Original Article

Stethoscope disinfection campaign in a Nigerian teaching hospital: results of a before-and-after study

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Abstract

Introduction: This study aimed to assess the impact of a stethoscope disinfection sensitization campaign among doctors and nurses in a Nigerian teaching hospital.

Methodology: The design was a before-and-after study. Pre-program measurements were used to provide a baseline against which the post-program results were compared. Interventions that promoted compliance with stethoscope disinfection practice that were implemented included training and education on stethoscope disinfection and introduction of 70% isopropyl alcohol disinfectant at points-of-care places. Microbiological assessment of stethoscopes used by health workers was conducted after the intervention and the outcome was compared with the pilot study results.

Results: After the intervention, of the 89 stethoscopes screened, 18 (20.2%) were contaminated with bacterial agents. A higher prevalence of stethoscope contamination was observed among stethoscopes from the intensive care unit (66.7%), the VIP unit (50%), and the antenatal unit (37.5%). The main isolates were *Staphylococcus aureus* (44.4%) and *Escherichia coli* (50%). The antibiotic sensitivity assessment indicated that the bacterial isolates were resistant to nearly all the antibiotics tested. All the 89 health workers whose stethoscopes were screened after the intervention admitted to cleaning their stethoscopes after seeing each patient, representing a compliance rate of 100%, unlike the 15% compliance at the pilot phase. The baseline stethoscope contamination rate was 78.5% versus 20.2% post-intervention.

Conclusions: Training and education and introduction of alcohol-based disinfectants inexpensive but very effective methods to improve stethoscope disinfection compliance among health workers in low-income settings.

Key words: stethoscope; disinfection; campaign; hand rub

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Introduction

The transmission of health care-associated infections (HCAIs) (nosocomial infections) in health care settings is a major public health problem worldwide. There is abundant evidence that healthcare workers are potential sources of HCAIs, which they can transmit to patients via their contaminated hands [1-3]. Some non-critical medical devices used by health workers for patient care have also been implicated in the transmission of HCAIs; these devices include electronic thermometers, blood pressure cuffs, stethoscopes, latex gloves, masks, neckties, pens, badges and lanyards, and white coats [1,4-8].

Of these devices, stethoscopes are routinely used in hospitals by medical doctors and other health workers, and have been reported to be a major potential vector for the transmission of HCAIs in the hospital environment [5,9-12]. The ability of the pathogens to attach and establish themselves on the diaphragm of stethoscopes makes possible the transmission of pathogens from person to person because the head of the stethoscope is usually placed in contact with a patient's skin. The skin surface contacted by the stethoscope head may be broken or open due to a variety of causes, including surgical incision, weeping dermatitis, infected lesion, rash, abrasion, laceration, puncture wound, needle sticks, open and infected wounds, and various tubes, drains, ostomies, topical irritation, micro-cuts, and skin breakdown [12-14].

Despite the high risk of HCAI transmission by stethoscopes, it has been reported that sanitation of stethoscopes is one of the most neglected practices of

health workers [5,9]. In many health care settings, patient safety guidelines do not adequately address proper stethoscope usage and maintenance for the prevention of disease transmission [13]. Similarly, despite the stethoscope's universal use by medical professionals, its proper care is not emphasized enough in the medical curriculum [9]. As a consequence, medical personnel and patients may be unaware of the potential risk associated with the use of non-sanitized stethoscopes.

The development of rational control methods for HCAIs requires the microbial evaluation of frequently used medical devices such as stethoscopes as well as the sensitization of health workers about the importance of continuous stethoscope disinfection practice. This study, therefore, explored the impact of a stethoscope disinfection sensitization campaign in a Nigerian teaching hospital. The purpose of the study was to provide scientific information that could aid in the development of intervention programs and guidelines for proper stethoscope usage and maintenance in order to prevent stethoscope-related HCAI transmission.

Methodology

Setting

The study took place between January 2010 and April 2011 at Ebonyi State University Teaching Hospital (EBSUTH) and its training extension facility, the Federal Medical Centre, located in Abakaliki the capital of Ebonyi State in southeastern Nigeria.

Study subjects

The study targeted physicians, nurses, and other health workers involved in direct patient contact.

Ethical considerations

Both the institutional and international guidelines on research ethics was strictly adhered to in all aspects of the project. The study was approved by the Ethics Committee of EBSUTH and by the Ethical Review Committee of the World Health Organization (WHO), Geneva.

