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Can ultrasound probes and gels be the source for opportunistic bacterial infections?

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Abstract

The aim of this study was to investigate the contaminant microorganisms on the surface of probes used in noninvasive ultrasound examination and in the gels. Culture samples were obtained from the convex abdominal probe at the beginning of the day and after use on every five patients. Cultures were taken from linear breast probe at the beginning of the day and after use one very two patients. All samples were taken after wiping with a dry tissue paper until no visible gel remained on the probes. Furthermore, the samples were taken from gels when the gel was first opened, at the end of the day and 24 hours after opening. A total of 76 samples from 25 breast probes, 33 abdominal probes and 18 gels were included. Bacteria was detected in 20 (80%) of 25 linear probe samples. Coagulase negative staphylococci (CNS) were detected in 19 (76%), Burkholderia cepacia and Staphylococcus aureus in two (8%), Cupriavidus pauculus and Stenotrophomonas maltophilia in one (%4). Bacterial growth was detected in 23 of 33 (69.7%) abdominal probes. aureus and S.maltophilia were isolated in 2 samples, most of which were CNS (n:20; 60.6%). The bacterial growth rate of all probes was 74.13% (43/58). Bacteria was detected in 2 of 18 gel samples (16.66%), two of which were CNS and one of them was S.maltophilia. Although more skin flora bacteria were detected in noninvasive probes and gels, a small number of pathogenic bacteria were also found in our study. Proper disinfection of the noninvasive probes and proper use of gels is therefore necessary. We believe that wiping with nonsterile dry tissue paper after each procedure is insufficient for disinfection of the probe surface. Disinfection and gel usage guidelines should be determined for ultrasound units both in our hospital and in our country.

Keywords: Ultrasound probes, ultrasound gels, bacteria, contamination

Introduction

All equipment used for the ultrasound examination (probes, keyboard, probe holder, cables, ultrasound gel, etc.) due to the nature of the process is in constant contact with patients, have a risk of colonization with various microorganisms. Survival times on dry inert surfaces of pathogen bacteria and fungus such as Candida can be several months or longer, and that of viruses such as several weeks [1]. There is a risk of bacterial transmission from contaminated ultrasound probes and gels to immunosuppressed cases, diabetic patients, infants, and patients with open wounds. As far as we can reach, the first report about cross-infection of ultrasound equipment was published in 1988 [2].

Worldwide, there are numerous studies reporting that ultrasound probes and gels are contaminated with various bacteria such pathogens or normal skin bacteria and that outbreak occur with these contaminant bacteria. These studies will be compared in detail in the discussion section. However, the number of these studies is limited in our country.

In this study, we aimed to investigate the contaminant microorganisms on the convex and linear probes which used for abdominal and breast ultrasound examination and in the gels.

Materials and Methods

Ethical approval for this prospective study was obtained from Local Ethical Authority. The study was conducted in an education and research hospital in radiology outpatient clinic. No ultrasound was performed to inpatients during the study. Samples were taken with sterile cotton swab (RTA, Kocaeli, Turkey) from the scanning surface of probes used in outpatients who admitted to the radiology unit for abdominal or breast scan using the swab streaking method described by Koibuchi et al [3]. Probes used in patients of all ages and both sexes were included in the study. During the days of the study, ultrasound probes were not used in patients with open wounds and known contagious diseases. Only probes used in one machine used by a specialist were included in the study.

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Culture samples were obtained from the convex abdominal probe at the beginning of the day and after use on every five patients and at the end of the day. Other culture samples were taken from linear superficial probe used for breast ultrasound at the beginning of the day and after use one very two patients and at the end of the day. All samples were taken after wiping with a dry tissue paper until no visible gel remained on the probes. Furthermore, the culture sample was taken from gels when the gel was first opened and at the end of the day. Every day a new gel bottle was opened for use. The gel used was nonsterile. A drop of sample was squeezed from the bottle onto the swab without touching the tip of the bottle. This gel was allowed to stand at room temperature until next morning and then another culture sample was taken. All culture procedures were continued for 6 days during routine ultrasound examination. All swabs were inserted in Stuart's transport medium and were sent to the Microbiology laboratory.

