The Effect of an Educational Intervention on the Contamination Rates of Stethoscopes and on the Knowledge, Attitudes, and Practices Regarding the Stethoscope Use of Healthcare Providers in a Tertiary Care Hospital*
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ABSTRACT

Objective: To determine the effects of an educational intervention on the contamination rates of stethoscopes and on the knowledge, attitudes, and practices (KAP) regarding stethoscope use of healthcare providers in a tertiary care hospital.

Methods: A quasi-experimental before and after study was conducted in a tertiary hospital wherein 90 stethoscopes of 172 healthcare providers were cultured. The provider’s KAP regarding stethoscope use were determined via a validated questionnaire. Both cultures and questionnaires were done unannounced before and four weeks after providing the experimental group with a 30-minute lecture-demo, posters, and flyers addressing nosocomial infections and the importance of stethoscope cleaning and hand hygiene.

Results: Sixty-nine percent of the 90 stethoscopes were contaminated. Sixty-eight of these stethoscopes were owned personally, while 22 were unit or shared stethoscopes. Thirty-two (77.1%) of the 45 stethoscopes from the experimental group and 30 of 45 stethoscopes (66.7%) from the control group had bacterial growth after 48 to 72 hours of incubation. The most common isolate was Staphylococcus sp. at 77.4%. Majority (97%) of the respondents believed that stethoscopes are potential vectors of infection. However, only 34% of the respondents cleaned their stethoscopes more than once daily and only 33% had cleaned it within the past 24 hours. High workload and lack of awareness were cited as reasons for not adhering to stethoscope care recommendations. The post-intervention contamination rates were significantly lower in the experimental group compared to the control (11.4% vs 44.2% for the control; p=0.001). Compared with the control, most of the KAP answers of the experimental group improved after the intervention (p<0.001).

Conclusion: Overall, the educational intervention significantly reduced the contamination rates of the stethoscopes coinciding with an improvement in the KAP answers of the experimental group compared with the control. Although these improvements are encouraging, the involvement of all healthcare providers and efforts to sustain these effects should be promoted.

Keywords: stethoscope, contamination rates, educational intervention, knowledge, attitudes, practices
Hospital-acquired infections exact a tremendous toll, resulting in increased morbidity and mortality and increased health care costs. Health care workers may be potential sources of these infections, because they can transmit a significant number of pathogens through hand carriage. The transmission of nosocomial infections through contaminated medical devices has been demonstrated in several studies done locally and abroad. Outbreaks of infection involving thermometers, gloves, blood pressure cuffs, and stethoscopes have also been documented in several studies. These form part of the rationale for the aggressive information campaigns among health care personnel to wash their hands before and after seeing each patient.

Stethoscopes have been recently shown to harbor various organisms on their diaphragm surfaces with coagulase-negative staphylococci as the predominant isolate. Studies have also shown that stethoscope cleaning practices are not only suboptimal but that health care personnel are resistant to improving these practices.

**Review of Related Literature**

Hospital-associated infections contribute significantly to morbidity and mortality and, consequently, to increased hospitalization costs. It is estimated that the odds of death are doubled for patients who develop hospital-associated infections, although clearly, factors such as underlying disease and severity of illness also contribute to the outcome. Although immunosuppressed hosts are especially vulnerable to infections acquired in a hospital, common hospital-associated infections occur even in immunocompetent hosts.

The most common nosocomial infections have remained the same over the years. Urinary tract infections, pneumonia, and surgical-site infections are most frequent. However, primary bloodstream infections, especially those associated with intravascular devices, have increased in frequency, as have infections in medical and surgical intensive care units (ICUs) and infections caused by antimicrobial-resistant pathogens.

Nosocomial infections are usually spread by health care workers themselves. Such spread has been observed to be transmitted through infected oxygen tubings, gloves, catheters, and, in limited studies, stethoscopes. In a study done by Patterson et al, an outbreak of *Acinetobacter* infections was attributed to transmission via contaminated gloves. A study done by Livornese showed that the nosocomial outbreak of infection due to a highly vancomycin-resistant strain of *Enterococcus* is the first epidemic in which an electronic thermometer was implicated as the vehicle of transmission of an infectious agent.

The study of Marinella, et al. showed that 100% of stethoscopes sampled from the health care workers at the University of Michigan Medical Center were contaminated with coagulase-negative staphylococci and other bacteria. A similar local study done by Purino, et al. involving 30 respondents showed that 57% of stethoscopes sampled from health care workers from the Santo Tomas University Hospital grew potentially pathogenic bacteria, the most common of which was *Staphylococcus aureus*. In the neonatal ICU (NICU), where pediatric patients are most susceptible, Wright, et al. found a direct correlation between stethoscope misuse and colonization of bacteria.

