

# An investigation of the microbiological contamination of ultrasound equipment

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## Abstract

**U**ltrasound equipment comes into direct contact with patients and practitioners during scanning procedures, enabling it to be a potential vehicle for the spread of nosocomial infections. A study was undertaken to determine the extent of contamination on this equipment and therefore the efficacy of the present decontamination guidelines.

Five ultrasound machines were sampled over a period of three months. Three used for non-invasive procedures and two for invasive procedures. The equipment was sampled from the probe, probe holder, keyboard and gel.

The results revealed that 64.5% of the total samples were contaminated with environmental organisms, 7.7% with potential pathogens and 27.8% were no growth. The most significant contamination was found on the non-invasive equipment, probably due to the lower level of decontamination practices designated for this equipment.

Following the study, comprehensive decontamination guidelines for all ultrasound equipment were devised and distributed to all ultrasound departments, and staff were educated on the need for improved decontamination regimes.

## Introduction

Nosocomial infections have become an increasingly recognised problem and medical devices can be one of the vehicles for the spread of these infections.

Ultrasound equipment has been the subject of several studies to determine its role in cross-infection, as these devices come into direct contact with patients.

If any part of the ultrasound equipment is contaminated, be that the ultrasound transmission media (gel), (which acts as a coupling medium that enables the transmission of sound from the ultrasound probe through into the patient's body and back

again), the probe that is placed onto the gel to scan, or even the keyboard the practitioners touch during scanning, then there is a risk of cross-contamination from the equipment to the patient.

One study by Kibria (2002) found that 39% of the probes used on surgical wards produced positive cultures after use and all were found to be dirty.

Fowler (1999), Karadeniz (2001) and Bello (2005) also detected bacterial contamination of the probe and gel. They also noted that the gel was often not removed or the equipment cleaned prior to subsequent patient examinations.

Abdullah (1998) found a 23.5% incidence of *Staphylococcus epidermidis* in the ultrasound gel, which has been recognised as a major cause of infections associated with prosthetic joints and the urinary tract.

Ohara (1998) revealed the transmission of bacteria from a patient's skin to the ultrasound instruments, the most significant organisms being *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

The same authors then performed an examination to determine the prevalence of contamination of the ultrasound instruments, probes and gel (Ohara et al, 1999).

Though this study was small, it also revealed high levels of contamination on the equipment, such as *S. aureus* (60% of which were methicillin-resistant) *Acinetobacter* species, *Candida albicans* and *Bacillus* species.

There have also been documented cases of nosocomial infections attributed to contaminated ultrasound equipment. Hutchinson et al (2004) identified six *Burkholderia cepacia* infections, which were confirmed as being acquired from the ultrasound gel used during ultrasound procedures.

Weist et al (2000) also describes an outbreak of pyoderma among neonates acquired from ultrasound gel contaminated with methicillin-susceptible *S. aureus*.

All of the above authors recommend that clear guidelines should be introduced into ultrasound departments to reduce the risk of microbiological contamination of this equipment.

**Table 1. Potential pathogens isolated**

Scanner	Site	Pathogen
Non-invasive	Probe	<i>Haemolytic streptococci</i> <i>Enterococcus faecalis</i> <i>Acinetobacter sp</i> (0001073)
	Probe holder	<i>Enterococcus faecium</i> (x2) <i>Enterococcus faecalis</i> <i>Acinetobacter lwoffii</i> <i>S. aureus</i> (fully sensitive)
	Keyboard	<i>Acinetobacter sp</i> <i>Acinetobacter lwoffii</i> <i>Acinetobacter sp</i> (0001073) <i>Enterococcus faecium</i> <i>Enterococcus faecalis</i> (x4)
	Gel	<i>S. aureus</i> (fully sensitive)
Transrectal	Probe	<i>E. coli</i> (5144532)
	Keyboard	<i>Acinetobacter sp</i> (0000051)
Transvaginal	Probe	<i>S. aureus</i> (fully sensitive)
	Keyboard	<i>Pseudomonas putida</i> (44443455) <i>S. aureus</i> (fully sensitive) (x2)

Due to the lack of national guidelines for the decontamination of ultrasound equipment, the authors decided to undertake a study to determine the extent of contamination on their ultrasound equipment, in order to formulate effective decontamination guidelines to reduce the risk of nosocomial infections acquired from this equipment.

