American Journal of Infection Control 46 (2018) 913-20

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Ultrasound probe use and reprocessing: Results from a national survey among U.S. infection preventionists

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Key Words:
Disinfection
Interventional ultrasound
Reprocessing
Probe
Endocavitary
Doppler
Ultrasound gel

Background: Improper infection prevention practice associated with ultrasound probe use has been linked to increased infection risk, outbreaks, and death. Although guidelines for reprocessing and use of probes exist, it is unclear how extensively these have been adopted in practice.

Methods: Infection preventionists from U.S. health care facilities were surveyed (N = 358). The anonymous survey had 31 multiple choice, sliding scale, and text response questions. The survey was developed and deployed and the data were stored in the REDCap system.

Results: A high degree of noncompliance with U.S. guidelines was identified. Surface probes used in invasive procedures were not high-level disinfected or sterilized 15% (intraoperative) to 78% (peripheral line placements) of the time. Of invasive procedures, 5%-47% did not use sterile gel (same procedures, respectively). Of the participants, 20% were aware of instances where an ultrasound probe was used but was not correctly reprocessed. Extensive breaches of infection control guidelines were reported. The rapid expansion in use of ultrasound has brought clinical benefit but may be exposing patients to preventable infection risk.

Conclusions: Infection preventionists are well placed to act as major drivers of change based on their expertise and experience in the management of infection risk across facilities and health systems. They, along with clinicians responsible for probe use and reprocessing, should review practices relating to ultrasound in their facilities. Where practice does not comply with guidelines, policy and training should be updated to ensure patient safety.

In recent years, ultrasound procedures have seen a rapid expansion throughout U.S. hospitals, outpatient ambulatory settings, and medical offices. This expansion carries with it documented infection risks that have been recognized worldwide. In 2016, The Joint Commission found that 74% of all immediate threats to life declarations were related to improperly sterilized or high-level disinfected equipment.[1] In 2017, the first study to investigate the risk of improper reprocessing at an epidemiologic level was published.[2] The retrospective study, undertaken by a department of the NHS Health Scotland, showed that patients undergoing a transvaginal scan were 41% more likely (hazard ratio [HR], 1.41) to have positive bacterial cultures and 26% (HR, 1.26) more likely to be prescribed antibiotics in the 30 days after ultrasound versus matched controls ($P < .001$). Similarly, patients undergoing transrectal scans were 3.4 times (HR, 3.4) and 75% (HR, 1.75) more likely to have positive cultures and be prescribed antibiotics, respectively. Compounding these findings are recent studies demonstrating glutaraldehyde and *ortho*-phthalaldehyde (OPA) are ineffective in inactivating human papillomavirus (HPV).[3,4] It has also been reported that >80% of probe handles are contaminated with pathogens, including methicillin-resistant *Staphylococcus aureus*, supporting the call for inclusion of the handle in reprocessing along with the probe body.[5,6]

Patient deaths have also been reported as a result of ultrasound probe contamination. In 2012, a patient death because of hepatitis B after an endocavitary examination with an improperly

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Funding/support: Nanosonics provided a grant to support researcher time (R.M.C.) spent during survey development, deployment, analysis, and manuscript development.

Conflicts of interest: None to report.

Author contributions: R.M.C. was responsible for design of the survey process, initial survey design and validation, development of the manuscript, and primary writing. C.E. was responsible for survey deployment and management of the survey process. S.F. and C.E. were responsible for survey design, analysis of survey results, critical review, and editing of the manuscript.

https://doi.org/10.1016/j.ajic.2018.03.025

reprocessed transesophageal ultrasound probe was reported.[7] Numerous outbreaks implicating contaminated ultrasound gel have also occurred, including cases where bacteremia and death resulted.[8,9] These outbreaks demonstrate the risks associated with surface ultrasound–guided procedures and suggest the probe and gel can contaminate the puncture site during imaging. Appropriate use of sterile gel and adequate ultrasound probe reprocessing play key roles in preventing these adverse events.

Globally, there has been a movement toward ultrasound-specific guidelines from Europe, the United Kingdom, and Australia in response to these recent findings and outbreaks.[10-14] In November 2017, in response to results from a practice survey, the European Society of Radiology Ultrasound Working Group published best practice recommendations regarding infection control in ultrasound use. These recommendations include a minimum of high-level disinfection (HLD) and use of a sterile sheath and gel for interventional ultrasound (eg, biopsies, injections, or any procedure where the skin is breached). In addition to HLD for endocavitary procedures, they strongly recommend the use of sterile gel inside and outside the cover.[15]

The United States has ultrasound-specific guidance from the Centers for Disease Control and Prevention (CDC) and the American Institute of Ultrasound in Medicine (AIUM), and the Association for the Advancement of Medical Instrumentation (AAMI) has developed an American National Standard ST58 on the HLD and sterilization of reusable medical devices.[16-18] The recent highly publicized outbreaks associated with flexible endoscopes and endoscopic retrograde cholangiopancreatography are timely examples of the consequences of reprocessing failures.[19-22] It is important to investigate and understand ultrasound use practices, associated patient safety risks, and the gap that is present between existing practice and best practice, as defined in U.S. guidelines and standards.

