Comparison of Probe Disinfection Procedures in Routine Ultrasonography: Hot Water versus Antiseptic Wiping

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Abstract

Objective  It is commonly known that ultrasonography (US) transducers function as both a reservoir and means of transfer for hospital infections. The current study aimed to compare the antimicrobial effectiveness of using >80°C water versus antiseptic wipes to disinfect US transducers.

Methods  Subsequent to abdominal inspections in three groups of 20 patients, a swab culture was taken from the transducer in each case. Neither a mechanical nor chemical disinfection was applied to the transducer in the first group. As for the second group, the transducer was placed in >80°C hot water for five minutes. In the third group, the transducer was wiped clean using antiseptic wipes.

Results  Of the 60 swab samples collected, 40 did not produce any growth. The number of samples exhibiting growth in the first group involved 18 cases of coagulase-negative staphylococcus (CNS), as well as 15 cases of Listeria spp., one case of Corynebacterium spp. and one case of Bacillus spp., while only one case of CNS was observed in the second and third groups, respectively. The culture growth and colony forming units rate were significantly higher in the samples obtained from the first group than in those obtained from the other groups (p<0.01). As for the second and third groups, no significant differences were found in terms of the amount of colonization and growth (p=1.00).

Conclusion  Being a practical and a simple method for particular use in developing and underdeveloped countries, where it is hard to access relatively costly transducer disinfection materials, such as antiseptic wipes, hot water disinfection may play an active role in fighting hospital infections.

Key words: transducer, hot water, antiseptic wiping

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Introduction

Ultrasonography (US) is a significant medical tool that is frequently used in diagnostic and interventional procedures. Since US transducers are reusable, they inevitably function as both a reservoir and means of transfer for hospital infections unless properly cleaned. US transducers may turn into a reservoir for bacteria following US procedures in patients with bacterial colonization on the skin, such as that involving methicillin-resistant Staphylococcus aureus (MRSA), Actinobacteria spp. and Pseudomonas spp. In cases in which the transducers are not correctly sterilized, infections may occur in patients whose immune system is suppressed or in whom invasive procedures, such as catheterization, have been applied. It should be noted that such infections

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can increase costs as well as result in morbidity and mortality (1, 2). Hospital infection outbreaks originating from US transducers and contaminated US gels have been reported in the literature (3-5). It has been demonstrated that most microorganisms that grow in swab samples from transducer surfaces consist of Staphylococcus subtypes that are commonly found in skin flora (6-11).

Several methods are used to clean US transducers, including sterile paper towels, 0.9% saline solution, antiseptic solutions, alcohol and ultraviolet light (UV); however, no second optimal method has been identified due to inconsistent results (12-16). Therefore, the development of a practical and economic disinfection method is required.

This study aimed to compare the antibacterial effectiveness of >80°C water versus antiseptic cleansing in disinfecting US transducers. Concurrently, the effects of the duration of the US procedure on transducer colonization were examined.

### Materials and Methods

This study was designed as a prospective double-blind study. The US procedures were conducted for three months (between June and September 2012) in the US room of our hospital’s radiology department. Patient variables, such as age, gender and the duration of US, were recorded. A total of 60 patients were divided into three groups of 20. All patients were given an abdominal (the area between the xiphoid process and symphysis pubis) US (Logiq P5, GE Healthcare) inspection. Neither a mechanical nor chemical disinfection was applied to the transducers in the first group. In the second group, the surface of the transducers (5 Hz, convex) was disinfected by placing the transducer in hot water for five minutes. Finally, in the third group, the surface of the transducers was sterilized using antiseptic wipes (Cleanisept Wipes, Desomed®, Desomed, Izmir, Turkey -0.25 g didecyldimethyl ammonium chloride, 0.25 g alkylbenzyldimethyl ammonium chloride, 0.25 g alkylethylbenzylidethyl ammoniumchlorid). All patients were briefed about the study beforehand and provided their informed consent. Ethics approval was received from the Gulhane Military Hospital Ethics Committee, Ankara, Turkey.