Although most patients might not be especially prone to infection after contact with contaminated stethoscopes, patients with open wounds such as those with burns or tracheostomies and severely immunocompromised patients, such as preterm neonates with catheters and tubings, may be colonized by potential pathogens. Infection may develop in these patients at a later time. Another important possibility is the dissemination of multi-resistant organisms that may manifest as an outbreak that may be traced to the use of contaminated thermometers, gloves or blood pressure cuffs. Handwashing and barrier protection remain the simplest and most important infection control measures. However, hospital personnel remain poorly compliant with these measures.

Most studies reveal that stethoscopes used only in designated areas were contaminated less frequently than stethoscopes belonging to individual medical personnel. Likewise, cleaning the stethoscope diaphragm reduces the bacterial count effectively. In one study, the bacterial count was reduced by 94% with alcohol swabs, 90% with non-ionic detergent and 75% with antiseptic soap. A study comparing the efficacy of immediate versus daily cleaning of stethoscope using 66% ethyl alcohol, showed comparable effects between...
the two interventions, with reduction rates of 28% and
25%, respectively.14 Direct correlation studies between
hospital nosocomial infection rates and stethoscope
misuse have not been done yet. Thus, investigating
the attitudes and practices toward stethoscope use is
important to come up with specific and well-directed
measures. Similar descriptive surveys on stethoscope
practices done done abroad and locally were mostly on adult
patients with varying results.

Some studies have been done to improve
compliance with handwashing and stethoscope
cleaning. Barriers to compliance to an infection
control program that have been identified include
inaccessible cleaning agents, high workload,
insufficient knowledge of recommended guidelines,
lack of awareness of the impact of the program,
forgetfulness, and insufficient time.16, 17

The Hospital Infection Control Committee (ICC)
of The Medical City maintains a policy that classifies
the stethoscope as a non-critical item, which means
that because the stethoscope does not come in contact
with mucous membranes, it only needs low-level
disinfection using soap and water and/or 70% alcohol.21
Some stethoscope manufacturers provide instructions
on the care and maintenance of stethoscopes. 3M,
maker of Littmann stethoscopes, and MedPass
provide their products with these instructions.2, 24 In
2007, the Centers for Disease Control issued a new
guideline which advises health care facilities to
develop and implement policies and procedures to
ensure that reusable patient care equipment is cleaned
and reprocessed appropriately before use on another
patient.20 Despite these recommendations, stethoscope
cleaning practices remain sub-optimal. This study aims
to determine if potential pathogens of infection are
present in a pediatric and adult health care provider’s
basic diagnostic tool – the stethoscope, to determine
health care workers’ KAP about stethoscope care,
and to determine the reasons for non-compliance to
stethoscope care recommendations.

OBJECTIVES

1. To determine the effect of an educational
   intervention on the bacterial contamination rates
   of stethoscopes of health care providers
2. To determine the effect of an educational
   intervention on the knowledge, attitudes, and
   practices of healthcare providers regarding
   stethoscope care and use
3. To determine the reasons for non-adherence to
   stethoscope care recommendations
4. To correlate healthcare providers’ knowledge,
   attitudes, and practices with the bacterial
   contamination rates of stethoscopes

MATERIALS AND METHODS

Setting. The study was conducted in a tertiary private
hospital that provides primary and tertiary medical
care for residents of Pasig City and surrounding areas.
Handwashing facilities are conveniently located
throughout the hospital. Non-medicated soaps, paper
towels and alcohol-based disinfectants are available
in all areas. The units are divided into pediatric,
medicine, OB, and surgical floors with a bed capacity
of 35 patients each. Each unit is provided with an
average number of five stethoscopes per floor but staff
members are allowed to bring their own stethoscopes.
The Neonatal and Adult Intensive Care Units are
provided with about 15 stethoscopes each unit, to be
used by about 15-30 personnel (1:1-2 ratio). The adult
and pediatric emergency rooms (ERs) are provided
with one to three stethoscopes per unit. Most of the
nurses assigned in the ER, ICU, and NICU use the
unit stethoscopes instead of bringing their own stethoscopes.

Research design. A quasi-experimental before
and after study was used. Duration of the study was 6
weeks.