A cursory review of practice among a small group of U.S. infection preventionists (IPs) was done in late 2016, and concerns were identified regarding the increasing use of ultrasound technology and the associated practices that ensure their safe use for patient care.[23] To better understand existing practices and the gaps that may exist, a larger survey was undertaken. The objectives of the larger survey were (1) to define the current state of ultrasound use in U.S. health care facilities, (2) to identify existing practices regarding decontamination and disinfection of the ultrasound probes, and (3) to identify practices that serve to prevent infection transmission to patients across the spectrum of procedures that depend on the use of ultrasound probes.

METHODS

A survey was developed, pilot tested, and revised with the intent to deploy in an electronic format to U.S. IPs practicing in a variety of health care settings. The project was reviewed by the University of Louisville Institutional Review Board and was deemed exempt. A standardized e-mail message was crafted containing a link to the survey and a short video describing the intent of the survey and a brief background of the problem. The survey consisted of 31 questions and was deployed using a Web-based e-mail service. The REDCap system was selected as the survey development, deployment, and data storage platform.[24] Survey questions included multiple choice response options and sliding scale response options for questions involving perceptions and confidence. Anonymity was ensured by procedures that prevented retention or tracking of any e-mail address or respondent information. Within the survey, there was a link to a Portable Document Format file containing all survey questions and response options. This was provided so respondents could observe and investigate existing practices prior to completing the survey. E-mails were sent in August 2017 with the survey link and a video link along with information about the intent of the survey. Three additional e-mail reminders were sent at regular intervals. The survey closed 8 weeks after the initial deployment in October 2017.

Data analysis was performed by personnel in the University of Louisville Data Coordinating Center. Descriptive statistics were reported with frequency and percentage for categorical data. Medians and interquartile ranges (IQRs) were reported for continuous data.

RESULTS

Respondent demographics

A total of 12,937 IPs were sent the survey link with 358 surveys completed for a response rate of 2.8%. The response rate and sample size are similar to ultrasound surveys from Australia/New Zealand and Europe.[25,26] Most IPs worked in a hospital setting (59.5%). The remaining respondents were from long-term care, long-term acute care, outpatient clinics, or ambulatory surgery centers (<10% each). Each facility had a median of 1 (IQR, 2; minimum, 0; maximum, 34) full- or part-time IP and a median of 1 (IQR, 2; minimum, 0; maximum, 31) full- or part-time certified IP.

Ultrasound and Doppler probe use throughout health care facilities

Figure 1 shows the wide range of ultrasound use in the respondents' facilities.

Radiology, obstetrics/gynecology/maternal fetal medicine, the emergency department, and the operating room had the highest rates of ultrasound usage. The departments where there was highest uncertainty about ultrasound usage were physical therapy, neurology, oncology, and anesthesiology.

Use of ultrasound probes, probe covers, and ultrasound gel in procedures

Respondents were asked about ultrasound use and reprocessing in specific procedures. If the procedure was performed, the respondent was asked about ultrasound probe reprocessing (Fig 2 and Table 1), use of sheaths or covers (Table 1), and type of ultrasound gel used (Table 2). Current ultrasound use and reprocessing guidelines have been published by both the CDC and the AIUM.[16,17] Additionally, AAMI has developed an American National Standard on the requirements for sterilization and HLD of reusable medical devices in health care facilities.[18] These recommendations are summarized in Figure 2A. Answers compliant with the recommendations appear in Figure 2B (probe reprocessing) and are indicated in Table 1 (probe reprocessing and sheath use) and Table 2 (gel use). Respondents who did not have the procedure at their facility or were unsure were excluded from subsequent reprocessing and use questions. Of respondents, 37% were unsure about injections (ultrasound-guided delivery of drugs/therapeutics to tissue or bloodstream, such as nerve blocks and intra-articular injections), 29% were unsure about scans across nonintact skin (ultrasound probe across nonintact skin, such as burn, skin breakdown, and partially healed wound), 22% were unsure about intraoperative scans (eg, surgical procedure, contact with sterile body cavity or sterile tissue), 20% were unsure about tissue sampling (ultrasound-guided tissue sampling procedure, such as biopsies), 7% were unsure about peripherally inserted lines (ultrasound-guided peripheral line placement), 2% were unsure about central venous catheter (CVC) placement (ultrasound-guided central line placement), 2% were unsure about intact skin (ultrasound probe across intact skin, such as fetal heart tone, pulse check, and transabdominal scan), and 1% were unsure about endocavitary scans (eg, contact with mucous membranes; rectal, vaginal, or esophageal use).

