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Stethoscopes as vectors of staphylococci at a veterinary teaching hospital

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ABSTRACT

The issue of nosocomial infections, or healthcare-associated infections (HAIs), remains a significant concern in healthcare settings worldwide. In recent times, there has been growing attention towards medical devices, notably stethoscopes, as potential vectors for pathogen transmission. This study aimed to evaluate the prevalence of Staphylococcal contamination on stethoscopes used by students and staff at Istanbul University-Cerrahpasa Faculty of Veterinary Medicine's animal hospital. Furthermore, it gathered information about stethoscope usage habits, cleaning practices, handwashing routines, participants' knowledge about nosocomial infections, and their interest in learning more about these infections and stethoscope hygiene. The analysis of 50 stethoscope samples revealed that 27 (54%) were contaminated with one or more Staphylococci. The isolated 30 *Staphylococcus* spp. included *Staphylococcus epidermidis* (n=17; 56.7%), *Staphylococcus hominis* (n=10; 33.3%), *Staphylococcus pasteuri* (n=1; 3.3%), *Staphylococcus capitis* (n=1; 3.3%), and *Staphylococcus schleiferi* (n=1; 3.3%). Notably, the absence of the highly pathogenic *Staphylococcus aureus* in all samples provides some reassurance. However, the presence of various *Staphylococcus* spp. raises concerns due to their pathogenic potential. These findings align with previous research on stethoscope contamination, emphasizing the persistent problem of bacterial colonization on these crucial medical devices. Despite variations in bacterial prevalence among studies, *Staphylococcus* spp. consistently emerge as common contaminants, emphasizing the need for comprehensive stethoscope hygiene protocols in veterinary healthcare settings. To the best of our knowledge, this is the first report describing the vector potential of stethoscopes in a veterinary setting within Turkey. The study suggests the necessity for further research, taking a proactive approach to tackle the challenges of nosocomial infections. This would enable the development of strategies to ensure a safer healthcare environment for patients and healthcare providers.

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Introduction

Nosocomial infections, also known as healthcare-associated infections (HAIs), continue to be a significant concern in healthcare settings worldwide. While close contact between humans and their animal companions can lead to the exchange of bacterial strains (Kaspar et al., 2018; Rossi et al., 2020), similarly close contact in a hospital environment can lead to infections, increased morbidity, mortality, and healthcare costs (Cohn & Middleton, 2010). While the role of hands and surfaces in the transmission of HAIs is well-established (Al-Beeshi et al., 2021; Nivedhitha et al., 2021; Rojas et al., 2017; Suleyman et al., 2018), the potential role of medical devices, such as stethoscopes, in the dissemination of pathogens has gained attention in recent years. Their contamination serves as a potential source for transmitting pathogens among individuals in the veterinary healthcare setting (Fujita et al., 2013; Leite et al., 2023; Souza et al., 2022).

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Stethoscopes are indispensable tools for veterinary healthcare providers, facilitating accurate diagnosis and patient assessment. However, their frequent and close contact with patients, coupled with inadequate cleaning and disinfection practices, can contribute to microbial contamination. Approximately four decades ago, the emergence of nosocomial infections highlighted the possibility of stethoscopes serving as potential vehicles for transmission (Gerken et al., 1972; Mangi & Andriole, 1972).

Ever since then, numerous researchers have showcased the ability of stethoscopes to harbour pathogens (Fujita et al., 2013; Heldeweg et al., 2022; Marinella, 1997; Núñez et al., 2000). In a study conducted by Gerken et al., an examination was carried out on the cultures of 100 stethoscopes utilized in a teaching hospital. The findings revealed that approximately 21% of these stethoscopes harboured Staphylococci (Gerken et al., 1972). In the year 1996, Smith et al. conducted a study where they analysed 200 stethoscopes obtained from hospitals and outpatient clinics. The results indicated that a staggering 80% of the stethoscopes were found to be contaminated with bacteria. The predominant type of bacteria detected was *Staphylococcus* spp. (Smith, 1996). In a study by Gupta et al., a total of 50 stethoscopes were evaluated, and it was found that all of them were culture positive for bacterial growth. The predominant bacteria isolated from these cultures was coagulase negative *Staphylococcus* (CoNS), accounting for approximately 77% of the isolates (Gupta et al., 2014).

Although more study has been conducted in this area at human medicine, stethoscope studies that include veterinary hospitals have also shown the same results (Leite et al., 2023; Souza et al., 2022). These collective discoveries have sparked worry that stethoscopes might serve as a potential origin for hospital-acquired infections. To address this concern, it is essential to assess the extent of microbial contamination on stethoscopes and explore the associated hygiene practices among healthcare professionals.