#### Aim

Through this investigation, the authors set out to achieve the following:

- Assess the microbiological contamination of the ultrasound equipment used for non-invasive, transvaginal and transrectal examinations
- Assess the efficacy of the present decontamination regimes for ultrasound equipment
- Formulate effective cross-trust decontamination guidelines for the ultrasound equipment.

#### Method

- Five ultrasound machines were sampled in total – three used for non-invasive scanning on intact skin, where the scanning probe may be placed on the skin of any area of the body, one used for transrectal scanning and one for transvaginal scanning. These are invasive probes where the probe is covered with a sheath and placed into the rectum or vagina respectively for scanning to take place
- The machines were sampled randomly on different days of the week and at different times over a period of three months to ensure a variety of practitioners were studied
- All ultrasound machines were sampled 15 times from the probe, probe holder, keyboard and gel. These areas were chosen, as they are pieces of equipment, which have contact with either the patient or the practitioner during scanning

- The sampling was performed with the sampler wearing sterile gloves, moistening a dry swab with sterile saline, to ensure better capture, and rubbing the swab over the sample area. The samples were then taken immediately to the laboratory for processing
- All types of transmission media were tested for antibacterial properties
- The following information was documented during each sampling:
  - Grade of staff performing the examination
  - Comments on the cleanliness of the equipment e.g. gel left on the probe.

#### Processing

Cultures were performed on highly nutritious non-selective media (Columbia blood agar) designed to support the growth of most commonly encountered bacteria and fungi.

Cultures were incubated for 48 hours at 30°C, in order to grow environmental microorganisms, some of which will not grow at 37°C, as well as microorganisms of potential clinical importance.

In addition, enrichment culture of swabs was performed in brain-heart infusion broth for 48 hours at 30°C prior to sub-culture onto Columbia blood agar and subsequent incubation for 48 hours at 30°C.

Direct culture allowed us to assess the degree of contamination present on any of the equipment whereas enrichment culture allowed us to detect small numbers of organisms present.

Potential pathogens recovered (e.g. *S. aureus* or *haemolytic streptococci*) were identified to species level using standard methods. Confirmed pathogens that were isolated were then referred for appropriate sensitivity tests using standard methods (Andrews, 2001).

#### Results

In total, 302 samples were taken from the five ultrasound machines. Skin/environmental organisms were isolated from 64.5% of the samples. These included *S. epidermidis*, which is a skin organism but occasionally may be the cause of infection e.g. of prosthesis or intravenous lines. Also *Bacillus cereus*, which is common in the environment, but extremely rarely pathogenic.

Potential pathogens (microorganisms that commonly cause disease) were isolated from 7.7% of the samples (a list of which can be seen in Table 1), and 27.8% were no growth.

The non-invasive equipment grew the highest percentage of potential pathogens. Of the 180 samples taken from the non-invasive equipment, 65% (117) grew skin/environmental organisms, 9.4% (17) grew potential pathogens, three of which were from the probe and 25.6% (46) were no growth.

Some 83.3% (50) of the samples from the transvaginal ultrasound equipment grew skin/environmental organisms, 6.7% (4) grew potential pathogens, one of which being *S. aureus* (fully sensitive) from the probe and 10% (6) were no growth.

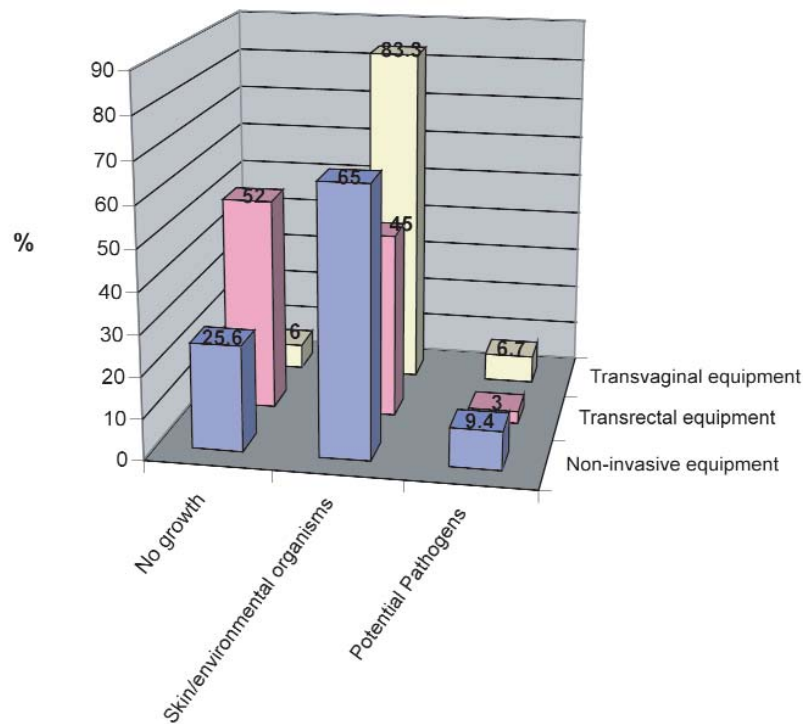
The transrectal ultrasound equipment was found to have the least contamination with skin/environmental organisms recovered from 45% (27) of the 60 samples, potential pathogens from only 3% (2) and 52% (31) of the samples being no growth (see Figure 1).

