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Contamination status and disinfection effect of ultrasound instrument surface in an infectious disease hospital

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ABSTRACT: Objective The purpose of this study is to understand the working habits of healthcare workers and the contamination of ultrasound instrument surfaces in the ultrasound clinic of infectious disease hospitals, and to explore the effect of disposable medical disinfectant wipes on disinfecting the surface of ultrasound instruments, so as to provide reference for the infection control in the department of medical ultrasound. **Methods** A questionnaire survey was conducted on the working habits of 24 staff in the ultrasound department. According to the *Hygienic Standard for Hospital Disinfection* (2012-GB15982), the surfaces (probes, wires, and keyboards) of 16 ultrasound diagnostic instruments currently in use were examined for colony sampling and cleanness. Disposable medical disinfectant wipes containing compound double-chain quaternary ammonium salt were used to wipe and disinfect the probe, and the samples were sampled and tested again after disinfection. A total of 256 samples were effectively detected. The number of colonies and cleanness of each tested site before and after disinfection were compared and analyzed. **Results** The frequency of work clothes replacement, hand hygiene implementation, frequency of ultrasound probe cleaning and disinfection in the clinic exceeding standard were lower than those in the clinic non-exceeding standard. The cleanliness of 256 samples after cleaning and disinfection did not exceed the standard, and the number of colonies exceeding the standard was significantly reduced after disinfection (P<0.001). The contamination of the probe, instrument keyboard surface, and wire using disposable medical disinfectant wipes after cleaning and disinfection was significantly improved compared to the contamination before cleaning and disinfection. There was a statistically significant difference between the ultrasound probes before and after cleaning and disinfection (P<0.05). **Conclusion** Bad working habits of medical staff lead to serious pollution of instrument surfaces. The surface of the medical ultrasonic diagnostic instruments, especially the surface of the ultrasound probe, is seriously polluted. The disinfectant wipe containing compound double-chain quaternary ammonium salt has a good disinfection effect on ultrasound probes.

KEY WORDS: Ultrasound probe; Compound double-chain quaternary ammonium salt; Disinfection effect; Habits of medical staff

Introduction

Medical ultrasound diagnosis is now an indispensable auxiliary means of medical examination as new technologies, new norms, and new diagnostic and therapeutic levels continue to improve. Ultrasound examination has been widely applied in clinical practice because of its high diagnostic accuracy, image cleaning, and accurate positioning. ultrasound probe, as an important part of ultrasound diagnostic instrument, can lead to patient infections if it is not sterilized thoroughly due to its full, contact with the patient's skin, mucous membranes, and organs. In recent years, there have been successive reports of serious bacterial overload in ultrasound probes and the presence of multiple pathogenic bacteria, and even the investigation of multi-drug-resistant bacteria, which poses a great threat to patient safety[1-3]. In-

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fectious disease specialist hospitals are prone to nosocomial infections due to the admission of a greater number of patients with blood-borne diseases, high demand for ultrasound diagnostics, intensive flow of people in the department, and the patients themselves belonging to the susceptible population because of a variety of illnesses lead to a decline in physical fitness, resistance, and immunity[4]. Therefore, scientific and effective cleaning and disinfecting methods are essential for the prevention of cross-infection in infectious disease specialist hospitals.

1 Methods

1.1 Risk assessment

The risk factor assessment of the department was carried out through on-site inspection, unannounced inspection, hand hygiene compliance survey, departmental staff interviews and questionnaires from October 2023 to January 2024 in order to effectively minimize the contamination of the environmental substances in the ultrasound clinic of our hospital. According to the results of the relevant inspections and surveys, the following major risk factors that may lead to environmental surface contamination are summarized in Table 1.

1.2 Source

During the daily inspection from January to March 2024, the ultrasound probe surface, instrument keyboard surface, and wire were randomly sampled and tested for colony count and cleanness before and after disinfection (after 30 minutes of wiping and disinfecting with disposable medical disinfectant wipe containing composite double-chain quaternary ammonium salt). A total of 256 valid samples were obtained and a comparative analysis was made on the colony count and cleanness before and after disinfection.

1.3 Sampling method

Sampling was performed according to the *Regulation of disinfection technique in healthcare settings* (WS/T367—2012)[4]. A sterilized specimen plate in 5 cm*5 cm was placed on the surface of the tested object. A cotton swab soaked in 0.03 mol/L phosphate buffer solution (PBS) or saline sampling solution was applied five times horizontally and vertically in the specimen plate. The swab was then rotated and four consecutive plate areas were sampled. If the sampled surface is less than 100 cm^2, all the surface was taken; if the sampled surface is more than 100 cm^2, 100 cm^2 was taken. The hand-contacted portion was cut off, and the swab was placed in a tube containing 10 ml of sterile test eluent for testing. Door handles and other small objects were sampled by applying cotton swabs directly to the surface of the object. If there is any disinfectant residue on the surface of the sampled object, the sampling solution should contain the corresponding neutralizing agent. After sufficient shock elution, 1.0 ml of eluent was inoculated in ordinary nutrient agar dishes, and the sample was immediately transferred to an incubator at 37℃. After 48 h, the number of bacteria was counted.