Study design

The aim of the study was to influence medical practitioners to disinfect non-critical medical devices by demonstrating how the contamination rate of these devices can be reduced by disinfection. This research was an impact evaluation designed to improve compliance with the practice of stethoscope disinfection. The research employed a before-after study design. Pre-intervention measurements were taken to provide a baseline against which the post-intervention results were compared. As in a standard before-after study, outcomes were measured before the program intervention was implemented (baseline) and after it was implemented.

Pre-intervention/pilot study

The pre-intervention (pilot/baseline) study conducted between August 2007 and May 2008 provided background information about the stethoscope disinfection practice of health workers in EBSUTH. It involved assessments of health workers' knowledge, attitudes, and practices (KAP) surrounding stethoscope handling and maintenance, including disinfection practice, using a structured pre-tested questionnaire. This was accompanied by the microbiological assessment of physicians' and nurses' stethoscopes using standard laboratory procedures. Baseline compliance with stethoscope disinfection practice was also assessed during this phase [5].

Intervention strategy

Training/sensitization workshops were organized for doctors and nurses in the hospital, and the results from the pilot study [5] were used to motivate improvement in stethoscope disinfection practice. The training on stethoscope disinfection focused on stethoscopes and transmission of HCAIs in hospital settings, rationale for stethoscope disinfection, and stethoscope disinfection procedures. The results of the pilot phase were also presented. Each training session lasted about two and a half hours and involved a focus group discussion (FGD) comprised of 5-10 doctors and 6-12 nurses per group. The FGD identified the factors associated with non-compliance with consistent stethoscope disinfection practices and the potential solutions to address them. As a part of the intervention measures, units of 70% isopropyl alcohol hand rub were procured and placed in strategic points-of-care places within the hospital to serve for both hand hygiene and stethoscope disinfection purposes. The Head of Nursing Services Department (HNSD) was in charge of the hand rub distribution and replacement in the various hospital wards throughout the intervention period. A total of 202 health workers (39 doctors and 163 nurses) were trained in a series of workshops. A total of 21 doctors and all the 163 nurses completed the questionnaire on stethoscope handling and maintenance practices.

Post-intervention evaluation

Adherence to stethoscope disinfection practice was assessed by interview as well as by the microbiological assessment of stethoscopes. The Project Team interviewed the health workers about their adherence to stethoscope disinfection practices during stethoscope sampling.

Sampling and laboratory methods

Sampling of each consenting participant's stethoscope was done using a sterile swab stick moistened in a physiological saline, which was used to swab all over the surface of the diaphragm of each stethoscope. The swab was placed in a tube and transferred to the Medical Microbiology Laboratory of Ebonyi State University Abakaliki for analysis. All the swabs collected were directly inoculated on blood agar and MacConkey agar. The pairs of inoculated media were incubated aerobically at 37^{o}C for 24 hours and then examined for bacteria growth according to standard protocol [15]. Bacteria were isolated by assessing colony characteristics and Gram reaction, and conducting catalase and coagulase tests; hemolysis, sugar fermentation, and other biochemical tests including indole production, citrate utilization and urase activity; triple sugar iron (TSI) agar test (for glucose, sucrose and lactose fermentation); gas and hydrogen sulphide production tests; and oxidase tests, according to protocols previously described [15]. The resulting bacterial isolates were subjected to antibiotic sensitivity analysis using the disk diffusion method [15]. The disks used are commercially available (Optun Laboratories Nig Ltd, Lagos, Nigeria). Gram-positive disks contained: ciproflox, nufloxacin, gentamycin, lincocin, streptomycin, rifampin, floxapen, erythromycin, chloramphenicol, and ampiclox. The Gram-negative discs contained tarivid, peflacin, ciproflox, augumentin, gentamycin, streptomycin, ceporex, ampicillin, septrin, and nalidixic acid.

Data analysis

The key findings of the pilot study [5] were compared with the results of the present study. Proportions were expressed in percentages. Differences between proportions were assessed using Chi square analysis. Statistical significance was set at 0.05. The responses from the focus group discussion were noted and were analyzed based on Giorgi's phenomenological approach [16], which has been elaborated by Albert *et al.* [17]. The analysis included the following steps: (a) going over all the textual data to gain an overall impression; (b) identifying all comments that appeared significant to the research and extracting these meaning units, and; (c) independent abstracting of the meaning units, followed by discussion and consensus.

