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SCIENCE

TRANSOESOPHAGEAL ECHOCARDIOGRAPHY

A SYNOPSIS OF IMPORTANT FACTORS THE HEALTHCARE CLINICIAN SHOULD KNOW

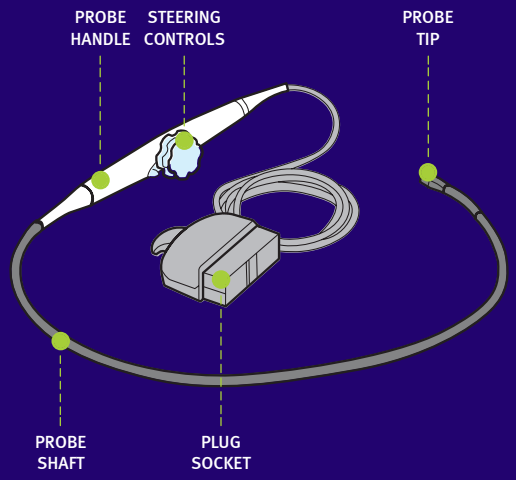

FIGURE 1. COMPONENTS OF A STANDARD TOE PROBE

CATEGORY	DEVICE APPLICATION	EXAMPLES OF DEVICES	LEVEL OF DISINFECTION REQUIRED
CRITICAL	Contact with the bloodstream or sterile tissues	Surgical instruments (e.g. scalpels)	**Sterilisation:** Destroys all forms of microbiological life
SEMI-CRITICAL	Contact with intact mucous membranes or non-intact skin	Endocavity ultrasound probes	**High-level Disinfection (HLD):** Destroys all microorganisms excluding high amounts of bacterial spores
NON-CRITICAL	Noncritical Contact with intact skin	Stethoscopes, blood pressure cuffs	**Low-level Disinfection (LLD):** Destroys most bacteria, some viruses and some fungi

TABLE 1. THE SPAULDING CLASSIFICATION. REPRODUCED FROM 'GUIDELINE FOR DISINFECTION AND STERILIZATION IN HEALTHCARE FACILITIES' (CDC, 2008)[10]

Transoesophageal Echocardiography (echo) is a procedure that utilises ultrasound waves to create two or three-dimensional pictures of the heart and surrounding blood vessels. The device used to achieve this is a transoesophageal echocardiography (TOE) probe.

OVERVIEW

Areas of cardiac muscle failing to contract adequately due to poor blood flow or injury from cardiac arrest can be detected by echo, as can potential blood clots inside the heart, fluid build-up in the pericardium and problems with the aorta; the main artery that carries oxygen-rich blood from the heart to the body. Clinicians may also use echo to diagnose heart and blood vessel diseases in adults and children. In addition, echo can be used to guide cardiac catheterisation, as a tool to prepare for surgery or assess a patient's status during or after surgery[1,2].

TOE PROBES

TOE probes are flexible, non-lumened ultrasound probes. Each device comprises a probe tip (which can be flexed up, down, right or left), probe shaft, probe handle with steering mechanisms, cable and plug socket (**Figure 1.**). The componentry of a TOE probe is identical regardless of the manufacturer.

Handling any part of the probe may act as a reservoir for contamination. For example, the steering controls are a high-touch area that the clinician manipulates to provide images of the cardiac muscle or blood vessels as required. Using gloves in which proteinaceous material is present (e.g. blood, sputum) can lead to the transference of soiling which may dry and provide an ideal environment for biofilm formation. The steering controls are not sealed and cannot be removed from the device. Similarly, the plug socket is not sealed and contamination or liquid ingress can cause damage to the delicate electronics[3].

RISKS OF INFECTION ASSOCIATED WITH THE USE OF TOE PROBES

Bacterial outbreaks of infection from the use of TOE probes in cardiac surgery have been reported in the literature. In one report, eight patients demonstrated clinical cultures positive of *Escherichia coli* in either sputum, blood or both one to four days after surgery. Cultures of samples from the TOE probe used in surgery [on these patients] were positive for *E. coli*. Deficiencies noted during the cleaning process included not visually inspecting the TOE probe before cleaning it, cleaning the TOE probe in close proximity to a waste sink and storing the TOE probe in a closed case on top of a refrigerator, where temperatures were routinely elevated. Visual inspection revealed cracks in the ring of the TOE probe and a small white fibre hanging loose from the edge. Once the damaged TOE probe was removed from use, no additional instances of *E. coli* were identified in cardiac surgery patients[4].

In another reported instance, a one-month outbreak of multidrug-resistant *Pseudomonas aeruginosa* (MDRP) was observed in all patients monitored with a TOE probe during cardiac surgery. The probe showed a defect five millimetres in diameter at the surface near the transducer, and the MDRP strain was traced to this defect. Removal of this probe from cardiac surgery resulted in no further MDRP positive cases in the subsequent eight years since the outbreak.[5]

Inadequacies in **(1)** the condition of the device used in cardiac surgery **(2)** decontamination processes (i.e. cleaning, disinfection) and **(3)** storage conditions enabled the harbouring of bacteria within the devices involved in the two aforementioned outbreaks.

