ORIGINAL ARTICLE

Cleaning Methods for Ultrasound Probes

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ABSTRACT

Objective: To determine the effectiveness of three different methods of ultrasound probe cleaning for the prevention of nosocomial infections.

Study Design: Experimental study.

Place and Duration of Study: Radiology Department, the Aga Khan University Hospital, Karachi and Microbiology Department, JPMC, Karachi, from December 2006 to April 2007.

Patients and Methods: A total of 75 culture swabs from ultrasound probes used for sonographic examinations of different body parts of patients were included in the study. Probes were prospectively randomized into three equal groups with 25 probes in each group. Culture was sent before and after using three different techniques of cleaning ultrasound probe, which included sterilized paper towel, 0.9% saline and swipe over with standard bath soap applied on group A (n=25), group B (n=25) and group C (n=25) respectively. Number of Colony Forming Unit (CFU) of bacteria were calculated on standard agar plate to find out the effectiveness of cleaning methods in reducing bacterial count from the ultrasound probe after the procedures. All samples were tested in single microbiology lab by using same bacterial growth media provided by same manufacturer. Kruskall Wallis, Jonchkheere-Terpstra and Wilcoxon sign rank tests were applied to find out statistical significance.

Results: There was a significant reduction in bacterial count after applying either of all three cleaning methods for ultrasound probe compared to count on the probes before cleaning ($p<0.001$), however, soap cleaning method was the most effective in decreasing bacterial count to the minimum level in comparison to other two methods ($p<0.001$). The overall reduction in pathogenic bacterial count after performing each cleaning method was 45%, 76% and 98% for paper cleaning, normal saline and soap cleaning method respectively.

Conclusion: Cleaning ultrasound probe after performing each procedure is a cost-effective practice with potential of reducing nosocomial infections. Soap cleaning technique is the most effective method for reducing bacterial count acquired due to patients' body contact with the ultrasound probes.

Key words: *Ultrasound. Cleaning methods. Nosocomial infection. Disinfection. Contagious diseases.*

INTRODUCTION

Nosocomial infections either develop in hospital or occur due to microorganism acquired from hospitals, leading to significant patient morbidity and mortality.[1-2] The prevalence of nosocomial infection reported from the hospitals of South-East Asia is 10%, which is the second highest regional distribution in the world.[2] Radiology department in hospital is a potential source of nosocomial infection as it is an integral part of medical services for admitted as well as for walk-in patients. Ultrasonographic suite is one of the busiest areas and most commonly used imaging modality and a large number of sonographic examinations are performed in tertiary care hospitals.

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Many studies have shown that ultrasound (US) probes are ideal vector for transmitting the pathologic organism from one patient to another vulnerable patient, unless there are effective cleaning methods.[3-10] This is particularly relevant in interventional ultrasound procedures and endocavitary sonographic examinations. The limited literature is divided regarding the potentiality of US probes to act as a vector for cross infection and its prevention.[4,6,7] Aylirffe[11] summarized the infection control guidelines in hospitals, which need to be tailored in sonographic practice, and there are no clear international guidelines regarding the cleaning methods of ultrasound probes. The manufacturer's recommendation to soak the probe for 20 minutes in weak sodium hypochlorite solution or wash with soap and running water is generally impractical due to time constraints. Alcohol wipe and other commercially available disinfectants are effective[6,7] and easy to use but harmful to US probes and not recommended by vendors. A new technique of sterilizing ultrasound probe by using ultraviolet cycle in disinfectant chamber, has been found to be effective but may not be applicable in every setting due to high cost and complexity.[12] Paper towel cleaning method is being used efficiently in clinical settings but its effectiveness is

questionable in certain situations like in admitted patients with high risk of infection.[13] Condom, surgical glove and other physical barrier between probe and exposed surface of patient are safe but neither convenient nor economical to use for scanning in every examination.[14] Lack of an effective and easy cleaning practice for US probes may place patients and community at risk.

Previous studies have shown some of the effective methods for ultrasound probe cleaning in reducing the bacterial count.[3,4] However, from this part of world where disease burden is high with poor personal hygiene, no study has been conducted to calculate the effectiveness of such technique. In this study, a new soap wipe technique was also introduced, which is safe and cost-effective for US probe cleaning as a part of infection control intervention and for the prevention of nosocomial infection to test the hypothesis that soap cleaning is the most effective method of cleaning ultrasound probe after examination of patients to sterilize the probe before using on other patients.

The objective of this study was to determine the effectiveness of different methods in US probe cleaning. It was hypothesized that there is a difference in reduction of bacterial count from ultrasound probe by different cleaning methods.