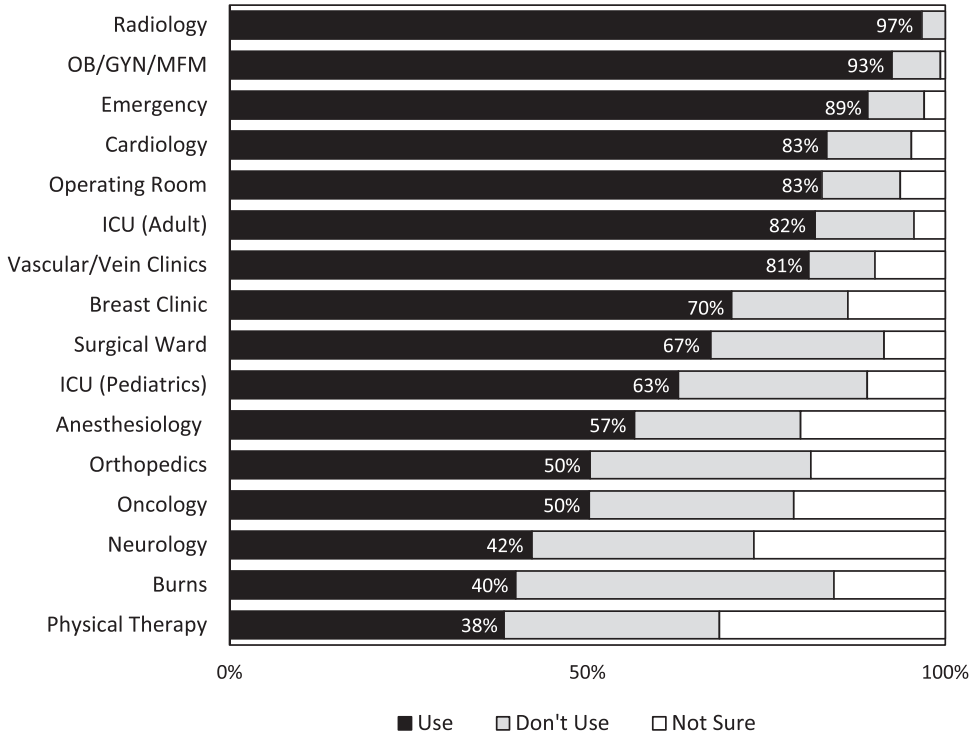

Fig 1. Ultrasound and Doppler probe use throughout health care facilities. Respondents with the department in their facility indicated whether ultrasound and Doppler probes were used. Data are ordered from most to least reported usage (radiology: n = 335; OB/GYN/MFM: n = 296; emergency: n = 305; cardiology: n = 254; operating room: n = 319; ICU [adult]: n = 275; vascular/vein clinics: n = 173; breast clinic: n = 191; surgical unit: n = 281; ICU [pediatrics]: n = 110; anesthesiology: n = 297; orthopedics: n = 266; oncology: n = 203; neurology: n = 187; burns: n = 45; physical therapy: n = 206). *ICU*, intensive care unit; *OB/GYN/MFM*, obstetrics/gynecology/maternal fetal medicine.

Summary of ultrasound infection control policies

Current CDC, AIUM, and AAMI recommendations were used to determine compliant responses to survey questions regarding policy (Table 3). Questions covered ultrasound probe reprocessing, policies and procedures, storage, training, preferences for automation and standardization, and whether current policies need updating.

Use of HLD methods

Where HLD was performed, survey respondents were asked to select the HLD method used. Of the respondents, 52% used an automated sonicated hydrogen peroxide mist device, 21% used an OPA soak, 11% used an accelerated hydrogen peroxide soak, 5% used a glutaraldehyde soak, 2% used an automated soaking device, and 9% used other methods. Other methods consisted of a range of responses similar to "not sure" and "we do not perform HLD" and products including sprays and wipes.

Known reprocessing failures and infections from ultrasound procedures

Of respondents, 2.5% were aware of situations where an ultrasound probe may have been implicated or involved in an infection. These included cases of dermal infections, infections from ultrasound-guided breast biopsy, vascular infection, and pelvic inflammation. Of respondents, 20% reported they were aware of instances where an ultrasound probe was used but was not correctly reprocessed. There were approximately 3 times more reports of instances involving semi-critical endocavitary probes than semi-critical/critical surface probes in this case. Most reported failures were reportedly in obstetrics-gynecology or emergency departments followed by urology, operating rooms, hepatology, or radiology. Other common reprocessing failures were attributed to noncompliance with the disinfectant manufacturer instructions for use, failure to document reprocessing, improper storage, and failures in probe transport during or after reprocessing.