In the first group, a swab sample was collected from the whole transducer surface using a sterile cotton-tip culture swab (Cultiplast® tampon swab, LP Italiana SPA, Milano, Italy) subsequent to the US procedure, and the samples were simultaneously cultured in both 5% Sheep Blood Agar and Eosin-methylene-blue (EMB) Agar (Salubris®, Salubris, Istanbul, Turkey). As to the second group, non-sterile public water was boiled in the US room and stored in a non-sterile non-insulated container, and the transducer was later placed in the water for five minutes. Simultaneously, the water temperature was measured using a digital thermometer (Fluke 54 II Thermometer Digital, Fluke Australia Pty, Melbourne, Australia); the mean temperature was 83.9°C (80.5-86.5°C). After the transducer was left to dry for one minute, swab samples were obtained as described in the first group. In the third group, the transducer surface was completely cleaned with antiseptic wipes following the US procedure, and swab samples were similarly collected after a one-minute drying period. Each sonographic procedure was timed using a chronometer. The ultrasonographic procedures were conducted by a radiologist with two years of experience, while the disinfection, swab sample collection and culturing procedures were carried out by an infectious disease specialist who also had two years of experience in the field. The radiologist disinfected his hands with soap and hot water for at least one minute between the examinations. Neither the radiologist nor infectious disease specialist had information regarding the related laboratory findings, except for the patient’s clinical diagnosis. A standardized coupling gel (Naturel Ultrasound Gel/Naturel Med/Turkey) was used during the examinations. The gel was disposable, hypoallergenic, non-irritating and non-sterile, although disinfected, and used for every patient separately. The coupling gel was not applied to any patient, but rather the surface of the transducer. The examination table was cleaned and disinfected with hypochlorite, and a new disposable tissue paper was used to cover the surface for every patient immediately prior to the examination. The paper was not applied to clean any surfaces of the ultrasound machine. After 24-48 hours of incubation in a 5% CO2 incubator under the supervision of a microbiologist who was uninformed of both the patient variables and cleaning method, the cultured samples were evaluated. In the plates on which growth was observed, the microorganisms were identified using conventional methods, including assessments of Gram coloration, colony morphology, catalase, coagulase and sensitivity to novobiocin, bacitracin, optokine and trimethoprim + sulfamethoxazole. An automatic microbiological identification system (BD Phoenix TM 100, Becton Dickinson®, Becton, Dickinson and Company, Franklin Lakes, USA) was used when necessary to identify the bacteria in the plates with growth. No anaerobic cultures were used. The bacteria in the medium were counted based on the number of colony forming units (CFU).

All data were analyzed using the SPSS 15.0 software program. The normality of the distribution was tested using the singe-sample Kolmogorov-Smirnov test. As for intergroup comparisons of continuous data, the non-parametric Kruskal-Wallis test was used. The Pearson chi-square test was employed for discrete data, whereas Fischer’s exact test was used in cases in which the expected value was below 5. A p value of <0.05 was recognized as being statistically significant.

### Results

The subjects included 38 men and 22 women. The mean age of the patients was 32±18.7 (1-76) years in the first group, 26±13.8 (1-62) years in the second group and 27±16.7 (1-69) in the third group. No statistically significant differences were found between the groups in terms of age.
The number of samples with growth identified in the cultures (p=0.17, p=0.06). All statistically significant correlations between the groups in terms of colonization and growth in the culture. The results did not reveal any significant differences (CFU <100,000 and CFU >100,000) and the amount of colonization and assess the feasibility of preventing transducer contamination by shortening the inspection time. Consequently, no significant correlations were found between the genders in any of the three groups (p=0.31). All of the participants were outpatients, and no lesions or open wounds on the skin were detected in any patient.

Of the 60 swab samples collected, 40 produced no growth. The mean CFU of the 20 samples that exhibited growth was 71.550 (7×10^2) ±41.193 (min: 10^1, max: 10^3). The identified microorganisms were as follows: coagulate-negative staphylococcus (CNS) (N: 17), Listeria spp (N: 1), Corynebacterium spp. (N: 1) and Bacillus spp. (N:1) (Table). The number of samples with growth identified in the first group was 18 (CNS: 15, Listeria spp: 1, Corynebacterium spp: 1, and Bacillus spp: 1), while only one sample with growth was observed in both the second and third groups.

The rate of culture growth and CFU values were significantly higher in the samples obtained from the first group than in those obtained from the other groups (p=<0.01). As for the second and third groups, no significant differences were found in terms of the amount of colonization and growth (p=1.00). Without regard to the disinfection method, the patients were categorized into two groups according to the duration of the ultrasound procedure: under 360 seconds (N: 29) and over 360 seconds (N: 31). These two groups were then compared with respect to the number of colonies (CFU <100,000 and CFU >100,000) and the amount of growth in the culture. The results did not reveal any significant correlations between the groups in terms of colonization or growth in the cultures (p=0.17, p=0.06). All statistical analyses and p values are summarized in Table.