The main aim of this research was to evaluate the prevalence of Staphylococcal bacterial species on stethoscopes used by students and staff at Istanbul University-Cerrahpasa Faculty of Veterinary Medicine. Additionally, the study anonymously collected data on stethoscope usage patterns, cleaning practices, handwashing routines, participants' knowledge of nosocomial infections, and their interest in learning more about these infections and proper stethoscope hygiene.

Materials and Methods

This study was performed from April 2022 to July 2022 at Istanbul University-Cerrahpasa Faculty of Veterinary Medicine. Samples from stethoscope diaphragms of randomly chosen students and staff of the faculty were obtained at the University's animal hospital and analysed at the laboratory of the Microbiology Department. In this study, 50 stethoscope samples were collected from 33 participants, as 8 of the participants owned more than one stethoscope, also 9 of the stethoscopes were the belonging of the facility for the usage of teaching staff and students. During sampling, information was collected about the participants' demographic information, professional roles, gender, and stethoscope usage habits, like the frequency of stethoscope usage, cleaning frequency, materials used for cleaning, and hand washing practices after examinations (Table 1-2). Additionally, their knowledge about nosocomial infections and interest in learning more about nosocomial infections and stethoscope hygiene were recorded (Table 3).

The diaphragms of stethoscopes were swabbed using sterile transport swabs moistened with phosphate-buffered saline solution (PBS). Following sampling, the swabs were immediately transported to the laboratory and inoculated onto mannitol salt agar and blood agar plates. The inoculated plates were incubated at 37°C for 24-48 hours. The identification of isolates showing staphylococcal morphology continued using standard microbiological identification techniques and classical biochemical tests (Table 4), which are routinely employed in the laboratory to confirm the identity of the *Staphylococcus* spp.

Results

The study comprised 33 participants who were randomly selected during their shift at the teaching hospital of Istanbul University-Cerrahpasa Faculty of Veterinary Medicine, with 14 undergraduate students (42.4%), 12 PhD students (36.4%), and 7 assistants/ instructors (21.2%). Of the participants, 16 were female (48.5%) and 17 were male (51.5%) (Table 1).

Table 1. Participant demographics

	n	%
Role		
Undergraduate student	14	42.4
PhD student	12	36.4
Assistant/Instructor	7	21.2
Gender		
Male	17	51.5
Female	16	48.5

In this article, Table 2 presents the data on stethoscope usage frequency, cleaning practices, and handwashing routines after examination among the participants. The frequency of stethoscope usage varied among participants, with 14 individuals (43%) reporting daily use, 11 (33%) reporting usage a few times a week, 3 (9%) reporting usage once a week, 3 (9%) reporting rare usage, and 2 (6%) reporting never using a stethoscope. Regarding stethoscope cleaning practices, only one participant (3%) reported always cleaning the stethoscope after use, while 4 participants (12%) cleaned it often, 11 participants (34%) cleaned it sometimes, 9 participants (27%) cleaned it rarely, and 8 participants (24%) never cleaned it. The most commonly used material for stethoscope cleaning was alcohol (n=15, 45.5%), followed by clean fabric (n=5, 15.2%), while 5 participants (15.2%) used other materials, and 8 participants (24.2%) reported not using any material for cleaning. Regarding hand washing after examinations, 20 participants (60.6%) reported always washing their hands, 6 participants (18.2%) reported often, 2 participants (6.1%) reported sometimes, and 5 participants (15.2%) reported rarely washing their hands. No participant reported never washing their hands.

Table 2. Participants' general hygiene, stethoscope usage and cleaning practice

Usage frequency	**n**	**%**
Daily	14	42.4
Few times a week	11	33.3
Once a week	3	9.1
Rare	3	9.1
Never	2	6.1
Cleaning frequency		
Always	1	3.0
Often	4	12.1
Sometimes	11	33.3
Rarely	9	27.3
Never	8	24.3
Stethoscope cleaning material		
Alcohol	15	45.4
Clean fabric	5	15.2
Other	5	15.2
Nothing	8	24.2
Hand washing after examination		
Always	20	60.6
Often	6	18.1
Sometimes	2	6.1
Rarely	5	15.2

Additionally, Table 3 showcases participants' knowledge about nosocomial infections and their interest in learning more about nosocomial infections and stethoscope hygiene. In terms of knowledge about nosocomial infections, 12 participants (36.4%) were aware of nosocomial infections and took necessary precautions, 15 participants (45.5%) were aware but did not always take precautions, 5 participants (15.2%) had heard about nosocomial infections but did not possess much knowledge, and only one participant (3%) had never heard about nosocomial infections. Regarding participants; interest in learning more about nosocomial infections and stethoscope hygiene, 23 participants (69.7%) expressed a desire to acquire further knowledge, 4 participants (12.1%) showed no interest, and 6 participants (18.2%) were hesitant.