Respondent confidence related to aspects of ultrasound and Doppler probe use and reprocessing

Respondents were asked to rate their confidence regarding various aspects of ultrasound probe use and reprocessing. Respondents were 95% confident (median) they knew all the locations (ie, departments) where ultrasound and Doppler probe procedures are performed at their facility (IQR, 19%); 75.5% were confident they knew the identity of all the staff involved in ultrasound and Doppler probe use and reprocessing at their facility (IQR, 45%); 80% were confident they knew the types of procedures for which ultrasound and Doppler probes are used within their facility (IQR, 36%); 81% were confident they could respond to surveyor questions regarding reprocessing practices at their facility (IQR, 30%); and 78% were confident that the reprocessing policies for ultrasound and Doppler probes in their facility are followed (IQR, 40%).

DISCUSSION

These results represent the first nationwide survey describing ultrasound probe use, reprocessing, and disinfection practices in U.S. health care facilities from the perspective of the facility IP. The reported broad use of ultrasound within settings made a compelling case for identifying existing practice gaps so that movement can be made toward ideal practice (Fig 1).

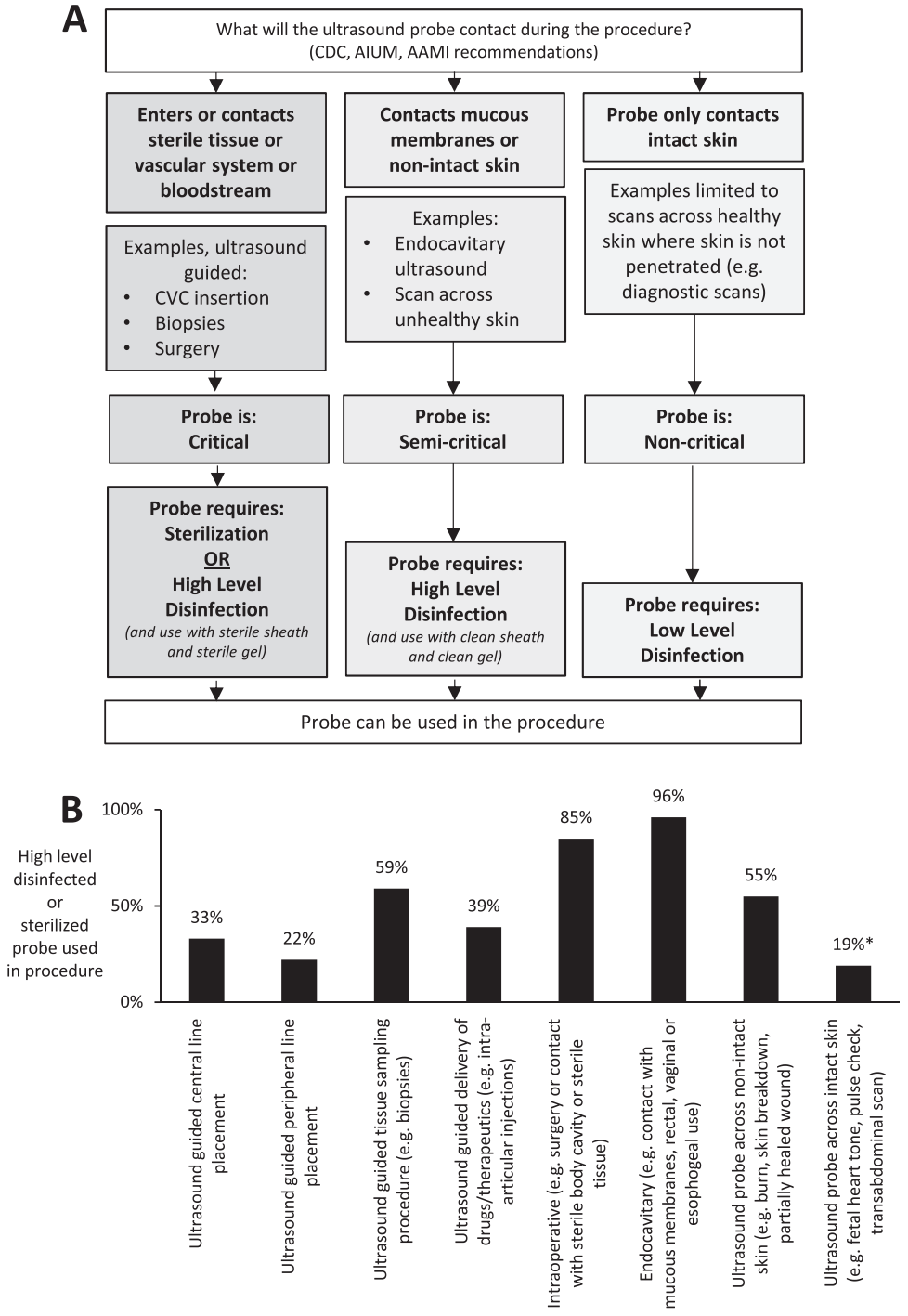

Fig 2. Ultrasound probe reprocessing compliance. (A) Algorithm summarizing CDC, AIUM, and AAMI reprocessing and use recommendations. The CDC defines nonintact skin as areas of the skin that have been opened by cuts, abrasions, dermatitis, chapped skin, and so forth. (B) Probe reprocessing compliance with CDC, AIUM, and AAMI recommendations for probe reprocessing level. Data expressed as a percentage of those who indicated the procedure was done at their facility (see Tables 1 and 2 for total respondents by procedure). For all procedures, a minimum of high-level disinfection ensures compliance. The exception is ultrasound probe across intact skin where all answers are compliant because the probe is noncritical (denoted with *). *AAMI*, Association for the Advancement of Medical Instrumentation; *AIUM*, American Institute of Ultrasound in Medicine; *CDC*, Centers for Disease Control and Prevention; *CVC*, central venous catheter.

There was obvious discordance between reported practices and recommendations from the CDC, AIUM, and AAMI. When analyzing responses, all 3 sources were interpreted and their recommendations summarized (Fig 2A). Although it is important to note that these guidelines and standards vary slightly in their language around recommendations, they recommend that critical probes (those that enter or contact sterile tissue or the vascular system or bloodstream) should undergo sterilization, or at a minimum HLD, and be used with a sterile sheath. Sterile single-use gel is also recommended. Probes that are used in a sterile field are subject to these stringent requirements. This is interpreted to include probes used in interventional procedures such as CVC insertions, peripherally inserted lines, needle guidance in biopsies and injections, and intraoperative scans. All items in the sterile field, in-

