JOURNAL OF CURRENT RESEARCH IN SCIENCE (ISSN 2322-5009)
CODEN (USA): JCRSDJ
2014, Vol. 2, No. 6, pp: 788-793
Available at www.jcrs010.com

ORIGINAL ARTICLE

EVALUATION OF ICU MICROBIAL CONTAMINATION IN QOM HOSPITALS USING OBSERVATIONAL AND MICROBIAL MONITORING METHODS WITH THREE INDICES OF OBSERVATION, COLONY COUNT, AND METHICILLIN-RESISTANT *S. AUREUS*

Ali Akbar Riyahin[1],Mohsen Eshraghi[2],Mohammad Gharehbeglou[3*] , Zahra Ahmadli[4], Ghodratollah Karami[5], Mohammad Esmaeil Shahrzad[6]

1. Assistant Professor, Department of Medicine, Qom Branch, Islamic Azad University, Qom, Iran
2. Head of department of Surgery, Qom University of Medical Sciences, Qom, Iran
3. Department of Medicine, Qom Branch, Islamic Azad University, Qom, Iran
4. Environment health specialist, Ayatollah Gulpaygani Hospital, Qom, Iran
5. Expert at the Office of Treatment Deputy, Qom University of Medical Sciences, Iran
6. Student Research Committee, Hormozgan Medical Sciences University, Bandar Abbas, Iran
[*] Corresponding author email: m.gharebeglou@yahoo.com

ABSTRACT: Hospital-acquired infections are considered one of the most important infectious diseases. Various studies have confirmed the relationship between poor conditions of hospital hygiene and transmission of microorganism causing hospital-acquired infections (1). Correct management of the cleaning process in hospitals is necessary, and monitoring the cleaning efficiency is one of the effective elements in this management. This study was conducted to evaluate the hygienic conditions at the environmental surfaces in hospitals before and after daily cleaning and to compare the efficiency of the observational and microbial methods in evaluating hygienic conditions and cleaning of the environmental surfaces at the hospitals in Qom.In this descriptive-cross-sectional study, the cleaning status of ICUs was evaluated through the two methods of observational and microbial using three indices of observation, aerobic colonies count, and methicillin-resistant *Staphylococcus aureus*. Nine spots with the highest possibility of contact with personnel, patients, and visitors were chosen in the patients' rooms in the ICUs. The environment was monitored twice a week for a period of 10 weeks, before and after daily cleaning procedures of the wards. For the observational method (direct visual evaluation of cleaning), an observer recorded the results as acceptable (clean and hygienic) or unacceptable (contaminated and unhygienic). In the microbial method, samples were collected from the selected spots and sites using swabs. Spots with microbial loads of more than 2.5 cfu/cm^2 were reported as unacceptable (contaminated and unhygienic) and spots with microbial loads of less than 2.5 cfu/cm^2 were reported as acceptable (clean and hygienic). As an important cause of hospital-acquired infections, methicillin-resistant *S. aureus* was considered as the indicator organism. The required data were collected through the mentioned methods and entered in the specialized tables and diagrams; they were then analyzed using SPSS and McNemar' test.In this research, statistical analysis was performed using checklists and the results of cultured microbes. In the observational method, the percentages of infected spots before and after cleaning procedures were 59% and 41.5%, respectively, employing the ICNA index (Infection Control Nurses Association). In the microbial method, these percentages were 57.5% and 47.5%, respectively, using the ACC index (Aerobic Colony count), and 7% and 5.5%, respectively, employing the MRSA index (methicillin-resistant *S. aureus*). The results showed that the frequency of the contaminated spots was reduced after cleaning using all three indices of observation, colony count, and *S. aureus*. This reduction was 17.5% in the observation, 10% in the colony count, and 1.5% in the MRSA indices; suggesting that the cleaning methods are ineffective on dangerous microbial species, *i.e.* methicillin-resistant *S. aureus*.