The ultrasound gels were tested for antibacterial properties. This was achieved through assessing their inhibitory effects to two common pathogenic organisms, *E. coli* (gram -ve) and *S. aureus* (gram +ve).

The tests revealed that the gel (Gel Diagnostic Sonar Limited) used with the non-invasive equipment and the transrectal equipment had some inhibitory effect (4mm and 8mm respectively), however the gel used for transvaginal examinations had no inhibitory effects.

The disinfectant solution, T-spray, used to disinfect the transvaginal equipment was also tested and found to have a

Figure 1. Summary of results



	No growth	Skin/environmental organisms	Potential Pathogens
■ Non-invasive equipment	25.6	65	9.4
■ Transrectal equipment	52	45	3
■ Transvaginal equipment	6	83.3	6.7

significant inhibitory effect to *E. coli* and *S. aureus* (26mm and 30mm respectively). Areas of poor practice observed at the time of sampling were:

- Non-invasive and transrectal ultrasound equipment was often found to be visibly dirty
- Routine ultrasound probes were not cleaned of gel post-procedure on six occasions
- The elastic band used to hold the sheath on the transvaginal probe was not changed between patients
- Practitioners often did not decontaminate their hands pre- or post-procedure.

There was no significant difference in practice or sampling results between the different grades of staff.

### Discussion

The results reveal that the ultrasound equipment was often significantly contaminated and therefore a potential vehicle for the spread of infection.

The most significant results were recovered from the non-invasive equipment, which had the highest percentage of clinically significant contamination.

There may be two reasons for this. First, that compliance with existing decontamination protocols was sometimes poor, although not all the samples contaminated with potential pathogens correspond to poor practice. Second, that the level of decontamination for this equipment was much lower compared to that for the invasive equipment.

At the time of sampling the following guidelines were in existence for the non-invasive equipment:

- Personnel must wash their hands after each patient contact
- Gel must be wiped from probe after each examination

- Keyboard and probe holder must be decontaminated with detergent at the beginning and end of each day and whenever visibly soiled
- Transmission medium (gel) containers must be decontaminated on the outside with detergent daily
- After an examination on a known or suspected infected patient, the probe must be cleaned with an antibacterial solution e.g. aqueous chlorhexidine, rinsed and dried. All other areas of the machine must be cleaned with a 70% alcohol wipe (if not contraindicated by the manufacturers).

The level of decontamination needed for non-invasive ultrasound equipment is unclear. However, in the author's trust, this equipment is used to examine immunocompromised patients and it was felt that the level of contamination with the existing decontamination guidelines was unacceptable and therefore needed to be improved to reduce the risk to this patient group.

The lower level of contamination on the ultrasound equipment used for invasive procedures probably reflects the fact that it was decontaminated to a higher level with the use of disinfectants.

Much of the contamination detected was found on the keyboard, which was not included in the decontamination guidelines at that time.

The decontamination guidelines for this equipment at the time of sampling were that the probes should be covered with disposable single patient sheaths for each examination onto which the gel was placed.

Once the examination was complete the sheaths were discarded. The transvaginal probe was then sprayed with T-spray, left for five minutes and then dried ready for re-use.

The transrectal probe was cleaned with detergent and hot water, submerged into a disinfectant tank containing Gigasept for

## Box 1. Infection control guidelines

### Non-invasive ultrasound equipment

- All practitioners MUST disinfect their hands immediately before and after each patient contact
- After EVERY examination, all gel must be removed from the probe then it and the keyboard must be cleaned with a detergent wipe and then with a compatible disinfectant (e.g. T-spray)
- After contact with a known/suspected infected patient, all other areas of the machine should also be cleaned with a detergent wipe and then with a compatible disinfectant (e.g. 70% alcohol wipe)
- The probe holder and gel containers must be cleaned with detergent at the beginning and end of each day, and whenever visibly soiled
- All other areas of the ultrasound machine must be cleaned with detergent at least once a week, and kept free from visible soiling and dust at all times
- The use of a gel containing antibacterial properties is recommended.