Table 1
Use of ultrasound probes and covers in ultrasound procedures when respondents were certain their facility performed the procedure

Procedure	Ultrasound-guided CVC insertion (n = 277)								
Probe status	Sterile (n = 6; 2%)*			HLD (n= 85; 31%)*			LLD or ILD (n = 186; 67%)		
Probe cover type	Sterile*	Clean	None*	Sterile*	Clean	None	Sterile	Clean	None
Total	6 (2%)	0 (0%)	0 (0%)	69 (25%)	11 (4%)	5 (2%)	146 (53%)	15 (5%)	25 (9%)
Procedure	Ultrasound-guided peripheral line placement (n = 208)								
Probe status	Sterile (n = 2; 1%)*			HLD (n = 43; 21%)*			LLD or ILD (n = 163; 78%)		
Probe cover type	Sterile*	Clean	None*	Sterile*	Clean	None	Sterile	Clean	None
Total	2 (1%)	0 (0%)	0 (0%)	29 (14%)	8 (4%)	6 (3%)	76 (37%)	29 (14%)	58 (28%)
Procedure	Scan, intact skin (n = 338)								
Probe status	Sterile (n = 2; 1%)*			HLD (n = 61; 18%)*			LLD or ILD (n = 275; 81%)*		
Probe cover type	Sterile*	Clean*	None*	Sterile*	Clean*	None*	Sterile*	Clean*	None*
Total	0 (0%)	1 (0%)	1 (0%)	15 (4%)	23 (7%)	23 (7%)	19 (6%)	66 (20%)	190 (56%)
Procedure	Scan, nonintact skin (n = 109)								
Probe status	Sterile (n = 5; 5%)*			HLD (n = 55; 50%)*			LLD or ILD (n = 49; 45%)		
Probe cover type	Sterile*	Clean*	None*	Sterile*	Clean*	None	Sterile	Clean	None
Total	3 (3%)	2 (2%)*	0 (0%)	40 (37%)	8 (7%)	7 (6%)	24 (22%)	11 (10%)	14 (13%)
Procedure	Endocavitary scan (n = 323)								
Probe status	Sterile (n = 17; 5%)*			HLD (n = 295; 91%)*			LLD or ILD (n = 11; 3%)		
Probe cover type	Sterile*	Clean*	None*	Sterile*	Clean*	None	Sterile	Clean	None
Total	12 (4%)	4 (1%)	1 (0%)	168 (52%)	117 (36%)	10 (3%)	5 (2%)	6 (2%)	0 (0%)
Procedure	Intraoperative scan (n = 159)								
Probe status	Sterile (n = 52; 33%)*			HLD (n = 83; 52%)*			LLD or ILD (n = 24; 15%)		
Probe cover type	Sterile*	Clean	None*	Sterile*	Clean	None	Sterile	Clean	None
Total	49 (31%)	1 (1%)	2 (1%)	79 (50%)	0 (0%)	4 (3%)	21 (13%)	2 (1%)	1 (1%)
Procedure	Ultrasound-guided tissue sampling (n = 196)								
Probe status	Sterile (n = 25; 13%)*			HLD (n = 90; 46%)*			LLD or ILD (n = 81; 41%)		
Probe cover type	Sterile*	Clean	None*	Sterile*	Clean	None	Sterile	Clean	None
Total	22 (11%)	1 (1%)	2 (1%)	75 (38%)	12 (6%)	3 (2%)	53 (27%)	12 (6%)	16 (8%)
Procedure	Ultrasound-guided therapeutic delivery (n = 101)								
Probe status	Sterile (n = 4; 4%)*			HLD (n = 35; 35%)*			LLD or ILD (62; n = 61%)		
Probe cover type	Sterile*	Clean	None*	Sterile*	Clean	None	Sterile	Clean	None
Total	4 (4%)	0 (0%)	0 (0%)	31 (31%)	2 (2%)	2 (2%)	34 (34%)	12 (12%)	16 (16%)