Out of the 50 stethoscopes, 30 Staphylococcal species were isolated from 27 (54%) stethoscope swabs, 11 samples (22%) showed no bacterial growth, while the remaining samples (24%) showed single- or mixed cultures other than *Staphylococcus* spp. The isolates obtained from the stethoscopes revealed a diverse array of *Staphylococcus* spp. Among the isolates, 17 were *Staphylococcus epidermidis* (56.67%), 10 were *Staphylococcus* hominis (33.33%), 1 was *Staphylococcus pasteuri* (3.33%), 1 was *Staphylococcus capitis* (3.33%), and 1 was *Staphylococcus schleiferi* (3.33%). Notably, S. aureus, a significant pathogenic species, was not detected in any of the samples.

Table 3. Knowledge and interest in HAIs and stethoscope hygiene

Knowledge	n	%
Aware and take precautions	12	36.3
Aware but not always take precautions	15	45.4
Do not have much knowledge of the topic	5	15.1
Never heard about nosocomial infections	1	3.0
Interest in further learning		
Yes	23	69.7
No	4	12.1
Hesitant	6	18.2

Table 4. Methods and biochemical tests for identification of Staphylococci from bacterial isolations

Basic Characteristics	**Fermentation of**	**Enzymatic Reactions**
Catalase	Arabinose	Arginine dihydrolase
Coagulase	Cellobiose	Lysine decarboxylase
Gelatine hydrolysis	DNAse	Ornithine decarboxylase
Haemolysis	Fructose	
Nitrate reduction	Lactose	
Oxidase	Maltose	
ONPG	Mannitol	
Pigment	Mannose	
Shape	Raffinose	
Urease	Ribose	
6.5% NaCl	Sucrose	
	Trehalose	
	Xylose	

Limitations: Single-Centre Study: The study was conducted at a single veterinary teaching hospital in Istanbul, Turkey. This may limit the generalizability of the findings to other veterinary healthcare settings in different regions.

Limited Bacterial Identification: The decision to narrow the scope of bacterial identification to *Staphylococcus* spp. was made to specifically assess their prevalence and potential implications in the veterinary environment. However, future research endeavors may explore a broader range of bacterial species to gain comprehensive insights into stethoscope contamination and its impact on veterinary healthcare.

Antibiotic Resistance Testing: The assessment of antibiotic resistance profiles of the isolated *Staphylococcus* spp. was beyond the scope of this study. Future investigations should focus on exploring the resistance patterns and evaluating the potential risk posed by these bacteria in the context of HAIs, thereby contributing to a more comprehensive understanding of their clinical implications and informing effective infection control measures.

Discussion

The presence of bacteria on the diaphragms of veterinary stethoscopes is a predictable discovery that aligns with previous culture surveys conducted on stethoscopes used by physicians.

Upon comparing multiple studies on stethoscope contamination, several consistent findings emerge regarding the bacterial species identified and *Staphylococcus* spp. were commonly isolated. Our study found single or multiple *Staphylococcus* species in 27 (54%) out of 50 stethoscopes, including S. epidermidis, S. hominis, S. pasteuri, S. capitis, and S. schleiferi. Other studies also reported *Staphylococcus* spp. as the predominant bacteria. Gupta et al. found that all 50 stethoscope samples were culture positive, with CoNS being the most commonly isolated bacteria (77%) (Gupta et al., 2014). Similarly, Leontsini et al. found that pathogenic or potential pathogenic CoNS were isolated in 87.6% of the stethoscopes sampled, with S. epidermidis being the most predominant species (39.4%), followed by S. hominis (19.7%) (Leontsini et al., 2013). This founding is also similar to ours.

Unlike most studies that primarily investigate stethoscopes used by human physicians, our research with Souza et al., Leite et al., and Fujita et al.'s study specifically examined stethoscopes employed in veterinary settings (Fujita et al., 2013; Leite et al., 2023; Souza et al., 2022). In the study by Souza, bacterial growth was observed in 73.33% of stethoscopes before disinfection, and *Staphylococcus* spp. accounted for 35.3% of the isolates (Souza et al., 2022).

The study by Fujita et al. reported similar findings to ours, demonstrating the presence of diverse bacteria on the stethoscope diaphragms. The recovered organisms included normal skin flora, agents of opportunistic infections, and potential pathogens. Among the isolated bacteria, S. epidermidis was present in 15% of the samples, while the resistant strain of S. epidermidis constituted 8%. S. pseudintermedius and S. hominis represented 12% and 4%, respectively, while S. simulans and S. warneri each accounted for 4% of the total isolates (Fujita et al., 2013).