Culturs were inoculated to blood agar (RTA, Kocaeli, Turkey) and Eosin methylene blue agar (RTA, Kocaeli, Turkey) and evaluated after 48 hours at 350C incubation. Conventional methods (catalase, coagulase, Gram stain etc.) and automated identification device (Phoenix, BD, France) was used for identification of bacteria.

Results

Ultrasound examination was performed in 173 patients (128 females, 45 male) from 4 months to 90 years of age for six days. A total of 76 culture samples from 25 breast probes, 33 abdominal probes and 18 gels were included in the study. The number of bacterial growths in each culture uptake step was shown in table 1.

Bacterial contamination was detected in 20 (80%) of 25 linear probe samples. Coagulase negative staphylococci (CNS) was detected in 19 (76%), Burkholderia cepacia and Staphylococcus aureus in two (8%), Cupriavidus pauculus and Stenotrophomonas maltophilia in one (%4). Two different bacterial species were observed in four samples. Bacterial growth was detected in 23 of 33 (69.7%) abdominal probes. aureus and S.maltophilia were isolated in 2 samples, most of which were CNS (n:20; 60.6%). When all probe samples were considered, the bacterial growth rate was 74.13% (43/58) (Table 1).

Bacterial growth was detected in 2 of 18 gel samples (16.66%), two of which were CNS and one of them was S.maltophilia (Table 1).

Discussion

Our hospital is a tertiary care hospital where many ultrasound examinations are performed. It has been known for the last 2 to 3 decades that ultrasound equipment and gels may be contaminated with various bacteria and may present a risk of contamination to patients [2,4]. It has been found that even more bacteria are present on the surface of the probes than bus poles and toilet seats [5]. In our study, the rate of bacterial contamination was very high (%74) in the cultures taken from probe surfaces. Most of the isolated bacteria are CNS (67.24%) found in the normal skin flora. In addition, pathogenic bacteria such as B.cepacia, S.aureus, C.pauculus and S.maltophilia were isolated from a small number of probes. According to our results %74 probe bacterial contamination rate of probes suggest that approximately 3 in every 4 patients can potentially be infected with these bacteria and can develop infection if she or he is an immunocompromised person.

In studies similar to our study, it has been reported that probe surfaces are most often contaminated with skin flora bacteria such as CNS, Micrococci or Diphteroids [6-12]. Adding anaerobic culture methods to their studies, Ejtehadi et al. found the most common Peptostreptococci as anaerobe contaminants [13]. In some of these studies, a small number of bacterial contamination with S.aureus [6, 8, 9, 12), Pseodomonas spp. [7,8], Acinetobacter spp [7,9), Bacillus spp. [6,11] other gram negative bacilli [7] or Enterococci [9] were also reported on the surface of the probes. In our study, pathogen bacterial contamination rate was approximately 33%.

In our study a bacterial growth rate of approximately 16% was found in gels. It is known that ultrasound gel-related outbreaks of S.aureus and Klebsiella pneumoniae in neonates and pregnant women [4,14]. Mattar et al. and Skownorek et al. reported that 23% and 57% respectively of the gels contaminated with various bacteria such as S.aureus, Enterococcus faecalis, Staphylococcus epidermidis, Bacillus spp [7,11]. In another studies; S.aureus, Acinetobacter spp, S.maltophilia and CNS growth was detected in the gels [9,12]. In gels, substances such as paraben esters are generally used as preservatives and antimicrobial. Gels used in our hospital contain isothiazoline and propylene glycol as preservatives. Considering our growth rate and CNS growth in unopened gel sample, these substances are ineffective or not enough. Commercially available gels do not inhibit bacterial growth [15]. Unfortunately, there are still reports of outbreaks with gels in which only preservatives are used [16,17]. There are some recommendations for the use of sterile and non-sterile gels, but there are no guidelines in our country. In general, it is recommended to use daily disposable bottles and to prevent contact of the tips of the gel bottles with the patient's skin [18-20].