NOTE. Values are n or as otherwise indicated.
CVC, central venous catheter; *HLD*, high-level disinfection; *ILD*, intermediate-level disinfection; *LLD*, low-level disinfection.
*Indicates compliance with the Centers for Disease Control and Prevention, the American Institute of Ultrasound in Medicine, and the Association for the Advancement of Medical Instrumentation.

cluding the probe, gel, and sheaths and covers, should be sterile. For ultrasound use, the probe should minimally undergo HLD and sterile sheath-cover and gel used according to guidelines.

Ultrasound use during CVC insertions and peripherally inserted lines demonstrated high noncompliance because respondents reported most probes undergo low-level disinfection (LLD) or intermediate-level disinfection (ILD) (Fig 2B and Table 1). Recently reported outbreaks resulted in patient death and bacteremia associated with contaminated gel used during CVC placements.[8,9] These studies described pathogen transmission during ultrasound procedures, and demonstrate that the probe contacts the puncture site because typically gel is moved around by the probe to visualize the anatomy. Because probe sheaths break (reviewed in the CDC guidelines) and may become contaminated during application to the probe, the probe still needs a minimum of HLD before use in these procedures.[16] The high rates of sterile cover use in these procedures (where most probes undergo LLD/ILD) may indicate an overreliance on the probe sheath as a protective barrier (contradicting CDC and AIUM recommendations) or may suggest a lack of knowledge about the guidelines (Table 1). These responses could also reflect practice by experienced clinicians and teams specialized in inserting peripheral lines, where the needle passes the probe underneath the skin and the probe does not contact the puncture site. However, it is important to note that inadvertent probe or needle movement could result in cross-contamination of the puncture site, particularly if there are less experienced practitioners performing these insertions. Policy and practice should address all possible outcomes resulting from the range of staff performing vascular access procedures. Part of this is the likelihood of contact with the vascular system in light of techniques and teams involved at each facility. According to Scottish and Irish guidelines, probes used for vascular access (venepuncture) require HLD.[10,11]

Other procedures were described where probes used in a sterile field were inappropriately reprocessed using LLD or ILD. These included tissue sampling (eg, biopsies), therapeutic delivery (eg, intra-articular injections), and intraoperative scans (eg, surgery). High rates of sterile cover use coupled with these inappropriate use cases may suggest an overreliance on the probe sheath or lack of understanding of guidelines. In some cases, critical probes that had been sterilized were used with a clean sheath or cover, which could enable contamination of a sterile device. If the probe is sterilized, no sheath or cover would be required; however, if used, it should be sterile. There is a recognition that sterile gel should be used in procedures with a sterile field; however, the notable rates of multiuse gel bottles is concerning, presenting a potential pathogen transmission opportunity (Table 2). Gel, when used in a sterile field, should be sterile single use.[15,17]

The CDC, AIUM, and AAMI recommend semi-critical probes (that contact mucous membranes or nonintact skin) undergo HLD and be used with a sterile or clean sheath and sterile or clean single-use gel. For semi-critical probes, there was generally good compliance in endocavitary procedures (96% used HLD or sterilization).

Table 2
Use of ultrasound gel in ultrasound procedures when respondents were certain their facility performed the procedure

Procedure	Ultrasound-guided CVC insertion (n = 277)		
Gel status Total	Sterile single use* 207 (75%)	Clean single use 26 (9%)	Multiuse 44 (16%)
Procedure	Ultrasound-guided peripheral line placement (n = 208)		
Gel status Total	Sterile single use* 109 (52%)	Clean single use 34 (16%)	Multiuse 65 (31%)
Procedure	Scan, intact skin (n = 338)		
Gel status Total	Sterile single use* 56 (17%)	Clean single use* 58 (17%)	Multiuse* 224 (66%)
Procedure	Scan, nonintact skin (n = 109)		
Gel status Total	Sterile single use* 71 (65%)	Clean single use* 10 (9%)	Multiuse 28 (26%)
Procedure	Endocavitary scan (n = 323)		
Gel status Total	Sterile single use* 183 (57%)	Clean single use* 53 (16%)	Multiuse 87 (27%)
Procedure	Intraoperative scan (n = 159)		
Gel status Total	Sterile single use* 152 (96%)	Clean single use 3 (2%)	Multiuse 4 (3%)
Procedure	Ultrasound-guided tissue sampling (n = 196)		
Gel status Total	Sterile single use* 157 (80%)	Clean single use 12 (6%)	Multiuse 27 (15%)
Procedure	Ultrasound-guided therapeutic delivery (n = 101)		
Gel status Total	Sterile single use* 72 (71%)	Clean single use 9 (9%)	Multiuse 20 (20%)