Keywords: ICU contamination, observational monitoring, microbial monitoring

INTRODUCTION

Hospital-acquired infections are one of the most important infectious diseases. In developed countries with sufficient facilities and financial resources, about five percent of patients develop hospital-acquired infections, while this percentage is higher in developing countries (and even reaches 27%). These infections affect not only the patients but also all those who get in contact with them (hospital personnel, caregivers, and visitors) (2).

The relationship between undesirable hygienic conditions in the environment of the hospitals and the transmission of microorganisms has been confirmed in various studies (1). It has been confirmed that important pathogens related to hospital-acquired

infections such as methicillin-resistant *S. aureus* and vancomycin-resistant *Enterococci* that have contaminated environmental surfaces (such as bedside tables, cupboards, doorknobs) can remain viable for a long time and be transmitted to various people (3). *S. aureus* is one of the most important factors that cause hospital-acquired infections, and methicillin-resistant strains of *S. aureus* are a serious threat in these infections (4-8). *Enterococcus fascium* is the most common strain of vancomycin-resistant *Enterococci* isolated in hospitals (9).

Results of eight studies have shown that the rate of infection in patients hospitalized in rooms previously occupied by patients infected with methicillin-resistant *S. aureus*, vancomycin-resistant *Enterococci*, *Clostridium difficile*, or *Acinetobacter*, are on average 73% higher than patients hospitalized in other rooms (10).

Five recent studies have indicated that routine cleaning and disinfection can reduce the transmission risk of methicillin-resistant *S. aureus* and vancomycin-resistant *Enterococci* averagely by 40% (10). Therefore, correct management of the cleaning process in hospitals is necessary and vital, and monitoring cleaning efficiency is one of the effective elements in this management (11).

Observational or visual monitoring and microbial monitoring using swabs, blood agar, Mueller-Hinton culture media, and colony count are among the standard methods used for evaluating cleaning efficiency (12).

Sherlock *et al*. studied cleaning procedures in the internal medicine ward in a hospital in Ireland and found that 5.5% and 7.9% of the studied spots were unhygienic using the ICNA observational and the ACC microbial methods, respectively (13).

Results of another study by Malak *et al*. carried out in the surgery wards of four hospitals in Britain, showed that 90% and 10% of the spots were clean and hygienic, using the observational and microbial methods, respectively (11).

Moreover, Cooper *et al*. studied 27 spots in their research at the internal medicine and surgery wards in England and Wales before and after cleaning procedures using the ICNA observational and ACC microbial methods. They reported that the percentages of unhygienic spots were 20% and 10.75% in the observational method and 77% and 75% in the microbial method before and after cleaning, respectively; and the average difference in the percentages of unhygienic spots in the observational and microbial methods was 65.75% (14).

In Iran, billions of rials are spent each year to clean and disinfect hospitals, yet there are no guidelines or standards for monitoring daily cleaning in hospitals, and no studies have been conducted on the extent of involvement of environmental surfaces (and the role they play) in the occurrence and spread of hospital-acquired infections. This is while empirical evidence and results of numerous studies conducted in developed countries indicate the great importance of environmental surfaces, and the cleaning procedures of these surfaces, in controlling hospital-acquired infections.

MATERIALS AND METHODS

This descriptive-cross-sectional study was conducted to determine the hygienic conditions of the ICUs at the hospitals in Qom in 2013 using the ICNA observational method and the microbial method employing the ACC and MRSA indices. The research population included the environmental surfaces at the ICUs in Qom hospitals. Review of similar studies led to the selection of nine spots in the patients rooms that were the most probable to be touched by hand by the hospital personnel, patients, caregivers, and visitors. Therefore, these spots had the maximum degree of infection and, were the most probable sources for the transmission and spread of infections. The evaluated spots included bedside tables, light switches, sink taps, nursing station, telephone receivers, doorknobs, chairs or furniture, patients' beds, refrigerator handles, and the floors of these rooms (because of high commuting) as the tenth spot in the ICUs.

