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Original Research Article

Clinically significant bacteria on doctors stethoscope in Makurdi, Nigeria and their antibacterial susceptibilities

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ABSTRACT

Background: The stethoscope is highly susceptible to contamination, specifically by the diaphragm that comes into contact with the patient's body. This study aims at determining the presence of, and the most prevalent bacteria on medical interns and doctors' stethoscopes at the federal medical centre (FMC) and Benue State university teaching hospital (BSUTH), Makurdi, assess antimicrobial susceptibility of the isolates, and compare the levels of stethoscope contamination between the hospitals.
Methods: The study was a hospital-based cross-sectional study undertaken between December 2020 and May 2021. A total of 99 samples were taken using sterile swab sticks from the diaphragms of the sampled stethoscopes. Standard microbiological and biochemical tests were performed to identify the bacterial diversity. A paired sample t-test was used to compare the numbers of bacteria-contaminated stethoscopes used by doctors and interns in the two hospitals. A $p<0.05$ was considered as statistically significant.
Results: *Escherichia coli*, and coagulase negative *Staphylococci*, were found in all of the stethoscopes tested. *S. aureus* was found to be the most prevalent pathogen in both hospitals (43.43%), followed by CoNS (29.29%), *Klebsiella pneumonia*, and *Escherichia coli* (both 16.16% and 11.11%) respectively. All of isolates were susceptible to the antibiotics tested. There was a significant difference in the numbers of stethoscopes contaminated from FMC (58.75, 19.31) and BSUTH (72.5, 18.52); t (3)=28.72, p=(9.27E-05), with BSUTH showing highest contamination.
Conclusions: To reduce number of pathogens and risk of transmission, it is recommended that stethoscopes be sanitized after each patient consultation. Disposable stethoscope heads should also be considered to prevent cross-contamination.

Keywords: Stethoscopes, Healthcare workers, Bacteria, Antimicrobial susceptibility, Healthcare-associated infections, Makurdi

INTRODUCTION

Healthcare-associated infections (HAIs) are a substantial public health challenge globally, and patients acquire these infections during the period of receiving healthcare.[1-3] These infections initially appear approximately 48 hours or more following hospitalization or in the 30 days following treatment.[4] In high-risk populations, such as neonates, the elderly, and patients in critical care, infections are significantly more severe, resulting in longer hospital admissions, prolonged impairment, additional expense on health systems, and increased morbidity and mortality.[5-7] Healthcare professionals' hands are a major vehicle for transmitting microorganisms, but research has shown that contaminated medical devices are thought to be responsible for at least half of all HAIs in the United States.[5,8-10]

Medical devices include thermometers, stethoscopes, and otoscopes, etc., and when contaminated, can transmit microorganisms from healthcare workers to patients.[1,2,5] Rene Theophile Hyacinthe Laënnec, a French physician, invented the stethoscope in 1916.[11] Stethoscopes, considered the pride of physicians and healthcare workers, are acoustic medical devices used for auscultation, i.e., listening to sounds produced by different body parts such as the lungs, and heart, etc. and are extensively used in medical practice. It has been reported that the level of microbial colonization on stethoscopes is comparable to an individual's hand, earning them the moniker "doctors' third hand".[12,13] However, while these instruments directly come in contact with several patients daily, appropriate sterilization is not commonly practiced, and thus they might result in cross-contamination.[2,14-17] Furthermore, though recommendations for careful sterilization of the stethoscope have been constantly suggested, disinfection of this device is not yet a conventional practice.[5,14,16,18]