NOTE. Values are n or as otherwise indicated.
CVC, central venous catheter.
*Indicates compliance with the Centers for Disease Control and Prevention, the American Institute of Ultrasound in Medicine, and the Association for the Advancement of Medical Instrumentation.

Table 3
Summary of ultrasound probe use and reprocessing policies

Compliance with guidelines (multiple choice questions)	Yes (compliant)	No
Policy can identify a semi-critical ultrasound probe.	193 (54%)	165 (46%)
Policy does not allow use of a low-level disinfected probe if a sterile probe cover is used in a semi-critical procedure.	208 (58%)	150 (42%)*
Policy allows the HLD exception for critical probes, where the critical probe can undergo HLD when used with a sterile cover and sterile gel.	143 (40%)	215 (60%)†
Policy instructs user to ensure a high-level disinfected probe is used for scans on nonintact skin, when a patient unexpectedly presents with nonintact skin.	222 (62%)	136 (38%)
Policy assigns timing and responsibility to determining disinfection-sterilization level of probe for a procedure.	233 (65%)	125 (35%)‡
Questions on policy	**Yes**	**No**
Do you have standard operating procedures for all procedures that use ultrasound and Doppler in your facility?	259 (72%)	99 (28%)
Are high-level disinfected probes labeled to distinguish them from other probes in storage?	224 (63%)	134 (37%)
Are all staff trained at the time of hire?	313 (87%)	45 (13%)
Are all staff retrained or assessed annually?	271 (76%)	87 (24%)
Preferences for policy	**Yes**	**No**
Would you prefer to standardize the products and processes for reprocessing ultrasound probes facility-wide?	330 (92%)	28 (8%)
Would you prefer to use automated processes for probe reprocessing?	326 (91%)	32 (9%)
Do you think your policy needs updating?	235 (66%)	123 (34%)

NOTE. Values are n or as otherwise indicated.
HLD, high-level disinfection.
*29% indicated not covered in policy.
†42% indicated not covered in policy.
‡35% indicated not covered in policy.

Respondents reported the use of HLD plus a sterile or clean cover. However, there were high rates of multiuse gel used for endocavitary procedures (27%). Multiuse gel is generally not recommended because it can become contaminated and become a vehicle for pathogen transmission. The use of multiuse gel inside a sheath is questionable because condoms and sheaths regularly break.[16]

Respondents reported high noncompliance with procedures involving ultrasound use on nonintact skin. Of the respondents, 45% reported that these probes should undergo ILD or LLD, despite this use meeting the definition of a semi-critical device according to the Spaulding classification.[27] This may reflect confusion with the definition of nonintact skin, or lack of recognition that probes on nonintact skin are semi-critical devices. For intact skin, all response options were correct because the probe is noncritical and guidelines recommend LLD. Interestingly, 18% of respondents were high level disinfecting these probes. Universal HLD policies (where all ultrasound probes undergo HLD) would be beneficial because the probe is ready for any procedure, where the probe could be available for critical, semi-critical, or noncritical use.

In most of the responses, it is clear that existing policies need to be amended to capture current guideline recommendations. Many respondents had policies that did not reflect ultrasound probe–specific reprocessing requirements noted in the CDC guidelines (Table 3). For example, 60% could not identify that critical probes can undergo HLD if used with sterile sheath or gel. Not recognizing these nuances can make reprocessing time-consuming, difficult, and inconsistent. Automation and standardization was preferred by most respondents (Table 3). These approaches make it easier to remove human error and enable consistent decision-making. Therefore, movement toward automation and standardized processes enables consistent and reliable practices. This is particularly important when ultrasound use is occurring in multiple locations and likely by varied individuals who are involved in the procedure and handling of the equipment.[28] Standardizing practices, such as labeling of probes in storage while awaiting use, could enable staff to distinguish between levels of disinfection used and prevent inadvertent use of incorrectly disinfected items. Facilitating consistent practices that are adherent with these evidence-based practices requires training and retraining.