Considering previous studies, these 10 spots of the environmental surfaces in the ICUs were monitored before and after the cleaning procedures twice weekly for 10 weeks (13). In each method, samples were taken from 400 spots: 200 before and 200 after the cleaning. The ICNA observational method and the microbial methods with the ACC and MRSA indices were employed for monitoring the selected spots.

The studied variables included microbial load, hygienic conditions, sampling spots or places, bed occupancy coefficient, and methicillin-resistant *S. aureus*. The required quantitative information was collected by determining the microbial load, through culturing microbes and conducting tests to identify methicillin-resistant *S. aureus* on the surfaces, and by visual observation using checklists before and after the cleaning procedures. This information was entered into tables and diagrams and was analyzed using SPSS and McNemar's test.

The ICNA auditing method for monitoring the hygienic conditions, the cleaning of environmental surfaces, and the efficiency of the cleaning procedures in preventing and controlling hospital infections, is used in many countries including Canada, England, Ireland, Scotland, and Wales (15). In this method, spots are evaluated through direct visual observation using guiding standards of suitable environmental cleaning established by the Infectious Diseases Advisory Committee of Canada, and the results are recorded and reported as acceptable (clean and hygienic) or unacceptable (contaminated and unhygienic).

In the microbial monitoring method using ACC and MRSA indices, swabs are used. The swabs are first moistened with normal saline, and then 10 cm^2 of the selected spot are swabbed in a zigzag manner. Each swab is then placed in a test tube containing 1 mL normal saline and stirred for 10 seconds. Next, 100 µL of the solution is cultured on two plates containing agar blood and Mueller-Hinton culture media. The plates are kept at 37 ˚C for 48 hours. The number of the cultured bacteria is calculated and recorded using a colony counter and based on cfu/cm^2. Considering previous research, spots with microbial loads of more than 2.5 cfu/cm^2 are reported as unacceptable (contaminated and unhygienic) and spots with microbial loads of less than 2.5 cfu/cm^2 are reported as acceptable (clean and hygienic). Based on similar research, methicillin-resistant *S. aureus* was considered the indicator organism. Standard methods including Gram staining, catalase, coagulase, mannitol fermentation (MSA), and DAase were used for identifying methicillin-resistant *S. aureus*, and the Oxacillin Screening Plate was employed for determining resistance against methicillin (16).

RESULTS

In total, 400 ICNA checklists were completed in this research for the 10 studied spots. Altogether, 59% of the spots were contaminated before cleaning procedures, which dropped to 5.41% after cleaning; and a significant difference existed between the dependent ratios based on McNemar's test (p=0.000). Of the 400 studied spots using the ACC index, 57.5% were contaminated before cleaning, which was reduced to 47.5% after cleaning; and a significant difference existed between the dependent ratios based on McNemar's test (p= 0.043). Moreover, the Wilcoxon nonparametric test performed to evaluate the ACC method on the samples before and after cleaning showed a significant difference (p=0.002 and z=3.130). Seven percent of the studied spots were infected with *S. aureus* before cleaning; this was dropped to 5.5% after cleaning and there was no significant difference between the percentages (p=0.629). Diagram 1 compares the percentage frequency distribution of the conditions at the spots in the three methods of ICNA, colony count (ACC), and methicillin-resistant *S. aureus* (MRSA).

In the 400 checklists that were completed based on the ICNA index, 201 spots (50.25%) were contaminated and 199 (49.75%) were clean. Sink taps with 77.5% and chairs with 25% were the most and the least contaminated spots, respectively.

Study of the samples using the ACC index revealed that 210 spots (52.5%) were contaminated and 190 spots (47.5%) were clean. Room floors with 95% and doorknobs with 35% were the most and the least contaminated spots, respectively.

As for MRSA, 400 samples were studied, of which 25 (12.5%) were contaminated and 375 (87.5%) were clean. Telephone receivers with 10% and sink taps with 2.5% were the most and the least contaminated spots, respectively.