Various cleaning and disinfection or sterilization guidelines for medical equipment have been recommended to prevent infections. The oldest known disinfection and sterilization guideline is the Spaulding classification [21]. Ultrasound probes used on the intact skin of the patient are defined as noncritical devices. Noncritical devices must be cleaned of debris (toweling, soap and water), then low level disinfection should be done with proper product such spray or wipes. This requirement is addressed in many guidelines [20,22-24]. In our country, this disinfection method of noncritical devices is mentioned in the guide prepared by Disinfection, Antisepsis and Sterilization Association [25]. However, there is no clear and specific guideline for ultrasound probes and gels used in invasive or noninvasive procedures for our country.

It is one of the oldest known and effective methods to wipe the probes used in noninvasive processes only with dry tissue paper [15]. We also use this method routinely. In a study conducted in Iran, it was determined that the bacterial load on probes decreased by 50% after wiping with dry tissue paper and this method was reported to be effective, inexpensive and device-friendly without damaging the probe [12]. Hayashi et al. and Mattar et al. also agree on this issue [6,7]. Some studies have reported that using soap after tissue wiping significantly reduces bacterial load [7,26]. In a

Table 1. Results of culture from probes surface and gels

	Number of colonies and notable species after breast ultrasound*					Number of colonies and notable species after abdomen ultrasound*					Number of colonies and notable species from gel samples*		
	B0	B1	B2	B3	B4	A0	A1	A2	A3	A4	A5	G0	Gend	G24
1.day	0	30 CNS	30 CNS	3 CNS	0	0	4 CNS	2 CNS	5 CNS	2 CNS	4 CNS	0	0	0
2.day	0	5 CNS	11 CNS	8 CNS	0	0	98 CNS	1 CNS	4 CNS	0	5 S.aureus	0	0	0
3.day	13 CNS	24 CNS	10 CNS 30 .cepecia	2 CNS	0	0	18 CNS	8 CNS 4 S.aureus	8 CNS	0	6 CNS	0	0	0
4.day	15 CNS	60 CNS	10 CNS 20 B.cepecia	0	1 CNS	1 CNS	2 CNS	0	0	0	2 CNS	0	0	2 CNS
5.day	Extreme CNS	Extreme CNS	15 CNS 2 S.aureus	Extreme CNS	0	0	Extreme CNS	0	4 CNS	6 CNS	2 CNS	2 CNS	0	0
6.day	0	2 C.pauculus	12 CNS	2 CNS 20 S.maltophilia	0	0	2 CNS	0	3 S.maltophilia	1 S.maltophilia	1 S.maltophilia	0	1 S.maltophilia	0

* The number of colonies growing on the medium is given.
Abbreviations:B0 and A0: Samples taken before the first patient's examination at the beginning of the day. Bn and An: Samples taken after every two patients for breast ultrasound and after every five patient for abdomen ultrasound. G0:Sample taken when the gel is first opened. G end:Sample taken at the end of the day. G24:Sample taken 24 hours after gel opening.

study conducted in our country, it was reported that it was enough to wipe the abdominal probes with a tissue paper. However, in mentioned study it has been appointed that the inguinal or axillary probes should be disinfected with alcohol and that antisepsis with alcohol in these body regions is more effective [27]. There are many studies indicating that at least low-level disinfection should be done when wiping probes with paper towels is insufficient [10,28]. Disinfection of probes with chlorhexidine is a low-level disinfection method that has been known for many years [29]. In two studies where probes were contaminated with methicillin resistance S.aureus and a low-level disinfection protocol was applied, quaternary ammonium or hydrogen peroxide compounds were reported to be effective in probe disinfection [28,30]. Sartoretti et al also agree that quaternary ammonium is an effective disinfectant [31]. In a similar study of Mullaney et al., probes were contaminated with S.aureus, P.aeruginosa and Escherichia coli and then showed the effectiveness of disinfection with antiseptic wipes [8]. Disinfection with ethanol is also known to be very effective [6,12,27] but ethanol damages probes [32]. In conclusion, our high bacterial contamination rate indicates that our probe cleaning method is not suitable.