PATIENTS AND METHODS

This randomized experimental trial was conducted in the ultrasound suite of Radiology Department, the Aga Khan University Hospital and Microbiology Department of Jinnah Postgraduate Medical Centre, Karachi, Pakistan, from December 2006 to April 2007. Departmental research committee approval was taken for this study. Linear and curvilinear sonographic probe with frequency range from 3.5 to 10 MHz was used for ultrasound examination. The inclusion criterion was US probe used for any patient's examination referred to ultrasound department for diagnostic or screening sonography of any part of body. Probes used for intracavitary or invasive procedures were also included. Patients of all ages and of either gender who underwent sonographic examination were included in this study. Ultrasound probe used in patients with open skin wound or known contagious diseases were excluded because of practice of special precautions and use of antiseptics.

After each ultrasound examinations, a trained person took microbiological sample by using standard speculum from the exposed transducer rubber seal surface of US probe before cleaning and second sample was taken after cleaning. Un-cleaned US probes were randomly assigned to any one of the three cleaning method groups according to a computer-generated random numbers (blocks of three) held by the primary investigator. Allocation was in sealed 75 envelopes containing name of one of the three cleaning methods thus 25 envelopes were made of each cleaning method. When each of the participants was presented for sonography, one envelope was randomly picked and opened for determining cleaning method to be applied. The methods of cleaning were clean paper towel, 0.9% saline and dried by tissue paper and cleaning with wet gauze, swip over a standard bath soap and dried by tissue paper.

Standardized and pre-sterilized sonographic gel was used for electrical transmission of sound waves from patient to ultrasound probe or vice versa. Radiologists who were performing sonographic examinations were wearing plastic disposable gloves during sonography and gloves were changed for every new patient procedure. Qualified radiographer performed cleaning, formal training of cleaning method was provided to them by arranging hands on workshops and informative lectures. Microbiology sample collection was performed by a trained doctor who was a postgraduate student of microbiology and blinded for the cleaning method applied to probe. After taking the specimen, it was coded and shifted immediately to central microbiology lab of BMSI JPMC to see the bacterial growth after 24-hours incubation period. Number of Colony Forming Unit (CFU) of bacteria were calculated on standard agar plate used for the growth of microorganism. All samples were tested in single microbiology lab by using same bacterial growth media provided by the same manufacturer. Microbiologist made final reports.

Pre-tested proforma was used for data collection and data was entered and analyzed in SPSS 15.0. Test for normality of data distribution was done. Since the distribution of data was not towards normality; hence non-parametric statistical tests were applied to find out significant differences. For comparing the median CFU after three different cleaning methods by using Kruskall- Wallis test was done. Post-hoc tests were also performed for pair-wise comparisons. Furthermore, Jonchkheere-Terpstra test was applied to find out the statistical significant difference in the effectiveness in progressive order of the three methods of cleaning. Wilcoxon sign rank test was applied before and after comparison of bacterial count in each cleaning method at 5% level of significance. P-value <0.05 was considered as significant.

RESULTS

A total of 75 ultrasound probes underwent three different cleaning methods after performing ultrasound procedures on the patients. In group A (n=25), where paper towel was used as a cleaning method, 45% (median=51) of bacterial counts were reduced which were significantly lesser than the bacterial count before cleaning method was applied ($p<0.0001$, Table I). In group B (n=25), 0.9% saline was used to the clean

Table I: Kruskall-Wallis test cleaning methods for ultrasound probes (n=75).

Cleaning methods	n	Median bacteria	Average rank of bacteria
Saline	25	51	40.75
Tissue paper	25	99	60.26
Soap wipe	25	5	13.00

$\chi^2 = 59.4$ DF = 2 P = 0.000

Post-hoc pair wise comparison p-value 0.000

Jonchkheere-Terpstra test giving p-value 0.000 (Test statistics= -8.45).

DF= Degree of freedom; P= P-value

ultrasound probe and the overall reduction in bacterial count was 76% (median=99) which was again significantly lesser than before cleaning (p<0.0001). In group C (n=25), the reduction in bacterial count was as high as 98% (median=5) after using cleaning method of wipe over the standard bath soap. This cleaning method also significantly reduced (p<0.0001) bacterial count from the ultrasound probe. After finding out the significant difference in three methods, post-hoc multiple comparisons test was done for each pair which showed that each pair of cleaning method was significantly different with the other method (p<0.0001). Each of the three methods of cleaning were significantly effective in reducing bacterial count from ultrasound probes as compared to bacterial count on the probe before applying cleaning methods (p<0.0001, Table II). However, bath soap was found to be the most effective method of cleaning US probe for the prevention of harmful bacterial transmission from one patient to another after performing ultrasonography, statistically proved with Jonchkheere-Terpstra test giving p-value 0.000 (Test statistics= -8.45).