In total, this study showed that 50.25% of the spots were contaminated and 49.75% were clean when using the ICNA method, while 52.5% of the spots were contaminated and 47.5% were clean when the microbial method with the ACC criterion was employed, and 12.5% of the spots were contaminated and 87.5% were clean when the methicillin-resistant *S. aureus* criterion was used.

DISCUSSION

Results of this study showed that the frequency of contaminated spots determined by using all three indicators of observation, colony count, and *S. aureus* declined after cleaning in comparison with before cleaning. This decrease was 17.5% in the observation, 10% in the microbial method with the colony count criterion, and 1.5% in the methicillin-resistant *S. aureus* criterion. This indicates that the inefficiency of the cleaning methods with regard to dangerous microbial species such as *S. aureus*, and that (despite this decrease) the frequency of contaminated spots after cleaning is still high. Several studies have indicated that cleaning is effective in reducing the frequency of contaminated spots, but the extents of the decrease have been different in these studies (7, 11). Results of the 2-week study Sherlock *et al*.

conducted in Ireland showed that the percentages of contaminated spots in the men's internal medicine wards determined after cleaning using the ICNA and ACC methods declined by 3.3 and 4.2%, respectively. No decrease was observed using the ICNA method, while the ACC method showed a 4.1% decline in the frequency of contaminated spots (7). In our opinion, one of the shortcomings of their study was its short duration and, hence, the volume of the samples studied was small, which made it impossible to perform statistical tests.

In another research, Cooper *et al*. studied 27 spots in the internal medicine and surgery wards in England and Wales before and after cleaning procedures using the ICNA and ACC methods. They reported the percentages of contaminated spots as 20% and 10.75% using the observational method with the ICNA index, 77% and 75% using the microbial method with the ACC index, and 20% and 10.75% using the microbial method with the MRSA index before and after cleaning, respectively (11).

The high percentage of contaminated places in our study was due to various variables including lack of a comprehensive and written cleaning program so that on some sampling days no cleaning was carried out (or was not performed completely or in a standard manner). The study conducted by Al-Hamad and Maxwell showed spots that were not regularly cleaned according to a definite program had higher microbial loads compared to others (17). Lack of basic training for the personnel involved in services and treatment regarding the importance of cleaning in controlling hospital infections is another reason for the high percentages of contaminated spots in our research. However, numerous studies have confirmed upgrading daily cleaning with the purpose of raising the level of hygiene considerably decreases contamination of environmental surfaces with pathogens found in healthcare centers (9).

Diagrams

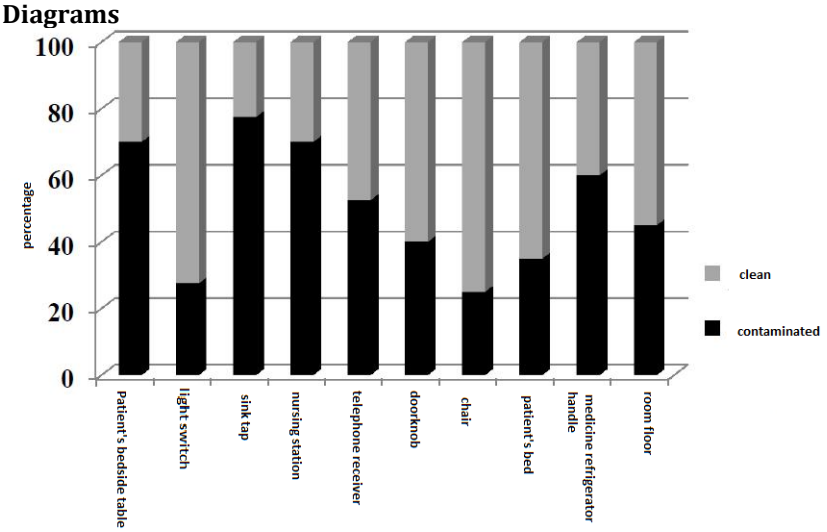

Diagram 1: Frequency distribution of contaminated equipment and environmental surfaces using the ICNA index