### Invasive ultrasound equipment

- All practitioners MUST wear disposable latex gloves during the examination and wash their hands immediately after each patient contact
- All probes must be covered with a new sheath and new elastic band used (if applicable) prior to each use
- After EVERY examination, the sheath and elastic band must be disposed of as clinical waste and the probe cleaned with a detergent wipe and then a compatible disinfectant
- The keyboard must be cleaned with a detergent wipe after each examination
- After contact with a known/suspected infected patient, all other areas of the machine must also be cleaned with a detergent wipe and then a compatible disinfectant (e.g. 70% alcohol wipe)
- The probe holder and gel containers must be cleaned with detergent at the beginning and end of each day, and whenever visibly soiled
- All other areas of the ultrasound machine must be cleaned with detergent at least once a week, and kept free from visible soiling and dust at all times
- The use of a gel containing antibacterial properties is recommended.

15 minutes, rinsed with water and dried.

There were no other decontamination guidelines for the other parts of the equipment except when the transvaginal probe was used on a known or suspected infected case, the other areas of the machine were cleaned with 70% alcohol.

### Recommendations

Following the study, the guidelines for the decontamination of non-invasive and invasive ultrasound equipment were revised.

When deciding on the recommendations it was important that not only were they effective but also practical, otherwise the compliance levels would continue to be poor.

The most significant changes were for non-invasive equipment, as it was felt that a higher level of decontamination was needed than merely wiping the gel from the probe.

It was decided that the probes needed to be cleaned thoroughly and disinfected. This would reduce the microorganisms to a level that is not harmful to health (Damani, 1997).

The first stage of decontamination for all the equipment was cleaning, which is an essential prerequisite to disinfection (Royal

College of Nursing, 2004).

Cleaning reduces the bio-burden and organic matter, which may shield the microbes from disinfectants so making the next stage ineffective (Wilson, 2002; Hoffman et al, 2004).

To achieve this the probes needed to have all gel removed from them and then be cleaned with detergent. The most effective way of doing this is with the use of warm water and detergent, however with this very expensive, delicate, electrical equipment and in busy departments such as these with limited facilities for decontamination processes, this would be impractical and pose health and safety risks.

Therefore the use of detergent wipes with up to 5% surfactant strength was advocated, as they are easily accessible and quick to use.

Due to the delicate membrane on the ultrasound probe the choice of disinfectants, which are compatible with this equipment, is very limited.

Certainly most current ultrasound probes cannot be disinfected with alcohol-based products. The author's chose T-spray II disinfectant (from Diagnostic Sonar Limited) to disinfect the

non-invasive probes and the transvaginal probes, as it is a product that is quick and easy to use and is specifically designed to disinfect ultrasound equipment, and the tests certainly showed that it has significant bactericidal properties.

Also manufacturers of ultrasound equipment such as Philips and SonoSite recommend its use for disinfecting their probes.

The regime to disinfect the transrectal probe, of being submerged in Gigasept for 15 minutes was not changed, as it appeared to be effective and the practitioners did not feel changes were needed in this area.

To disinfect the other areas of the ultrasound equipment, which are made of hard plastic and metal, after suspected or know infected cases, a 70% alcohol wipe was chosen.

Again this was because they are easily accessible, quick to use and 70% isopropyl alcohol is a rapid and effective disinfectant on clean surfaces (Mercier, 1997; McCulloch, 2000; Hoffman, 2004), and is recommended by Babb (2000) in his advice on decontamination of equipment.

The authors also advised that gel with antibacterial properties was used to further reduce the risk of the transfer of microor-

ganisms from the equipment to the patient.

The revised infection control guidelines (see Box 1) were distributed to the managers of all the participating departments and the infection control nurse was invited to some of the departments to give education sessions on the new guidelines and effective hand-washing practices, to assist in their introduction.

### Conclusion

The study demonstrated the need for effective decontamination practices when using the ultrasound equipment to reduce contamination and the risk this poses.

These guidelines have now been put in place, though these are only as good as those putting them into practice.

As with any infection prevention and control measures, there must be a high level of compliance to ensure their effectiveness.

It is hoped that the results of the study and subsequent education has highlighted the need for good practice within these departments, which in turn will positively impact on the quality of their patient care, by reducing the risk of nosocomial infections.

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