Table II: Wilcoxon sign rank test for difference between bacterial count before and after in the three cleaning methods.

Cleaning methods	Bacterial count[a] Median (IQ)	Bacterial count[b] Median (IQ)	Z[c]	p-value
Saline	219 (70)	51 (30)	-4.374[d]	0.000
Tissue paper	172 (190)	99 (61)	-4.373[d]	0.000
Soap wipe	307 (36)	5 (5)	-4.373[d]	0.000

a. Median bacterial count and inter quartile range before applying cleaning method.
b. Median bacterial count and inter quartile range after applying cleaning method.
c. Wilcoxon sign rank test statistic (an approximation of normal distribution).
d. Based on positive ranks.

DISCUSSION

Ultrasound probe can be a potential source of nosocomial infection by acting as a vector for transferring pathogenic organisms (commonly *Staphylococcus aureus*) which is particularly risky for immunocompromised patients.[15,16] Significantly high number of bacteria were identified in this study in the US probe before they were cleaned highlighting the importance of proper cleaning of probe before applying to next patient. Uncleaned sonographic probe may become a source of bacteria to next patient and may lead to nosocomial infection. In this study it was proved that by applying appropriate simple cleaning methods the number of bacteria on US probes can largely be reduced.

Paper wipe technique may not be highly effective as it only reduces 45% of bacteria, and these results are consistent with Spencer, Tesch and Fröschle.[3,7,8] However, other studies considered paper towel cleaning as a simple and effective method for ultrasound probe cleaning.[4,17] This method may not be appropriate for our patients where poor hygienic condition prevail in our population. Moreover, another study suggested that paper cleaning method can be applicable with acceptable effectiveness in outpatients but not for admitted patients, who are already at higher risk of nosocomial infection and single paper cleaning method might not be effective enough for routine use.[14]

Paper wipe followed by normal saline wipe is 76% effective and appeared better compared to simple paper towel cleaning. However, soap wipe technique was found to be the most effective of the cleaning methods tested with effectiveness of 98% and this is comparable to alcohol effectiveness of 99%.[14,15] Its routine use can be performed as the soap will not degrade the rubber seal as alcohol may do and increase the working life of the probe. However, large longitudinal studies are required to see the long-term effects of soap on probe. Findings of this study support the use of soap in probe cleaning like hand washing which is simple, easily available and cost-effective way of decontamination. It may be an alternative of expensive sonographic probe antiseptic materials specially for resource poor countries like us and can be used in far-flung health services of our country.

Furthermore, cleaning method needs to be tailored to the clinical situation to achieve an appropriate cost-to-benefit ratio and we are in process of adopting the following approach towards infection control in the ultrasound department. Before the examination of outpatients and short-stay inpatients, soap wipes technique is ensured to be an adequate cleaning method. Before the examination of patients at risk for contracting infection (i.e. neonates or immune compromised patients, for genital examination, or with unhealed wounds), probe covered by simple plastic glove is appropriate.

After the examination of the patients who may be a potential source of infection (those with MRSA-positive results, who are in the intensive therapy unit, or who have undergone multiple antibiotic courses), paper wipe followed by an alcohol wipe provides adequate cleaning to protect the next patient from cross infection. Frequent hand washing of sonographers and use of disposable hand gloves would also be helpful in preventing nosocomial infection. Furthermore, some of the studies suggest that prior cleaning with disinfectant of the body surface of patient undergoing sonographic examination is a better option for preventing nosocomial infection through ultrasound probes[18] but this technique may be inconvenient to the patient as well as for operator and

needs to be tested in our population.

This study had some limitations. Firstly, patients were not followed for determining the development of nosocomial infection after sonographic examination and it was biased towards the residual bacterial count. Identification of pathologic organism was not performed in residual CFU after each cleaning method. Although sonographic gel used for examination was standardized and aseptic but microbiological testing of gel was not done. Effects of chemical component of soap on ultrasound probe were also not tested, which require further exploration to establish its long-term impact.

CONCLUSION

Applying simple cleaning methods can prevent nosocomial infection from ultrasound probes; all three methods of cleaning can reduce the pathogenic bacterial count upto certain extent. However, soap wipes technique is the most effective and cost-effective method of cleaning which can be used in routine clinical practice for cleaning ultrasound probe. Special infection control measure should also be taken in high-risk group of patients.

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