The bacterial diversity of stethoscopes and other non-critical devices has been examined in depth, and the results reveal that they can be used to disseminate microorganisms.[14,19-28] The findings of these studies and others have revealed a wide range of contamination rates ranging between 30-100%, as well as a variety of bacteria.[21,23,29-32] These bacteria include the following *Streptococcus, Porphyromonas, Escherichia coli, Corynebacterium,* Methicillin-sensitive, and methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, *Granulicatella*, *Propionibacterium, Bacteroides*, *Prevotella*, vancomycin-resistant *Enterococcus* (VRE), and *Clostridium difficile*, etc. When bacteria contaminate stethoscope diaphragms, they can be disseminated to skin of patient in as little as 3 seconds.[14] Standard auscultation methods entail several min of skin contact, which provides many opportunities for pathogen transmission. Studies of this kind are scarce in Makurdi, Nigeria. The aim of this study is therefore to investigate presence of and most prevalent bacterial contaminants on stethoscopes from doctors and interns at 2 major hospitals in Makurdi, Nigeria, and to evaluate antimicrobial susceptibility patterns of isolates, and compare bacterial contamination levels between 2 hospitals.

METHODS

Sample collection and identification of contaminating bacteria

This was a hospital-based cross-sectional study undertaken at the FMC and BSUTH, Makurdi, from January to May 2021. Medical doctors and medical interns who regularly use a conventional stethoscope and work in any ward at the two hospitals were chosen at random. Ethical clearance for this study was obtained from the ethical committee of the ministry of health, Makurdi, Benue State. The sterile stick swabs were moistened with normal saline and used to collect duplicate samples from diaphragm of each stethoscope. The swabs were recapped, labeled, and immediately taken to the hospital laboratory where the samples were collected-FMC Wadata or BSUTH, Makurdi. Using aseptic techniques, each swab was streaked on cysteine lactose electrolyte deficient agar (CLED) (Becton Dickinson™, UK), mannitol salt agar (Oxoid, UK), and Mac-Conkey agar (Oxoid, UK) using standard procedures.[33] The media was prepared following the manufacturer's instructions. The plates were incubated aerobically at 37°C for 24-48 hours. Isolates were first characterized using gram staining, followed by evaluation of colony morphology, and biochemical tests-lactose test, motility, citrate, coagulase, indole, and catalase tests.[34]

Antimicrobial susceptibility testing

Antimicrobial susceptibility testing was performed using the Kirby Bauer disk diffusion method as per clinical laboratory standard institute (CLSI) guidelines.[34] Antibiotic discs were chosen based on regularly used antibiotics in the study location, and discs against gram-positive and gram-negative bacteria were used.

RESULTS

Identification of bacteria present on stethoscopes

In this study, 99 stethoscopes from 50 doctors and 49 medical interns investigated. Standard microbiological and biochemical assays were performed on the bacteria isolated from the stethoscopes, i.e., FMC and BSUTH, to determine the bacteria present. *E. coli, Klebsiella pneumoniae*, *coagulase-negative Staphylococci*, and *Staphylococcus aureus* were identified.

Most prevalent bacterial contaminants on the sampled stethoscopes

The prevalence of bacteria on the stethoscopes sampled from the FMC and BSUTH was determined. *S. aureus* was reported to be the most prevalent pathogen in both hospitals (43.43%), followed by coagulase negative *Staphylococcus* (29.29%), *K. pneumonia* and *Escherichia coli* (16.16% and 11.11%) respectively (Figure 1).

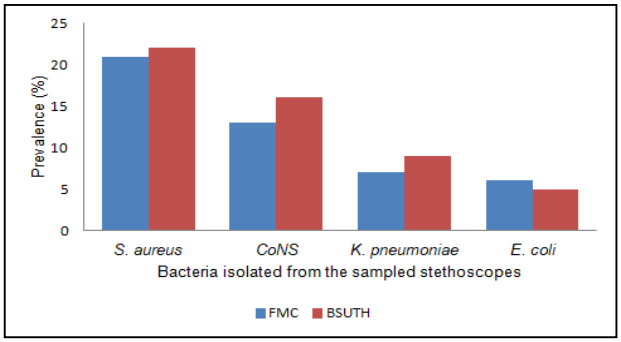

Figure 1: Prevalence of bacteria isolated for each hospital against the stethoscopes sampled.