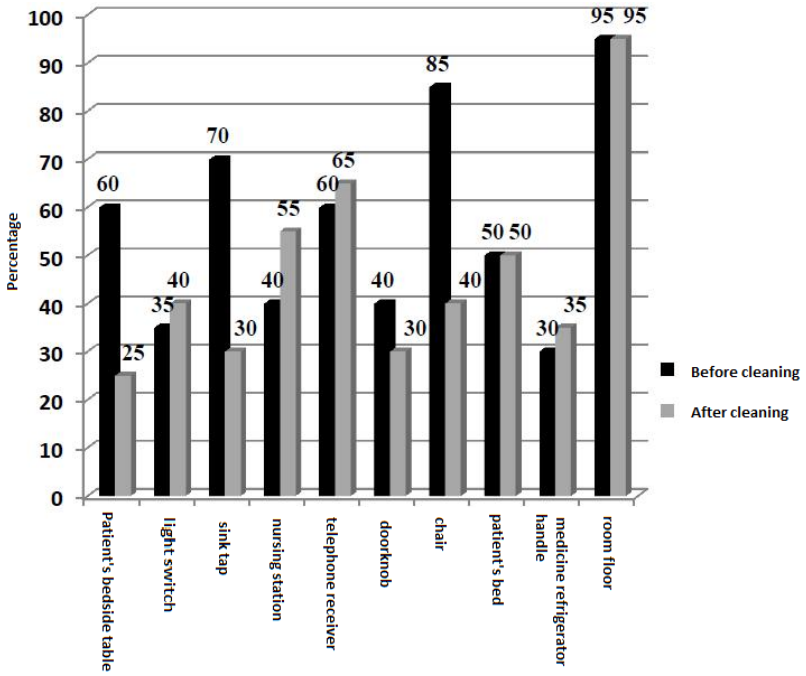

Diagram 2: Frequency distribution of contamination before and after cleaning using the ACC index

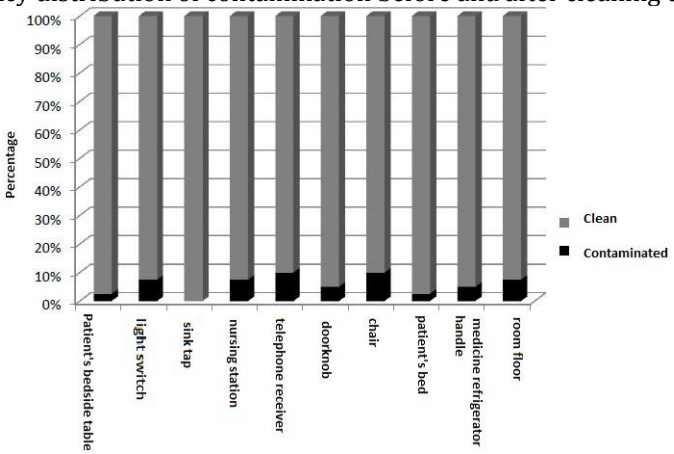

Diagram 3: Frequency distribution of contaminated equipment and environmental surfaces using the MRSA index

CONCLUSIONS

Results of this study show that cleaning can be an effective method in reducing microbial loads in the environment. Observational auditing methods and periodical microbial testing can be employed as a reliable tool for judging the condition of the cleaning process. Developing a standard guide for cleaning procedures, educating personnel, and programmed and continuous monitoring of cleaning procedures using valid scientific methods by the Committee for Controlling Infections and by managers of wards can raise the efficiency of the cleaning process and lead to hospitals being secure places for patients, visitors, and hospital personnel. Moreover, our study indicated the inefficiency of cleaning methods in controlling dangerous microbial species such as methicillin-resistant *S. aureus*.