Limitations of our study; performing in only one examination room and with a single device, using only tissue paper for probe cleaning, lack of sample number, not sampling from other ultrasound equipment such as cables and keyboard other than probes and gels.

Conclusion

In conclusion, although more skin flora bacteria were detected in superficial noninvasive probes and gels, a small number of pathogenic bacteria were also found in our study. These pathogens may cause infection in a patient with immunodeficiency (premature, neonates, dialysis patient, patient with acquired immunodeficiency, etc.) or invisible skin lesions. Proper disinfection of the noninvasive probes and proper use of gels is therefore necessary. We believe that wiping nonsterile dry tissue paper after each procedure is insufficient for disinfection of the probe surface. Disinfection and gel usage guidelines should be determined for ultrasound units both in our hospital and in our country.

Conflict of interests
The authors declare that they have no conflict of interest and any financial disclosures.

Financial Disclosure
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Ethical approval
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References

1. Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on in animate surfaces? A systematic review. BMC Infect Dis. 2006;6:130.

2. Spencer P, Spencer RC. Ultrasound scanning of post-operative wounds-the risk of cross-infection. Clin Radiol. 1988;39:245-46.

3. Koibuchi H, Hayashi S, Kotani K, et al. Comparison of methods for evaluating bacterial contamination of ultrasound probes. J Med Ultrasonics. 2009;36:187-92.

4. Weist K, Wendt C, Petersen LR, et al. An outbreak of pyodermas among neonates caused by ultrasound gel contaminated with methicillin-susceptible Staphylococcus aureus. Infect Control Hosp Epidemiol. 2000;21:761-76.

5. Sartoretti T, Sartoretti E, Bucher C, et al. Bacterial contamination of ultrasound probes in different radiological institutions before and after specific hygiene training: do we have a general hygienical problem? Eur Radiol. 2017;27:4181-7.

6. Hayashi S, Koibuchi H, Taniguchi N, et al. Evaluation of procedures for decontaminating ultrasound probes. J Med Ultrason. 2012;39:11-4.

7. Mattar EH, Hammad LF, Ahmad S, et al. An investigation of the bacterial contamination of ultrasound equipment's at a University Hospital in Saudi Arabia. J Clin Diag Res. 2010;:2685-90.

8. Mullaney PJ, Munthali P, Vlachou P, et al. How clean is your probe? Microbiological assessment of ultrasound transducers in routine clinical use, and cost-effective ways to reduce contamination. Clin Radiol. 2007;62:694-8.

9. Sykes A, Appleby M, Perry J, et al. An investigation of the microbial contamination of ultrasound equipment. Br J Infect Contr. 2006;7:16-20.

10. Westerway SC, Basseal JM, Brockway A, et al. Potential infection control risks associated with ultrasound equipment – a bacterial perspective. Ultrasound Med Biol. 2017;43:421-6.

11. Skowronek P, Wojciechowski A, Leszczyński P, et al. Can diagnostic ultrasound scanners be a potential vector of opportunistic bacterial infection? Med Ultrason. 2016;18:326-31.

12. Schabrun S, Chipchase L, Rickard H. Are therapeutic ultrasound units a potential vector for nosocomial infection? Physiother Res Int. 2006;11(2):61-71.

13. Ejtehadi F, Ejtehadi F, Teb JC, et al. A safe and practical decontamination method to reduce the risk of bacterial colonization of ultrasound transducers. J Clin Ultrasound. 2014;42:395-8.