Results

Prior to the the training workshop, none of the doctors regularly disinfected their stethoscopes after seeing each patient, but 39.2% of the nurses did. Among the doctors, 16.7% cleaned their stethoscopes frequently; up to 33.3% had never cleaned their stethoscopes. Over 90% of the doctors never washed their hands each time they used the stethoscope. Among the nurses, 21.3% cleaned their stethoscopes frequently, while 13.4% noted they had never done this; 55.7%, however, admitted they never washed their hands each time they handled their stethoscope (Table 1). Both nurses and doctors emphasized the need for elaborate sensitization campaign to highlight the importance of stethoscope disinfection practice through frequent workshops and reminders, the need for every health worker to own his/her stethoscope to avoid sharing the instrument with other health workers, and the importance of monitoring compliance (Table 2).

After the intervention, a total of 89 health workers were requested to make available their stethoscopes for screening and all consented, giving a response rate of 100%. Of the 89 stethoscopes screened, 18 (20.2%) were contaminated with bacterial agents. A higher prevalence of stethoscope contamination was observed among the stethoscopes from the intensive care unit (66.7%), the VIP unit (50%), and the antenatal unit (37.5%) (Table 3). The principal bacterial isolates were *Staphylococcus aureus* (44.4%) and *Escherichia coli* (50%) (Table 4). The antibiotic sensitivity assessment indicates that the bacterial isolates were resistant to nearly all the antibiotics tested. The bacterial isolates were, however, completely susceptible to gentamycin and ampicillin and showed significant susceptibility to ciprofloxacin and chloramphenicol (Table 5).

Table 1. The outcome of focus group discussion on stethoscope disinfection practice among doctors and nurses

Discussion Issues	Summary of responses from discussion groups
Factors associated with non-compliance with consistent stethoscope disinfection practices	• Lack of awareness about disinfection practices • Indifferent attitude towards disinfection practices by health workers • Absence of documentary guidelines on disinfection practices • Absence of continuous education on disinfection practices • Unreported consequences of non-compliance • Lack of research on stethoscope disinfection practices • Ignorance of health workers about stethoscope disinfection practices • Ignorance on the part of patients • Forgetfulness
Solutions to overcome difficulties to comply with stethoscope disinfection practice	• Continuous health education on stethoscope disinfection practice • Provision of disinfectants for stethoscope disinfection • Creation of policies on stethoscope disinfection • Provision of disposable stethoscopes • Promotion of research on the need for stethoscope disinfection. • Disinfection of stethoscopes in between patient use • Provision of a personal stethoscope to each doctor and nurse • Provision of pocket-sized disinfectant for all health care workers • Imposition of sanctions on erring staff • Frequent re-orientation of clinical staff on the practice of stethoscope disinfection practice • Commitment to stethoscope disinfection • Motivation by management of staff to comply with stethoscope disinfection • Supervision and monitoring to ensure compliance • Integration of stethoscope disinfection in training curriculum of medical schools • Instruction to patients to ask their care givers if they have disinfected their stethoscopes • Use of reminders in strategic locations in the hospital

All the 89 health workers whose stethoscopes were screened after the intervention admitted cleaning their stethoscopes after seeing each patient, representing a compliance rate of 100% unlike the 15% compliance rate in the pilot phase [5]. The stethoscope contamination rate in the pilot study was 78.5% [5], but at the post-intervention phase the rate was 20.2% (Tables 3 and 4). Thus, stethoscope contamination with bacteria was reduced drastically–by 58.3%—following the intervention. The difference in the trend between the outcome of the pilot study and the results of the post-intervention assessment was statistically significant (Table 6).

Discussion

The outcomes of the pre-training workshop assessment of stethoscope disinfection practice indicated very poor compliance among the doctors compared to the nurses. For instance, none of the 26 doctors who participated in the survey disinfected their stethoscopes after seeing each patient, and up to 15% had never cleaned their stethoscopes. Furthermore, over 90% of the doctors never washed their hands each time they used the stethoscope on patients. This finding clearly suggests that the need to orientate doctors to the importance of consistent stethoscope disinfection for the prevention of HCAIs cannot be overstated. A number of studies have indicated that training health workers on strategies to prevent HCAIs can improve compliance [1,18]. In addition to this, findings from many recent studies clearly suggest that educational/promotional campaigns geared toward health care workers can greatly improve compliance with stethoscope disinfection practice [19-22].