The cleanliness of ultrasound instrument surfaces (full surface of ultrasound probe, full surface of instrument keyboard, full surface of wire) was examined using an ATP fluorescence detector.

1.4 Test method

After sufficiently oscillating the sampling tube, 1.0 mL of eluent with different dilutions was taken to inoculate the petri dish, and the melted nutrient agar medium cooled to 40℃~45℃ was poured into 15 mL~20 mL per dish, and incubated in a constant temperature box at 36±1℃ for 48 h. The number of colonies was counted. Target microorganisms were

Table 1 Major risk factors for contamination of environmental surfaces at ultrasound clinics

No.	Risk factor
1	The compliance and accuracy of hand hygiene of the departmental staff is low, and some of them have excessive colonies in hand hygiene monitoring.
2	Department staff's concept of disinfection at any time needs to be improved.
3	The awareness of personal protection of the department staff needs to be improved, and the fabric management of work clothes needs to be standardized.

tested when suspected to be related to outbreaks of nosocomial infections.

1.5 Result determination

1.5.1 Sampling result determination

B-scan ultrasonography in contact with the skin surface is low-risk medical equipment. The results were determined according to the *Regulation of disinfection technique in healthcare settings* (WS/T367—2012)[5]. The total number of colonies of low-risk medical devices ⩽200 cfu/100 cm^2 was considered to be qualified for disinfection, and pathogenic microorganisms could not be detected. The instrument keyboard and wire are low-risk items ⩽200 cfu/100 cm^2, otherwise it is exceeding the standard. The cleanness result of the ATP fluorescence test is qualified by ⩽50 fmol/piece on the surface of the object (class IV), otherwise it is exceeding the standard.

1.5.2 Determination of exceeding the standard in the clinic

If the number of bacterial colonies sampled from the instrument surface in the clinic exceeded 200 cfu/100 cm^2, it was recognized as unqualified, and this clinic was considered to be a clinic exceeding the standard in this study.

1.6 Statistical analysis

The data were analyzed by SPSS19.0 statistical software, and the count data were expressed as frequency and percentage (%). The comparison between groups was conducted by χ^2 test or Fisher's exact test, and $P<0.05$ was considered statistically significant.

2 Results

2.1 Comparison of staff habits

Environmental hygiene monitoring revealed exceedances of ultrasound probe and object surface colony counts in some departments. On the basis of daily infection control inspections, the Infection Management Department conducted a questionnaire survey of 24 staff members in the medical ultrasound department of the hospital. The results found that the frequency of change of work clothes, hand hygiene implementation, ultrasound probe cleaning, and disinfection of the frequency of clinic exceeding the standard is lower than the clinic non-exceeding standard ($P<0.05$). The difference and the same statistical method of investigation are detailed in Table 2.

2.2 Comparison of contamination before and after disinfection

Serious exceedances of colony count and cleanness were found in 256 samples tested using disposable medical disinfectant wipes before disinfection of the probe, instrument keyboard surface, and wire. After sampling, the ultrasound probe, instrument surface, and wire were wiped and disinfected with disposable medical disinfectant wipe containing compound double-chain quaternary ammonium salt. After 30 minutes, the mean colony counts of the samples collected from the keyboard surface and wire of the ultrasound probe, instrument surface, and wire met the standard (⩽10 cfu/cm^2). A total of 251 samples of ultrasound probes disinfected by wiping with disinfectant solution met the standard, except for five samples with colony counts exceeding 200 cfu/100 cm^2. The five disinfected samples with exceeded standards were traced and the cause is related to the operation of the disinfectant wipers. The cleanness of 256 samples cleaned and disinfected did not exceed the standard, and the number of exceeded standards of the colonies counts after disinfecting was significantly reduced ($P<0.001$). A comparison of colony contamination and cleanness before and after cleaning and disinfection of the three sites revealed a significant improvement in contamination after cleaning and disinfection of each site, and there was a statistically significant difference in the contamination of ultrasound probes before and after cleaning and disinfection ($P<0.05$). For details, see Tables 3 and 4.

3 Discussion

Ultrasound diagnosis is a routine examination at all levels of medical institutions. It highly relies on its probe to contact and check the human body, such as the intact skin, mucous membranes, and mucous membrane tissues. However, most doctors

Table 2 Comparison of work habits of ultrasound staff

	Clinic exceeding standard (n=10)	Clinic non-exceeding standard (n=14)	Chi-square	P
Years of working experience				
1 year and below	5 (50. 00)	4 (28. 57)	1. 14	0. 285
More than 1 year	5 (50. 00)	10 (71. 43)		
Change frequency of work clothes				
2 or more times per week	0 (0. 00)	3 (21. 43)	2. 45	0. 118*
1 time per week	10 (100. 00)	11 (78. 57)		
Hand hygiene before and after examination				
Before or after examining the patient	6 (60. 00)	14 (100. 00)	4. 80	0. 020*
Neither	4 (40. 00)	0 (0. 00)		
Types of gloves [a]				
Surgical latex gloves	4 (40. 00)	4 (28. 57)	0. 34	0. 558
Sterile PE gloves	1 (10. 00)	2 (14. 29)	0. 10	0. 754
Cleaning latex gloves	5 (50. 00)	7 (50. 00)	0. 00	1. 00
Cleaning PE gloves	8 (80. 00)	10 (71. 43)	0. 23	0. 633
Frequency of ultrasound probe cleaning				
After each patient examination	1 (10. 00)	8 (57. 14)	5. 53	0. 019
After each shift	9 (90. 00)	6 (42. 86)		
Frequency of ultrasound probe disinfection				
After each patient examination	1 (10. 00)	7 (50. 00)	4. 20	0. 040
After each shift	9 (90. 00)	7 (50. 00)		

Note: *Fisher's exact test was used because n<40 or theoretical frequency <1.