### Discussion

This study is thought to be the first article in the literature to use >80°C water as a disinfectant, apart from mechanical cleaning, on US transducers, in comparison with the antimicrobial effects of antiseptic wipes. Unfortunately, the literature does not clearly provide an accurate and applicable method of transducer disinfection (15). While some researchers have indicated that simple wiping with a paper towel prevents infection, others have argued that this method does not prevent bacterial contamination (12-14). Preventing transducer contamination is of vital importance for avoiding hospital infections. Furthermore, taking into consideration the frequency of US examinations in daily medical practice, as well as the variety and population of patients that undergo both diagnostic and interventional US procedures, it is important to develop an easily accessible, practical and economic method of disinfection.

Contaminated hand and transducer surface contact results in nosocomial infections through the same mechanisms. Transducer contamination is widely observed in a vast majority of patients when no disinfection method is used, with a corresponding rate of 90% (18/20) in our study. The microorganisms that grow on transducers are expectedly those commonly found in skin flora. In addition, Gram-positive bacilli were isolated from three patients. This finding indicates that any microorganism present in the skin flora is likely to contaminate the transducer and suggests that a variety of bacteria may be transmitted from high-risk patients, such as those with a MRSA-positive status and/or open or infected wounds. Previous research has shown that US transducers constitute a vector for microorganisms that are responsible for nosocomial infections with high rates of morbidity and mortality, such as MRSA and Pseudomonas spp. (17).

Heating is a widespread method of disinfection. Accordingly, the use of either three minutes in 70°C water or one minute in 80°C water has been reported to sustain antimicrobial effectiveness (18). Ogawa et al. found an 80°C automatic heated water system to be cost-effective in disinfecting dialysis solution distributor systems (19). In addition, previous reports have shown that many Gram-positive and -negative bacteria found in the skin flora are sensitive to water under boiling temperatures (20-22). In line with these findings, the results of our study indicate the antibacterial effectiveness of water used at a temperature of 80°C or above. In this study, skin floral CNS growth was observed in only one plate in the heated water group. In addition, a CFU value of 10^4 (18,000) or below 10^4 signifies a relatively low level of infection.

In the current study, the correlation between the ultrasonography inspection period and rate of transducer bacteria colonization was also assessed. We aimed to determine whether prolonged US inspection periods have an effect on colonization and assess the feasibility of preventing transducer contamination by shortening the inspection time. Consequently, no significant correlations were found between the duration of the ultrasound procedure: under 360 seconds (N: 29) and over 360 seconds (N: 31). These two groups were then compared with respect to the number of colonies (CFU <100,000 and CFU >100,000) and the amount of growth in the culture. The results did not reveal any significant differences (CFU <100,000 and CFU >100,000) and the amount of growth in the culture. The results did not reveal any significant differences (p=0.24). Similarly, no significant differences were obtained between the number of samples with growth and the amount of colonization and growth in culture.

### Table. Comparison of the Probe Disinfection Procedures in Routine Ultrasonography

<table>
<thead>
<tr>
<th>Growth in culture (n)</th>
<th>No Disinfection</th>
<th>80°C Hot Water</th>
<th>Antiseptic wiping</th>
<th>p value</th>
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<tr>
<td>US Duration</td>
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<td>(n: &gt;360 sec/≤360 sec)</td>
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<td>CFU (n: &lt;10^3 / &gt;10^3)</td>
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<td>Microorganism</td>
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<tr>
<td>1 Listeria spp.</td>
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<td>1 Bacillus spp.</td>
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<tr>
<td>1 Corynebacterium spp.</td>
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<tr>
<td>15 CNS*</td>
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* CNS: Coagulate negative staphylococcus

the rate of colonization and the inspection time. Similarly, no correlations were detected between the rate of colonization and the procedure time among outpatients, who are in the low-medium risk group in terms of infection risk. That being said, it should be noted that further prospective research on this subject is necessary, especially in patients with a high risk of infection and inpatient groups.

The limitations of our study can be summarized as follows. First, a limited number of patients participated in this study. Second, the participants had either a low or medium level of risk in terms of infection. Third, inpatients and/or those exposed to invasive treatment were not included.

In conclusion, hot water disinfection is a practical and simple method, especially in developing and underdeveloped countries, where it is difficult to access relatively costly transducer disinfection materials, such as antiseptic wipes. This efficacy of this method should be born in mind when fighting against infections with high morbidity and mortality rates. However, it is necessary to determine the exact temperature ranges and disinfection time. Only then will it be fully clarified whether this method is acceptable for use in the antimicrobial management of ultrasound examinations.

The authors state that they have no Conflict of Interest (COI).

References