Antibiotic susceptibility testing for bacteria isolated from the sampled stethoscopes

Antibiotic susceptibility testing of the isolates obtained from FMC was conducted. *S. aureus* was tested against 20 µg of Levofloxacin, *K. pneumonia* against 10 µg of Vancomycin, *E. coli* against 10 µg Gentamycin, and *CoNS* against 30 µg of Chloramphenicol. Although the disc potencies are unequal, the zones of inhibition indicate that all the isolated bacteria were susceptible to the tested antibiotics (Table 2).

Similarly, bacteria isolated from stethoscopes used by doctors and interns at BSUTH were subjected to antibiotic susceptibility testing. There is a difference in the antibiotics tested at FMC versus those at BSUTH.

The antibiotics were selected due to their availability at each hospital. Thus, *S. aureus* was tested against Rifampicin (30 µg), *K. pneumoniae* (Vancomycin 30 µg), *E. coli* (Streptomycin 20 µg), and *CoNS* (Erythromycin 30 µg. From the results, no resistance was found. The results are presented in Table 3.

Contamination levels for the hospitals investigated

The comparisons of FMC versus BSUTH indicate the following levels of contamination - *S. aureus* (53.8% versus 62.03%), *K. pneumonia* (38.46% vs. 46.20%), *E. coli* (47.62% vs. 52.3%), *CoNS* (37.97% vs.61.54%). For each bacteria isolated, BSUTH had the highest level of contamination as indicated in Table 3.

Table 1: Microbiological and biochemical characterizations of bacteria isolates obtained from stethoscope diaphragm at FMC and BSUTH.

Bacteria isolated	Morphological Characteristics	Gram test	Citrate test	Gram staining	Indole test	Coagulase test	Catalase test	Lactose test
E. coli	Shape: Straight rods Motility: Motile Opacity: Opaque Pigmentation: Yellow colonies on CLED	_	-	-	+	-	-	+
K. pneumoniae	Shape: Rods Motility: Non-motile Opacity: Opaque Pigmentation: Pink colour on MacConkey agar	–	+	-	-	-	+	+
CoNS	Shape: Cocci Motility: Non motile Pigmentation: Pink or red colonies on MacConkey agar	+	-	+	-	-	+	+
S. aureus	Shape: Cocci Motility: Motile Opacity: Opaque Pigmentation: Deep yellow colonies on CLED agar	+	+	+	-	+	+	+

Table 2: Zone diameters (to the nearest whole mm) for bacteria isolated from federal medical center.

Bacteria isolated	Antibiotic tested	Antibiotic concentration	Zone of inhibition	Result
S. aureus	Levofloxacin	20 µg	29 mm	Susceptible
K. pneumoniae	Vancomycin	10 µg	18 mm	Susceptible
E. coli	Gentamycin	10 µg	24 mm	Susceptible
CoNS	Chloramphenicol	30 µg	22 mm	Susceptible

Table 3: Zone diameter (to the nearest whole mm) for bacterial isolates from BSUTH, Makurdi.

Bacteria isolated	Antibiotic tested	Antibiotic concentration	Zone of inhibition	Result
Staphylococcus aureus	Rifampicin	30 µg	30 mm	Susceptible
Klebsiella pneumoniae	Vacomycin	30 µg	20 mm	Susceptible
Escherichia coli	Streptomycin	20 µg	20 mm	Susceptible
CoNS	Erythromycin	30 µg	28 mm	Susceptible

Table 4: Prevalence of the isolated bacteria in the study locations.

Bacteria isolated	FMC (%)	BSUTH (%)
S. aureus	85 (53.80)	98 (62.03)
K. pneumoniae	40 (38.46)	55 (46.20)
E. coli	50 (47.62)	64 (52.38)
CoNS	60 (37.97)	73 (61.54)

A paired sample t-test was conducted to compare the numbers of bacteria-contaminated stethoscopes used by doctors and interns at FMC and BSUTH. There was a significant difference in the numbers of stethoscopes contaminated in FMC (58.75, 19.31) and BSUTH (72.5, 18.52); t (3)=28.72, p=(9.27E-05). These results suggest that more stethoscopes used by doctors and medical interns at BSUTH were contaminated with bacteria.