In this study, the results of the microbiological assessments of stethoscopes used by health workers were interesting. It is gratifying to note that following the educational intervention, all the health workers whose stethoscopes were screened admitted they now consistently disinfect their stethoscopes using the alcohol hand rub provided.

Table 2. Outcome of the assessment of stethoscope handling and disinfection practice among doctors and nurses

Stethoscope disinfection practice	**Parameters assessed No. (%)**					
How long have you been using the stethoscope?	1-3 years		4-6 years		≥7 years	Total responses
Doctors	3 (13.6)		9 (40.9)		10 (45.5)	22
Nurses	5 (0.8)		54 (33.1)		103 (63.2)	163
Do you clean the stethoscope after seeing each patient?	Yes		No			Total responses
Doctors	-		23 (100.0)			23
Nurses	56 (39.2)		87 (60.8)			143
What do you use in cleaning the stethoscope?	Water	Soap and water	Alcohol/ Spirit	Antiseptic disinfectant	Never cleaned	Total responses
Doctors	-	-	11 (61.1)	3 (16.7)	4 (22.2)	18
Nurses	-	1 (1.2)	71 (82.6)	8 (7.7)	6 (7.0)	86
How many times do you clean your stethoscope in a month?	Never cleaned	≤5 times/ rarely	6-10 times/ occasionally	>10 times/ frequently	Always/ after seeing each patient	Total responses
Doctors	6 (33.3)	8 (44.4)	1 (12.5)	3 (16.7)	-	18
Nurses	17 (13.4)	46 (36.2)	16 (12.5)	27 (21.3)	21 (16.5)	127
Where do you usually keep the stethoscope when on duty?	Around the neck	Pocket	On the table	Cupboard/ shelf/drawer	Hanging on the trolley	Total responses
Doctors	5 (22.7)	12 (54.5)	3 (13.6)	1 (4.5)	1 (4.5)	22
Nurses	24 (16.1)	1 (0.7)	27 (18.1)	72 (48.3)	25 (16.8)	149
Where do you usually keep the stethoscope after work?	Pocket/ bag	Stethoscope case	On the table	Cupboard/ shelf/drawer	Hanging on the trolley	Total responses
Doctors	6 (27.3)	2 (9.1)	2 (9.1)	3 (13.6)	9 (40.9)	22
Nurses	6 (4.1)	17 (11.7)	6 (4.1)	88 (60.7)	26 (17.9)	145
Do you wash your hands each time you use the stethoscope to attend to patients?	Yes		No			Total responses
Doctors	2 (9.5)		19 (90.5)			21
Nurses	64 (44.1)		81 (55.8)			145
When did you clean the stethoscope last?	This week	Last week	Last month	Rarely/long time ago	Never cleaned	Total responses
Doctors	3 (15.0)	5 (25.0)	4 (20.0)	5 (25.0)	3 (15.0)	20
Nurses	67 (46.5)	18 (12.5)	20 (13.9)	23 (16.0)	16 (11.1)	144

Table 3. Microbiological assessment of stethoscopes from various wards after intervention

S/No	**Hospital Ward**	**Number of stethoscopes screened**	**Number (%) of stethoscopes contaminated**
1.	*VIP	4	2 (50.0)
2.	Medical	19	3 (15.8)
3.	Post natal/Gynaecology	3	1 (33.0)
4.	Orthopaedic	3	0 (0)
5.	Antenatal	8	3 (37.5)
6.	Surgical	15	2 (13.3)
7.	Paediatric	7	1 (14.3)
8.	Labour	3	0 (0)
9.	**GOPD	17	3 (17.6)
10.	Dental	6	1 (16.7)
11.	Emergency	1	0 (0)
12.	Intensive Care Unit	3	2 (66.7)
	Total	**89**	**18 (20.2)**

*VIP=very important persons

**GOPD=general out-patient department

Table 4. Bacteria isolates from stethoscopes of health workers screened after intervention

Bacteria isolates	Number (%) isolates
Staphylococcus aureus	8 (44.4)
Escherichia coli	9 (50.0)
Klebsiella pneumonia	1 (5.6)
Total	**18 (20.2)**

Table 5. Antimicrobial susceptibility of bacterial isolates from stethoscopes screened

