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● *Original Contribution*

POTENTIAL INFECTION CONTROL RISKS ASSOCIATED WITH ULTRASOUND EQUIPMENT – A BACTERIAL PERSPECTIVE

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Abstract—Ultrasound equipment used in trans-abdominal (TA) and trans-vaginal (TV) examination may carry bacterial contamination and pose risks to infection control during ultrasound examination. We aimed to describe the prevalence of bacterial contamination on ultrasound probes, gel, machine keyboard and cords and examined the effectiveness of low- and high-level disinfection techniques. This study was performed at a public hospital and a private practice. A total of 171 swabs were analyzed and bacterial species were identified using matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) analysis and polymerase chain reaction (PCR). Sixty percent of TA probes and 14% of TV probes had evidence of bacterial contamination after an ultrasound examination. Low-level disinfection was partially effective, but 4% of probes were still contaminated by spore-forming species. Some heated gel samples were highly contaminated with the environmental bacterium *Brevundimonas aurantiaca,* suggesting the gel was conducive to bacterial growth. Ultrasound machines, probe cords and gels were identified as potential sources of bacterial contamination and need to be cleaned and changed regularly to minimize risks of infection. (E-mail: j.basseal@asum.com.au) **© 2016 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Ultrasound, Bacterial contamination, Healthcare-associated infection, Patient safety, Disinfection.**

INTRODUCTION

Routine ultrasound examination may not be as safe as is assumed. This dynamic procedure provides a vehicle for cross-infection at several levels ranging from basic hand hygiene to exposure to ultrasound coupling gel and the ultrasound probe as well as transfer of infection from sources such as the probe cord and machine keyboard. In Australia, the National Health and Medical Research Council has reported that there are over 200,000 healthcare-associated infections in acute healthcare facilities each year. A number of organizations provide guidance that aims to reduce the risk of cross-infection. The National Health and Medical Research Council promotes a systems-based risk management framework, Standards Australia promotes best practice in disinfection and sterilization of reusable medical equipment and the Therapeutic Goods Administration regulates materials used for disinfection of medical equipment used in high-, medium- and low-grade infection environments. Ultrasound hygiene is promoted by professional organizations such as the Australasian Society for Ultrasound in Medicine, the American Institute of Ultrasound in Medicine and the World Federation of Ultrasound in Medicine and Biology.

Natural latex condoms are commonly used as probe covers but may not provide adequate protection against infection. A study examining 440 endocavity probes after covers were removed following (trans-vaginal) TV and trans-rectal scans found 68% had bacterial flora present, with pathogenic bacteria and viral nucleic acids, including human papilloma virus (HPV) on 3.4% and 1.5% of the probes, respectively (Kac et al. 2010). Another study (Casalegno et al. 2012) found that despite the use of probe covers, 24% of TV probes were contaminated by human DNA and 3.5% were positive for HPV.

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Recommended techniques for low-level disinfection did not remove infective agents in all cases and 3% of probes remained contaminated after cleaning. The authors concluded that high-level disinfection should be used for all endocavity probes. Ultrasound gel has also been reported to be contaminated with a number of pathogenic organisms including *Pseudomonas aeruginosa* and *Klebsiella oxytoca,* but there are no regulations relating to post-purchase packaging or use of this product (FDA Safety Communications 2012).

We aimed to document the potential risk for contamination with pathogenic micro-organisms that women are exposed to in contemporary practice when they attend for a trans-abdominal (TA) or TV scan. The study examined the efficacy of low-level and high-level infection control regimens for cleaning TA and TV probes and also assessed the potential for contamination from the probe cord, coupling gel and machine keyboard. Our intention was to provide data that would inform the development of robust clinical guidelines.

METHODOLOGY

Study samples

This was a blinded study conducted in the ultrasound units of a public hospital (ultrasound unit A) and a private clinic (ultrasound unit B) in Sydney, Australia. Ethical approval was sought and deemed unnecessary as this study did not involve patients or patient samples. Using Sterilin transport swabs (Thermo Fisher Scientific, Waltham, MA, USA), duplicate culture swabs were taken from TV and TA probes, cords, ultrasound machine keyboard and ultrasound gel bottles. The following protocols were used:

1. TV probe swabs: were obtained before patient use (following high-level disinfection [HLD] after the previous patient) and following patient use. First, the condom or vinyl probe cover was removed, the gel was wiped with a paper towel and the probe was swabbed. The probe was then rinsed under cold running water, dried with paper towel and cleaned with an alcohol-based wipe (low-level disinfection [LLD]) and re-swabbed. It was then subjected to HLD by immersion in a 2.4% glutaraldehyde solution (Cidex, CIVCO Medical Solutions, Kalona, IA, USA) for the disinfection time recommended by the manufacturer and was swabbed again.
2. TA probe swabs: were also obtained following patient use. A paper towel was used to wipe the ultrasound gel from the probe before the first swab. An alcohol-based wipe was then used to clean the probe (LLD) and the probe was re-swabbed.
3. Ultrasound unit keyboard (keys and rolling trackball) and ultrasound probe cords: these were swabbed separately without undergoing any disinfection.
4. Ultrasound coupling gel: sampled from (i) unopened gel bottles; (ii) unheated refillable gel bottles; and (iii) refillable gel bottles reheated throughout the d in a dry heater.

Growth, enumeration and identification of micro-organisms

A total of 171 swabs were obtained and were plated onto sterile Nutrient Agar and incubated at 37°C overnight to allow bacterial growth. All plates were assessed qualitatively and bacterial growth was recorded on a scale from 0 to 3, where 0 = no growth, 1 = 1–3 colonies, 2 = 4–10 colonies and 3 = >10 colonies and up to confluent growth. Bacterial colonies were isolated and purified by streak plating, and were subjected to matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) analysis using a Microflex LT/LRF MALDI-TOF (Bruker, Billerica, MA, USA) with a clinical database. In brief, each colony was spotted onto a MALDI-TOF target plate and overlaid with 1 μL trifluoroacetic acid followed by 1 μL matrix solution (1.5 mg α-cyano-4-hydroxycinnamic acid in 50% acetonite with 2.5% trifluoroacetic acid). Once dry, the plates were inserted into the Microflex to obtain spectral fingerprints that were compared to the database to obtain identifications. As recommended by the manufacturer, identification scores values > 1.7 were considered reliable identifications. All isolated colonies were tested in duplicate.

Colonies that could not be identified by MALDI-TOF were identified by 16 S polymerase chain reaction (PCR) sequencing. To extract DNA, bacterial colonies were emulsified in 500 μL of Milli-Q water in a beat-beating tube and vortexed for 30 s using a BenchMixer Vortexer (Benchmark Scientific, Sayreville, NJ, USA). Tubes were centrifuged for 10 min at 16,000 rpm and the supernatant containing the bacterial DNA was removed. PCR was performed in a reaction volume of 25 μL containing 50 mM KCl, 10 mM Tris-HCl, 1.5 mM $MgCl_2$, 1 μM dNTPs (Thermo Fisher Scientific), 0.5 μM each of 16 S full length universal primers 27 F (AGAGTTTGATCMTGGCTCAG) and 1492 R (CGGTTACCTTGTTACGACTT), 1 ng of genomic DNA prepared above and 1 unit of *Taq* polymerase (Qiagen, Hilden, Germany). PCR cycling included denaturation at 95°C for 30 s, annealing at 54°C for 30 s and extension at 72°C for 45 s repeated for 35 cycles, with a final extension at 72°C for 7 min.

PCR products were assessed for quality on a 1% agarose gel containing 1 x GelRed (Qiagen) with