14. Gaillot O, Maruéjouls C, Abachin E, et al. Nosocomial outbreak of Klebsiella pneumoniae producing SHV-5 extended-spectrum b-lactamase, originating from a contaminated ultrasonography coupling gel. J Clin Microbiol. 1998;36:1357-60.

15. Muradali D, Gold WL, Phillips A, et al. Can ultrasound probes and coupling gel be a source of nosocomial infection in patients undergoing sonography? An in vivo and in vitro study. AJR Am J Roentgenol. 1995;164:1521-4.

16. Hutchinson J, Runge W, Mulvey M, et al. Burkholderia cepacia infections associated with intrinsically contaminated ultrasound gel: The role of microbial degradation of parabens. Infect Control Hosp Epidemiol. 2004;25:291-6.

17. Jacobson M, Wray R, Kovach D, et al. Sustained endemicity of Burkholderia cepacia complex in a pediatric institution, associated with contaminated ultrasound gel. Infect Control Hosp Epidemiol. 2006;27:362–6.

18. Health Canada. Notice to Hospitals: Important safety information on ultrasound and medical gels. October 20, 2004. http://www.hc-sc.gc.ca/dhp-mps/medeff/advisories-avis/prof/_2004/ultrasound_2_nth-ah-eng.php. Accessed date January 02, 2020.

19. Nyhsen CM, Humphreys H, Koerner RJ, et al. Infection prevention and control in ultrasound-best practice from the European Society of Radiology Ultrasound Working Group. Insights Imaging 2017;8:523-35.

20. Rutala WA, Weber DJ. Healthcare Infection Control Practices Advisory Committee. Guideline for disinfection and sterilization in healthcare facilities, 2008. http://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf. Accessed date January 02, 2020.

21. Spaulding EH. Chemicals disinfection and antisepsis in the hospital. J Hosp Res. 1972;9:5-31.

22. American Institute of Ultrasound in Medicine (AIUM). Guidelines for cleaning and preparing external- and internal-use ultrasound probes between patients, safe handling, and use of ultrasound coupling gel. http://www.aium.org/officialStatements/57. Accessed date December 20, 2019.

23. Association for the Advancement of Medical Instrumentation (AAMI). ANSI/AAMI ST58:2013 Chemical sterilization and high-level disinfection in health care facilities. American National Standard.

24. Basseal JM, Westerway SC, Juraja M, et al. Guidelines for reprocessing ultrasound transducers. Australas J Ultrasound Med. 2017;20:30-40.

25. Disinfection Antisepsis Sterilization Association. National disinfection antisepsis sterilization guidebook. https://www.das.org.tr /index.php/das-rehber-kitabi. Accessed date December 15,2019.

26. Mirza WA, Imam SH, Kharal MS, et al. Cleaning methods for ultrasound probes. J Coll Physicians Surg Pak. 2008;18:286-9.

27. Karadeniz YM, Kilic D, Kara Altan S, et al. Evaluation of the role of ultrasound machines as a source of nosocomial and cross-infection. Invest Radiol. 2001;36:554-58.

28. Frazee BW, Fahimi J, Lambert Land Nagdev A. Emergency department ultrasonographic probe contamination and experimental model of probe disinfection. Ann Emerg Med. 2011;58:56-63.

29. Ohara T, Itoh Y, Itoh K. Ultrasound instruments as possible vectors of staphylococcal infection. J Hosp Infect. 1998;40:73-7.

30. Chu K, Obaid H, Babyn P, et al. Bacterial contamination of ultrasound probes at a tertiary referral university medical center. AJR Am J Roentgenol. 2014;203:928-32.

31. SartorettiT, Sartoretti E, Bucher C, et al. Bacterial contamination of ultrasound probes in different radiological institutions before and after specific hygiene training: do we have a general hygienical problem? Eur Radiol. 2017;27:4181-7.

32. Koibuchi H, Fujii Y, Kotani K, et al. Degradations of ultrasound probes caused by disinfection with alcohol. J Med Ultrason. 2011;38:97-100.