Studies assessing microbial growth on areas of devices not inserted into the patient, such as the cord, have revealed gross contamination[6]. Microorganisms found include those of pathogenic potential such as *Acinetobacter lwoffi* – a commensal microorganism found on the skin but shown to cause ventilator-associated pneumonia and bloodstream infections. Cords may be draped over patients during procedures and therefore appropriate cleaning and disinfection is paramount to avoid transmission of microorganisms.

In 2012, the Medicines and Healthcare products Regulatory Agency (MHRA) issued a Medical Device Alert (MDA/2012/037) following a death of a patient from hepatitis B infection. The infection may have been associated with an inappropriately decontaminated TOE probe[7]. Following this alert, guidelines, such as the NHS Scotland Guidance for Decontamination of semi-critical ultrasound probes; semi-invasive and non-invasive ultrasound probes[8], have been updated making high-level disinfection (HLD) mandatory for semi-invasive probes such as TOE probes.

CONCLUDING REMARKS

TOE probes are delicate and expensive devices requiring a high level of attention and care to ensure an adequate use life for the healthcare facility. In addition, adhering to decontamination procedures is important not only for patient care but also to ensure that it is possible to prove that accurate decontamination has taken place and that a given TOE procedure is not at fault should a patient be subsequently found to have infection.

The Tristel Trio Wipes System is a validated method suitable for the manual decontamination of the whole TOE probe, removing the necessity of differing decontamination systems for each different part of the device. All parts of the TOE probe must be disinfected, including the cable and the plug. Automated methods are not always feasible and can only decontaminate parts of the device, which can be immersed. Tristel Trio Wipes System overcomes this issue and ensures every part of a TOE probe is high-level disinfected.

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TOE PROBE DECONTAMINATION GUIDELINES

TOE probes are classified as semi-critical medical devices. Upon entering the patient, they make contact with the intact mucous membrane of the oesophagus and therefore according to the Spaulding classification[9] (**Table 1.**), require high-level disinfection after use.

A TOE probe is heat-sensitive and therefore cannot withstand the standard techniques of sterilisation utilising heat and steam. Although gas sterilisation is possible, the high costs and long cycle times involved render this technique impractical for routine use.

Guidance on the decontamination of TOE probes aiming to negate the risk of iatrogenic infection is detailed in several guidelines.

BSE advocates two methods for disinfection: manual or automated. Manual cleaning elicits the use of a wipe or soaking within a bath. It is highlighted that particular care must be taken to ensure that disinfection is carried out not only to the probe tip and shaft but also to the handle, cable, and sections of the socket of the probe. Some endoscope washer disinfectors (EWDs) enable automated disinfection of TOE probes by allowing immersion of the probe shaft in fluids and protecting the probe handle and socket from fluid exposure. However, the non-exposed parts of the probe will still require manual decontamination[3]. This is mirrored in the 2019 Healthcare Infection Society[11] (HIS) guidelines which state: “Areas of the probe and its associated parts that make contact with an operator’s contaminated hand also require decontamination”. HIS further comment that manual disinfection methods to achieve decontamination of devices and their associated parts comply with essential quality requirements.

The NHS Scotland guidance for the decontamination of semi-critical ultrasound probes describes the use of four potential methods: ultraviolet (UV) light, hydrogen peroxide, manual multi-wipes (Tristel Trio Wipes System) or EWDs. The Health Service Executive Guidance[12] also mirrors the four recommended methods of NHS Scotland[8].

The following principles must be maintained in the decontamination process of a TOE probe[12]:

1. At the beginning of each day ensure all decontamination equipment is cleaned and disinfected using approved wipes. Test all equipment as required to ensure it is fit for purpose.
2. Remove all accessories and the sheath from the probe. Using a single use lint-free cloth/wipe, remove the ultrasound gel and dispose of the sheath and wipes in the appropriate waste stream. Dispose of any single use accessories (e.g. biopsy needle guide) into the appropriate waste stream.
3. Clean the probe with a compatible solution. Once cleaned, examine the probe for cleanliness, dryness, damage and functionality.
4. Disinfect the probe according to the method dictated by the health care facility.
5. Following disinfection, inspect the probe to ensure there are no signs of discoloration or cracks, giving particular attention to the probe tip.
6. Rinse water should be potable quality if manual cleaning/disinfection/rinsing is used or, if an automated method (EWD) is used, it should be within the limits specified by the relevant regulatory body.

TOE probe manufacturers have now also acknowledged the use of single-use sheaths for echo procedures to **(1)** protect the probe from the acidic environment inside the body and **(2)**, prevent microorganisms from attaching to and accumulating on the surface of the probe. The CDC recommends using probes covers to reduce microbial contamination[10]. However, the use of sheaths cannot replace HLD.

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