Sampling procedure. Pediatric and internal
medicine consultant doctors, medical residents,
and nurses serving as health care providers in the
Floors, ER, NICU, and ICU were chosen via multi-
stage sampling. Initially, the health care providers
were divided into two groups: the pediatrics and
the medicine group. The medicine group was arbitrarily
assigned as the ‘odd’ group while the pediatrics
was the ‘even’ group. Using a paper bill, the last 3
digits from the serial number were determined by the
author and a qualified witness. The pediatrics group
was eventually assigned as the experimental group,
while the medicine group was assigned as the control.
A list of all the respondents who bring their own
stethoscopes was made for each of the two groups.
Each was assigned a corresponding number, and the participants were selected using the table of random numbers. All of the nurses from the ICU, NICU, and ER were included as a subgroup of their corresponding departments since they use shared unit stethoscopes. This was done to account for the post-intervention culture results, which they will collectively affect. This design was used to reduce the contamination of subjects during the interventional phase, since each unit of the two groups is compartmentalized.

Validation of the KAP questionnaire. The validation of questionnaires was conducted at another tertiary hospital located in Manila two months prior to the actual study period. The questionnaire was pre-tested for understandability of the questions and subsequently validated using factor analysis to create subscales for the different questions. Four subscales were generated. Cronbach’s alpha coefficient was calculated to test the reliability of the questionnaire. Cronbach’s alpha ranged from 0.61 to 0.93 for the four subscales. (Appendix B.).

Collection of cultures. On the first week of the study period, the diaphragm of the stethoscopes of the control and experimental groups were swabbed by the author and a research assistant and was sent for culture. The cultured stethoscopes were tagged with codes for easy identification during the post-intervention cultures. Collection of specimens for culture was unannounced and participants were not told that a repeat culture would be done after the first one.

All swabs collected were streaked on standard blood agar plates and were incubated for 48 to 72 hours. All organisms isolated were identified using the VITEK machine. The medical technicians were blinded as to the owners of the stethoscopes from which the cultures were obtained. The codes used for tagging the stethoscopes used were the same ones used for labeling the specimens in the agar plates.

Administration of the questionnaire. Simultaneous with the specimen collection for cultures, both groups were asked to answer the revised 5 to 10-minute self-administered questionnaire to gauge their knowledge, attitudes, and practices regarding the care and use of their stethoscopes. Codes corresponding to their stethoscope and culture identification tags were placed on the respondents’ questionnaires. Writing of names on the questionnaire was optional.

The educational intervention. On the second week of the study, an educational intervention was implemented in the experimental group. The intervention lasted for four weeks and consisted of a lecture-demo, performance feedback, and information dissemination (handouts, posters, flyers, stethoscope tags). These strategies aimed to improve knowledge and adherence to stethoscope care (See Appendix).

The 30-minute lecture was conducted by the infection control supervisor with the author’s assistance. The lecture contained some of the policies of the hospital ICC and a demonstration of proper handwashing and stethoscope cleaning. The summary of this lecture was also provided as a handout to them.

The performance feedback results were relayed to the involved units and participants under the experimental group including the result of the baseline stethoscope cultures. Information dissemination provided participants with encouragement and reminders to clean their stethoscopes. The control group, on the other hand, did not receive any of the said interventions until the study period was complete.

On the sixth week of the study period, the effect of the educational intervention was measured by giving the same self-administered questionnaire to both the experimental and control groups and by doing repeat cultures of the participants’ stethoscopes.

Sample size calculation: Using a level of significance of 0.05, power of 95% and previous data showing contamination rates of stethoscope at baseline of 89% (Jones et al, 1995) and contamination rates after an intervention of 56% (Melanson et al., 2003), the computed sample size per group was 36 stethoscopes. To account for a possible dropout rate of 25%, the actual sample size required was 45 stethoscopes per group. The study included a total number of 24 residents, 22 consultants, and 126 nurses. They were divided into the control group, comprised of 11 consultants, 12 residents, 11 nurses with personal stethoscopes, and 58 nurses with shared stethoscopes, and the experimental group, which consisted of 11 consultants, 12 residents, 11 nurses with personal stethoscopes, and 46 nurses with shared stethoscopes.
DATA ENCODING AND ANALYSIS

Data were encoded in Microsoft Excel. Statistical analysis was done using SPSS version 10. Qualitative data were summarized using frequency distribution. Quantitative data were summarized using mean and standard deviation. Two outcome variables were analyzed before and after the intervention: contamination rates of stethoscopes and the results of the KAP self-report questionnaire. Test for significance of the effect of the intervention for both outcomes was done using chi-square test. Comparison of the result of the KAP before and after the intervention was analyzed using the McNemar test. Level of significance was set at $p < 0.05$

Ethical considerations: The research protocol underwent technical and ethical review and was approved by the Hospital Research Ethics Review Board. The study participants signed a consent form. Their anonymity and confidentiality were guaranteed.