S. aureus, a significant pathogenic species, was notably absent in our and Fujita's study. Leite et al. investigated the occurrence of antimicrobial -resistant S. aureus in a Brazilian veterinary hospital environment by sampling humans, animals, surfaces, mobile phones and stethoscopes. In the study, out of 110 bacterial isolates, only 10 were identified as S. aureus, and these were found in human nasal cavities rather than on stethoscopes (Leite et al., 2023). The consistent findings were also observed in Leontsini et al.'s study, which investigated physicians' stethoscopes and reported the absence of S. aureus isolation from both the diaphragms and earpieces (Leontsini et al., 2013).

Anticipatedly, the isolation of S. aureus in animals is infrequent since, according to various studies, pets are more prone to being colonized by other types of *Staphylococcus*, such *as S. epidermidis*, *S. felis, S. intermedius, S. pseudintermedius, S. schleiferi,* and *S. simulans* (Bagcigil et al., 2012; Bierowiec et al., 2019; González-Domínguez et al., 2020). This finding is supported by other studies that display the fact that S. aureus organisms are seldom found on inanimate objects in the community due to their limited ability to survive on dry surfaces for more than 24 hours (Domon et al., 2016).

These distinctions are important because it provides valuable insights into the bacterial contamination associated with veterinary practices. By exploring the microbial presence on veterinary stethoscope diaphragms, these studies shed light on the potential risks and hygiene considerations in animal healthcare environments.

To the best of our knowledge, while numerous studies have been conducted in the country's multiple healthcare environments concerning human health (Eriş, F. N., et al., 2000; Kilic et al., 2011; Oguzkaya-Artan et al., 2016), and environmental sample from areas at veterinary education facilities have been examined (Bagcigil et al., 2012), this report is the first to describe the vector potential of stethoscopes in a veterinary environment in Turkey.

It is important to note that the prevalence of specific bacterial species may vary across studies due to factors such as study population, sample size, geographical location, and healthcare settings (Lee et al., 2018; Sivri et al., 2016). However, the consistent presence of Staphylococcus spp., particularly CoNS, suggests their potential role as common contaminants on stethoscopes. Also, a significant proportion of this study's participants reported irregular stethoscope cleaning practices, with only a small percentage consistently cleaning the instrument after use. Studies that investigated the frequency of stethoscope cleaning among students found controversial results. A survey conducted among 51 French students revealed that 82% of the participants reported cleaning their stethoscopes either regularly or occasionally (Duroy & Le Coutour, 2010). A Serbian study showed that a substantial number of students in the study had cleaned their stethoscopes (Gazibara et al., 2015). Similarly to our study, a survey amongst medical and nursing students in Jordan showed that only 8% cleaned their stethoscopes between patients, 38% did not clean their stethoscopes at all, 67% did not know how to effectively clean their stethoscopes (Bataineh et al., 2022).

The controversy in findings may be influenced by various factors, including cultural norms, educational settings, and individual attitudes towards hygiene. Additionally, variations in sample sizes and demographics of the surveyed populations could impact the results. These contrasting findings emphasize the need for further research to gain a comprehensive understanding of stethoscope hygiene practices among students worldwide. Policymakers and educators should consider implementing standardized guidelines and training programs to promote proper stethoscope disinfection.

Conclusion

This study aimed to assess the prevalence of Staphylococcal contamination on stethoscopes used at a veterinary teaching hospital. The results revealed Staphylococcal contamination in 54% of the examined stethoscopes, with various Staphylococcus spp., including S. epidermidis, S. hominis, S. pasteuri, S. capitis, and S. schleiferi.

While the absence of highly pathogenic S. aureus is reassuring, the presence of diverse Staphylococcus spp. warrants attention due to their potential pathogenicity and risk of opportunistic infections. This highlights the persistent challenge of bacterial colonization on stethoscopes in veterinary healthcare settings.

Through an extensive analysis of stethoscope usage habits and hygiene practices among the participants, a concerning pattern of inadequate cleaning protocols emerged. A mere fraction of participants adhered to regular cleaning after usage, with the majority employing suboptimal or infrequent cleaning practices. This lack of stringent hygiene measures accentuates the potential risk of cross-contamination and pathogen dissemination among patients and healthcare practitioners. Also, considering the interest shown by participants in learning more about nosocomial infections and stethoscope hygiene, educational interventions or training programs should be considered to raise awareness and improve hygiene practices.

This study significantly contributes to the limited literature on stethoscope contamination in veterinary healthcare, especially in Turkey. It is the first report examining stethoscope contamination in a veterinary environment in this region, providing valuable insights into microbial contamination associated with animal healthcare practices.

Future research should involve larger and diverse participant populations from various veterinary healthcare settings to ensure comprehensive representation. Additionally, in-depth studies exploring potential antibiotic resistance profiles of the isolated species are crucial to understanding their virulence and infection risk.

Through such research, the healthcare community in Turkey can proactively address the challenges of nosocomial infections and enhance patient safety in veterinary healthcare settings.

Conflict of interest

The authors declared that there is no conflict of interest.

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