Antibiotics	*Escherichia coli*	*Staphylococcus aureus*	*Klebsiella pneumonia*
Erythromycin	S	R	R
Ciprofloxacin	S	S	R
Clindamycin	R	R	R
Gentamycin	S	S	S
Cephalexin	S	R	R
Cotrimoxazole	R	S	R
Ampicillin	S	S	S
Cloxacillin	S	R	R
Cefriazone	R	R	R
Augmentin	S	R	R
Nitrfurantoin	R	R	R
Cefuroxime	R	R	S
Norfloxacin	R	R	R
Tetracycline	R	R	R
Nalidixic acid	R	R	R
Chloramphenicol	R	S	S

S = sensitive to antibiotics; R = resistant to antibiotics

Table 6. Comparative assessment of outcome of stethoscope usage and contamination between pilot study and post-intervention study

Parameter assessed	Pilot phase	Post-intervention phase	Percentage change	χ^2, *p*-value	Remarks
No. of stethoscope screened	107	89	NA	NA	NA
No. (%) of health workers who clean stethoscope with alcohol based disinfectant after seeing each patient	16 (15.0%)	89 (100%)	85% increase	141.29, $p<0.05$	Significant difference
No. (%) of stethoscope contaminated	84 (78.5)	18 (20.2)	58.3% decrease	66.12, $p<0.05$	Significant difference

NA= not applicable

The microbiological assessment of the stethoscopes showed that 20.2% of the stethoscopes were contaminated with bacterial agents. This is comparatively lower than the stethoscope contamination rate of more than 75% that we recorded in earlier pilot studies of health workers [5] and medical students in the hospital [23]. The significantly lower stethoscope contamination rate observed in the present study may be attributed to the practice of stethoscope disinfection to which the health workers adhered following the educational intervention and the provision of alcohol hand rub in the wards.

There are numerous reports which have indicated that regular disinfection of stethoscopes using alcohol-based disinfectants considerably reduced bacteria colonization of stethoscope diaphragms [20-22,24-26]. In a recent study, Mehta *et al.* clearly demonstrated that the alcohol-based hand rubs were efficacious in the disinfection of stethoscopes used by health workers [24]. Therefore, it is our opinion that continuous availability of alcohol-based hand rubs will not only enhance hand hygiene compliance, but will also serve for the disinfection of non-critical medical devices such as the stethoscopes used by health workers.

Among the stethoscopes contaminated with bacterial, analysis showed a high rate of *Staphylococcus aureus* colonization (44.4%). In our pilot study, a *Staphylococcus aureus* contamination rate of 53.6% was recorded [5]. A number of previous investigations found *Staphylococcus aureus* on 15.8% to 89% of stethoscopes used by health workers [26-29]. *Staphylococcus aureus* is known to have developed resistance to most conventional antibiotics [30]; this was also observed in the antibiotic sensitivity test results in this study. The contamination of stethoscopes with MRSA has been described [21], and implies an urgent need for health workers to adhere to stethoscope disinfection practices to prevent the transmission of MRSA to patients in healthcare facilities.

The importance of disinfecting stethoscopes is demonstrated in this study as a strategy to reduce the transmission of health care-acquired infection in the hospital via such non-critical medical devices. The campaign resulted in a comparatively lower stethoscope contamination rate compared to the outcome of the pilot study. The link between hand hygiene and stethoscope disinfection has already been established in a previous investigation by Schroeder *et al.*, who noted that simultaneously using hand foam to clean hands and stethoscope heads reduces bacterial counts on stethoscopes [19]. The current study has shown that an intervention strategy involving training/education and introduction of alcohol-based disinfectants is an inexpensive but very effective method of tremendously improving stethoscope disinfection compliance among health workers in low-income settings.

Conclusions

This study has exposed the high contamination rates of stethoscopes used by doctors and nurses. The study also demonstrates that nurses were more aware than doctors about the need to clean their hands and stethoscopes and also more compliant with infection control practices. The intervention measures that were instituted–training and easy availability of disinfectant –proved very effective in improving compliance. The main limitation of this study was the time lag between the pilot study and the actual study. This time lag may have influenced the outcome of this study, although we believe that the influence may not have been sufficiently significant to alter the overall outcome of the study. This is because the conditions and the staff of the hospital at both the pilot phase and the intervention phase were virtually the same.

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