ACKNOWLEDGEMENT

We express our sincere gratitude to our honorable colleagues who helped us conduct this research, especially Mr. Ashoori who cooperated in the execution of all stages of the study. We would also like to thank the honorable managers and the management staff of the hospitals in Qom, Mr. Jelvehdar the honorable laboratory supervisor at the Ayatollah Gulpaygani Hospital and his colleagues, and the Student Research Committee at the Islamic Azad University of Qom.

REFERENCES

Standard Principles for preventing hospital-acquired infections. Standard Principles for Hospital Environmental Hygiene .Journal of Hospital Infection 2001:47(Supplement) ;S21–S37available online at http://www.idealibrary.com.on IRE hi.

AslaniY,et al. Evaluation of microbial contamination of hospital equipment in hajar Center eduqationShahrekord. Journal of Nursing and Midwifery, Hamedan.2009:17(Number 1 , 2);19-23. [in Persian]

Rutala W, Weber D. Surface disinfection: should we do it?.journal of Hospital infection 2001:48 (Supplement A) ; S64-68.available online at http://wwv.idealibrary.com on IRE hi.

Wang JT, Chen YC, Yang TL, Chang SC. Molecular epidemiology and antimicrobialsusceptibility of methicillin-resistant Staphylococcusaureus in Taiwan. DiagnMicrobiolInfect Dis 2002: 42(3): 199-203.

Aires de Sousa M, Crisóstomo MI, Sanches IS, Wu JS, Fuzhong J, Tomasz A, de LencastreH. Frequent recovery of a single clonaltype of multidrug-resistant Staphylococcusaureus from patients in two hospitalsinTaiwan and China. J ClinMicrobiol 2003: 41(1): 159-63.

Kim HB, Park WB, Lee KD, Choi YJ, Park SW, Oh MD, Kim EC, Choe KW. Nationwidesurveillance for Staphylococcus aureus with reduced susceptibility to vancomycin in Korea. J ClinMicrobiol 2003: 41(6): 2279-81.

Tiemersma EW, Bronzwaer SL, LyytikäinenO, Degener JE, Schrijnemakers P, Bruinsma N, Monen J, Witte W, Grundman H; EuropeanAntimicrobial Resistance Surveillance System Participants. Methicillin-resistant Staphylococcus aureus in Europe, 1999-2002. Emerg Infect Dis 2004: 10(9): 1627-34.

National Nosocomial Infections Surveillance(NNIS) System Report, data summary from January 1992 through Jane 2004. Am J Infect Control 2004: 32: 470-85.

Andersen B, et al. Floor cleaning: effect on bacteria and organic materials in hospital rooms .Journal of Hospital Infection 2009:71; 57-65.

Andersen B, et al. Floor cleaning: effect on bacteria and organic materials in hospital rooms .Journal of Hospital Infection 2009:71; 57-65.

Malik E, Cooper A, Griffith C.Use of audit tools to evaluate the efficacy of cleaning systems in hospitals. Am J Infect Control 2003:31;181-187.

White L. Are hygiene standards useful inassessing infection risk?. Am J Infect Contro 2008:36;381-4.

Sherlock O, O'Connell N, Creamer E, Humphreys H. Is it really clean? An evaluation of the efficacy offour methods for determining hospital cleanliness. Journal of Hospital Infection 2009 :72; 140-146.

Cooper A, et al. Monitoring the effectiveness of cleaning in four British hospitals. Am J Infect Control 2007:35;338-41.

ontario.Best practices for environmental cleaning for prevention and controlof infection.toronto, canada,8,2009. [78] Clinical and Laboratory Standards Institute.Antimicrobialsusceptibilitytesting standards M2-A9 and M7-A7. 2006.

Alvaran M, Larson EL. Opinions knowledge andself reported practice to infection control amongnursing personal in long term care setting .Am J Infect Control 1994:22:367-370.

Weber D, et al.Role of hospital surfaces in the transmission of emerging health careassociated pathogens: Norovirus,Clostridiumdifficile, and Acinetobacter specie. AmJ Infect Control 2010:38;S25-33.