[a] This is a multiple-choice question, so the percentages in the table are the number of individuals wearing each type of glove compared to the number of individuals in the clinic.

Table 3 Comparison of the exceedance of bacterial colony count in the test site before and after disinfection

Item	Number of samples tested	Number of exceedances before disinfection	Number of exceedances after disinfection	P
Test site	256	213 (83. 20%)	5 (2. 00%)	<0. 001
Ultrasound probe (>200 cfu/cm^2)	78	72 (92. 31%)	5 (6. 40%)	<0. 001
instrument surface (>10 cfu/cm^2)	86	70 (81. 40%)	0 (0. 00%)	—
wire (>10 cfu/cm^2)	92	71 (77. 17%)	0 (0. 00%)	—
P		0. 027	—	—

Table 4 Comparison of exceedance of cleanness at the test site before and after disinfection

Item	Number of samples tested	Number of exceedances before disinfection (cleanness>50)	Number of exceedances after disinfection (cleanness>50)	P
Test site	256	163 (63. 67%)	0 (0. 00)	—
Ultrasound probe	78	58 (74. 36%)	0 (0. 00)	—
Instrument surface	86	45 (52. 33%)	0 (0. 00)	—
Wire	92	60 (65. 23%)	0 (0. 00)	—
P		0. 013	—	—

routinely wipe the ultrasound probe and the patient's skin with toilet paper after the ultrasound examination and then proceed to the next operation without any sterilization measures[6]. With the continuous development of ultrasound diagnosis, the technology of interventional ultrasound is gradually applied to clinical[8], and the cleaning and disinfection of interventional ultrasound in the process of diagnosis and treatment has attracted the attention of infection control. Infectious disease events occur

frequently due to improper disinfection of medical devices, resulting in nosocomial infections and adverse events. Some research shows that the medical staff's hand hygiene and medical device disinfection are not standardized, which constitutes an important risk factor for hepatitis virus infection[9]. Therefore, if the cleaning and disinfection of instruments and equipment are not given attention during the ultrasound diagnosis and treatment in infectious disease hospitals, nosocomial infections are highly probable, causing incalculable losses[10]. The disinfectant wipe containing compound double-chain quaternary ammonium salt has the advantages of strong bactericidal effect, low bactericidal concentration, small adverse reactions, no irritation, no carcinogens, low toxicity, and high safety. It can effectively clean the surface of disinfected objects, keep them clean, and prevent bacterial breeding. The method is simple, and there is no damage to the surface of medical devices. The disinfectant wipes are both clean and convenient in sterilization, which is convenient and available to healthcare workers[11].

A review showed that China has a serious contamination of ultrasound probes with a 50% to 100% bacterial exceedance rate of ultrasound probes[12]. Yin et al. found that the exceedance rate of total bacterial counts was 89.26% after sampling and testing the surface of in vitro ultrasound probes in 11 hospitals[13]. In this study, the cleanliness and bacterial colonization of the ultrasound probe surface were monitored, respectively, and the exceedance rate of cleanliness and bacterial colonization before sterilization was 92.31% and 74.36%, which was consistent with the results of related literature. Some findings have shown[14] that different disinfection methods have different effects, and the bacterial colonies of the probes disinfected with disinfectant wipe containing compound double-chain quaternary ammonium salt did not exceed the standard, and the qualification rate was 100%, which is the same as the findings of this study.

In this study, we carried out departmental risk assessment, questionnaire survey among ultrasonographers, and environmental microbiological sampling of hospital ultrasound probes in risk points. It was found that the cleaning and disinfection of B-scan ultrasonography is not optimistic and that there is a need to formulate effective disinfection standards of B-scan ultrasonography for ultrasound probes and related ultrasonography components to provide standard guidance for sterilization. In the face of the aggravation of population aging in China, the lower resistance of long-term hospitalized patients, and the spread of multidrug-resistant bacteria, the cleaning and disinfection of ultrasound probes and instrument surfaces are particularly important. This study shows that ultrasonographers should improve hand hygiene and the cleaning and disinfection of ultrasound probes and that the disposable medical disinfectant wipe containing compound double-chain quaternary ammonium salt is effective in cleaning and disinfecting after ultrasonography.

In conclusion, infectious hospitals should strengthen the daily cleaning, disinfection, supervision, and management of ultrasound probes and instrument surfaces, improve staff awareness of sensory control, and eliminate medical cross-infection caused by ultrasound probe surface contamination.

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