mohamad A. Evaluation of microbial contamination of hospital equipment in hajar Center eduqation Shahrekord. J Nurs Midwif, Hamedan 2009: 1, 2 (17); 19-23. [In Persian]

18. Yosefi Mashof R, Heidari Z. Survey on microbial contamination of intensive care wards of Hamedan hospitals. Zahedan Med J 2001; 2(3): 93-98. [In Persian]

19. Davari HA, Sodavi M, Kainpoor M. Bacterial contamination of intensive care wards of Hamedan hospitals. Res Med Sci Sci J Isfahan 1998;3(4): 267-271. [Full Text in Persian]

20. Vearncombe M, Piaskowski P, Armstrong I, Roth V, Baker D, Suh K, et al. Best practices for environmental cleaning for prevention and control of infection. Toronto, canada,8, 2009 available online at www.pidac.ca.

21. White LF, Dancer SJ, Robertson C, Mcdonald J. Are hygiene standards useful in assessing infection risk? Am J Infect Control 2008; 5(36):381-4.

22. Cooper RA, Griffith CJ, Malik RE, Obee P, Looker N. Monitoring the effectiveness of cleaning in four British hospitals. Am J Infect Control 2007; 5(35):338-41.

23. Yosefi Mashof R, Nazare M. Comparative study of bacterial contamination and disinfection of operating room contamination produced Hayzhyn in reducing pollution contamination in health centers in Hamadan.10th Congress of Environment Health,2007 Aug 8-10, Abadan, Iran. [In Persian].