Recently, information has been published regarding the lack of efficacy of OPA and glutaraldehyde against HPV.[3,4] A significant number of respondents reportedly used these disinfectants for endocavitary probe reprocessing after transvaginal scans where the probe directly contacts mucous membranes, where HPV is commonly present. Reprocessing transvaginal probes with low-level disinfectants has been shown to significantly increase the risk of positive bacterial cultures (HR, 1.41) and the prescription of antibiotics (HR, 1.26) in the 30 days after the ultrasound procedure ($P < .001$).[2] Wipes and sprays formed part of the other HLD practices, which is also concerning. The wipe and spray products listed by the responding IPs are not Food and Drug Administration approved as high-level disinfectants and should not be used for HLD purposes. Failure to properly high-level disinfect endocavitary probes can have serious patient safety consequences.

Most reported reprocessing failures and subsequent probe use involved endocavitary probes. Interestingly, when respondents were

asked for examples of infections where the ultrasound probe was known to be implicated or involved, the cases most likely involved the use of surface probes used in a sterile field during interventional procedures (infection after breast biopsy, vascular infections). In fact, a recent survey from the European Society for Radiology reported a similar rate of known cases of infection transmission during ultrasound procedures (2.7%). These rates may be understated because, unlike endocavitary procedures, many respondents were unsure if departments used ultrasound and whether procedures with critical surface probes were performed at their facility. Additionally, these cases are not reflective of practice in private clinics and medical office buildings because most respondents were from hospitals. The CDC, AIUM, and global guidelines all recognize the importance of minimally high-level disinfecting or sterilizing critical probes and using them with sterile sheath or sterile gel.[10-16]

There are several limitations to this study. First, the calculated response rate may be understated because of individuals included in the denominator who were not working in an IP role for which the survey was applicable (eg, public health, independent consultant, industry, academia). Additionally, some individuals may not have received the electronic survey because of institutional firewalls or filters. Second, most responses reflect practices occurring in hospital settings and may not be generalizable to the broader health care environment where ultrasound use is reportedly occurring. Third, the responses were gathered from the infection prevention professionals and not from others who may have knowledge of practices, such as sonographers or central sterile and reprocessing staff. Finally, the practical application of the current guidelines to vascular access can be considered based on the range of clinicians performing the procedures and their experience. The numerous outbreaks from central line insertions with contaminated ultrasound gel, including cases where bacteremia and death resulted, strongly support adherence to the existing guidelines.[8,9]

Notably, there did not appear to be concordance between overall respondent confidence and knowledge about specific procedures, policies, and infection prevention and control practices. Responding IPs were highly confident in their knowledge regarding locations of ultrasound use, procedures using ultrasound, and their ability to respond to surveyor questions. They were also confident in their ability to identify staff responsible for ultrasound reprocessing and that they were following facility policy. However, the data gathered suggest the reality of practice is less clear. For example, respondents were very confident about procedures performed but when asked about specific procedures and departments that use ultrasound, the “not sure” responses were high. This discordance suggests that there are ultrasound procedures being used that are either not obvious or visible, particularly interventional procedures that involve critical use devices. This lack of knowledge regarding practice also highlights the importance of training and retraining, and investigation of vascular access areas that may involve the use of specialized teams.

CONCLUSIONS

The survey confirms the expansion of ultrasound to most hospital departments. Importantly, it reveals a wide range of probe use and reprocessing practice and significant noncompliance with guidelines despite high confidence from respondents. Documented infections from the literature and the recent wave in global ultrasound reprocessing guidelines underscore the urgent need to review policies and practice to ensure best practice for patient safety.

IPs are well placed to act as major drivers of change based on their expertise and experience in the management of infection risk across facilities and health systems. When new evidence emerges, infection prevention will typically (1) bring the new evidence forward to the infection control committee and to those responsible for overseeing patient safety; (2) collaborate with relevant frontline teams to review practice and initiate change in processes, if necessary; and (3) engage senior leaders and champions as appropriate. In this case, infection prevention would work with reprocessing counterparts, ultrasound department managers, and frontline teams.

A thorough approach to ensuring that probes are safe for patient use would include identifying the locations of ultrasound machines and probe usage and surveying reprocessing practices by department and procedure. Once practice has been profiled, it should be compared with existing guidelines and where there are inconsistencies, policy should be updated and staff retrained to ensure best practice. As the evidence from this study indicates, particular attention should be focused on the reprocessing of critical and semi-critical surface ultrasound probes and the appropriate use of sterile covers and gel. Familiarity and compliance with evolving best practice recommendations for the reprocessing of ultrasound probes will ensure that the growing number of patients undergoing these procedures are not exposed to preventative risk of transmission from improperly reprocessed equipment.

Acknowledgments

We thank Sue Barnes, RN, BSN, CIC, FAPIC, Roy Boukidjian, MSN, PHN, CIC, Robert Garcia, BS, MT, FAPIC, Sylvia Garcia-Houchins, RN, MBA, CIC, Amy Nichols, RN, MBA, CIC, FAPIC, Russell N. Olmsted, MPH, CIC, FAPIC, and John Whelan, BSN, RN, for reviewing the survey instrument and manuscript.

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