DISCUSSION

Pathogenic bacteria, specifically *Staphylococcus aureus*, were identified in 43.43% of the analyzed stethoscopes from BSUTH and FMC. *Klebsiella pneumoniae* (16.16%), *Escherichia coli* (11.11%), and CoNS were among the microorganisms found (29.29%). *S. aureus*, on the other hand, was the most prevalent bacteria in both hospitals studied, as well as, in the majority of research on healthcare workers (HCWs) stethoscope in other studies.[21,27-28] Other studies have also reported the bacteria identified in this study, on stethoscopes of HCWs.[14,21,25,27,29,31,35,36] The gram-positive *S. aureus* and *CoNS* are normal flora of the skin and mucous membranes in humans. Though they are not implicated in clinical infections on healthy skin, they do, however, have the ability to cause opportunistic infections and are an important part of the nosocomial pathogen family.[37,38] Both organisms have the ability to develop multiple drug resistance in patients, which may be critical for immunocompromised individuals. [28, 39-40] These bacteria can be shed from the human skin, hence this was expected. Gram-negative bacteria such as *E. coli* and *K. pneumoniae* are found in the normal human intestinal flora. Their presence on the sampled stethoscopes in the current study could be due to HCWs' poor hand hygiene practices. Antibiotic resistance is a global health issue that leads to higher expenditures, longer hospital stays, therapeutic failure, and mortality. Interestingly, none of the antibiotics tested showed resistance to the test antibiotics-rifampicin, erythromycin, vancomycin, reflacin, gentamycin, levofloxacin, streptomycin, or chloramphenicol. Thus, implying that the tested antibiotics would restrict the growth of bacteria in the case of an infection.

The bacteria isolated had a higher prevalence at BSUTH by comparison to FMC Makurdi. In this study, all the stethoscopes sampled were contaminated with bacteria, representing a 100% stethoscope contamination rate. The results obtained in this study are similar to other global investigations that identified high contamination rates ranging between 56-100% on stethoscopes used by healthcare workers.[23,27,28,30-32] High contamination rates may serve as potential vectors for the transmission of clinically significant pathogens causing HAIs.[41] It has been well established that disinfection of stethoscopes and hand hygiene are two important factors in stethoscope hygiene. The dissemination of bacteria on stethoscopes that are regularly disinfected is low. Panhotra et al found a contamination rate of 94.1% in stethoscopes that were never cleaned and 13.6% on those cleaned daily.[42] Similarly, hand washing of healthcare workers following patient contact resulted in a low contamination rate of 28.5%.[40] High stethoscope contamination rates in this study could be due to infrequent stethoscope disinfection practices, lack of funds to purchase disinfectants, or lack of hand hygiene by the workers. Though the study did not determine stethoscope disinfection, further studies will assess stethoscope disinfection and hand washing practices at the study sites.

The current study has some limitations. Some bacteria, for example, are not culturable, and 16sRNA testing was not performed on the isolates. Regular workshops and educational campaigns in Makurdi on stethoscope disinfection, other non-critical devices, and hand hygiene are recommended for doctors and other healthcare workers.

CONCLUSION

To our knowledge, this is the first study to investigate the bacterial contaminants on health workers stethoscopes in Makurdi, Benue State, Nigeria. According to the findings of this investigation, every stethoscope tested from Makurdi's two major hospitals had at least one clinically significant bacterium, but *S. aureus* was the most common, and no resistance was found. Although some of the bacteria found are part of the normal commensal flora of the human body, in some circumstances, such as when a patient is immunocompromised, patient-to-patient cross contamination can occur and cause disease. As a result, the stethoscope might act as a vehicle for the transmission of bacteria to other patients. In comparison to FMC Makurdi, BSUTH has a higher prevalence of bacterial contamination. At this time, it is unknown whether the facilities examined had stethoscope disinfection protocols in place for doctors and healthcare personnel. However, the significant prevalence indicates that there are no stethoscope disinfection policies in place or that they are not strictly followed.

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