RESULTS

Out of 172 participants, 80 belonged to the experimental group and 92 were in the control group. Thirty-three were males while 139 were females. Thirty-four percent of the respondents were from the ICUs. One hundred-twenty six of the respondents were nurses; the rest were consultant physicians and medical residents. The participants’ mean age was 27.8 years old. (SD 6.65). Sixty percent of the respondents used unit or shared stethoscopes. Mean length of practice was two and a half years with a mean patient contact of 11 hours per day (SD 6.04), 43 hours per week (SD 18.95). Majority of the subjects (64) used the Littmann brand of stethoscope. Table 1 shows the baseline characteristics of the respondents in the experimental and control groups.

Ninety stethoscopes comprised the study sample. Twenty-two were shared stethoscopes; the rest were personally owned. Among the 90 stethoscopes cultured in the pre-test, 62 (69%) were colonized. Thirty-two colonized stethoscopes were from the experimental group. Out of the 22 shared stethoscopes, 16 (72.7%) were colonized.

Table 1. Comparison of Respondents’ Profiles in the Experimental and Control Groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental (n=80)</th>
<th>Control (n=92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>Females</td>
<td>73</td>
<td>66</td>
</tr>
<tr>
<td>Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floors</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>ICU</td>
<td>0</td>
<td>54</td>
</tr>
<tr>
<td>NICU</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>ER</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>Role</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultant</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Resident</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Nurse</td>
<td>57</td>
<td>69</td>
</tr>
<tr>
<td>Stethoscope ownership</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Shared/unit</td>
<td>46</td>
<td>58</td>
</tr>
</tbody>
</table>
were colonized. Nine stethoscopes were from the experimental group, while the remaining seven were from the control group. The consultant physicians’ stethoscopes had the highest contamination rate. Ninety-one and 81.8% of the consultants’ stethoscopes were colonized in the experimental and in the control group, respectively. Table 2 shows that rates of stethoscope contamination did not differ significantly according to ownership, area of assignment or role before the intervention.

Post-intervention, there were significantly less colonized stethoscopes of staff in the floors and in the ER in the experimental group compared to the control group. The proportion of contaminated stethoscopes used by nursery staff in the experimental group was reduced from 71% to 31.2% (Tables 2 and 3).

### Table 2. Pre-intervention Stethoscope Contamination Rates and Distribution According to Ownership, Unit, and Users’ Role

<table>
<thead>
<tr>
<th>Ownership</th>
<th>Experimental (n=45)</th>
<th>Control (n=45)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall contamination rate</td>
<td>32/45 (71.1%)</td>
<td>30/45 (66.7%)</td>
<td>0.65*</td>
</tr>
<tr>
<td>Stethoscope ownership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared (n=22)</td>
<td>9/11 (81.8%)</td>
<td>7/11 (63.6%)</td>
<td>0.34*</td>
</tr>
<tr>
<td>Personal (n=68)</td>
<td>23/34 (67.6%)</td>
<td>23/34 (67.6%)</td>
<td>0.92*</td>
</tr>
<tr>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floors (n=42)</td>
<td>13/21 (61.9%)</td>
<td>12/21 (57.0%)</td>
<td>0.90*</td>
</tr>
<tr>
<td>ICU (n=17)</td>
<td>0</td>
<td>12/17 (71.0%)</td>
<td></td>
</tr>
<tr>
<td>NICU (n=18)</td>
<td>16/18 (88%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>ER (n=13)</td>
<td>3/6 (50.0%)</td>
<td>6/7 (85.7%)</td>
<td>0.16*</td>
</tr>
<tr>
<td>Role</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultants (n=22)</td>
<td>10/11 (90.9%)</td>
<td>9/11 (81.8%)</td>
<td>0.88*</td>
</tr>
<tr>
<td>Residents (n=24)</td>
<td>8/12 (66.7%)</td>
<td>6/12 (50.0%)</td>
<td>0.41*</td>
</tr>
<tr>
<td>Nurses (n=44)</td>
<td>14/22 (63.6%)</td>
<td>15/22 (68.2%)</td>
<td>0.75*</td>
</tr>
</tbody>
</table>

*not significant

Two out of the 90 stethoscopes grew more than one organism. Seventy-seven percent of the colonized stethoscopes in the pre-test group grew *Staphylococcus* sp. The rest were colonized with *Streptococcus* sp., *Bacillus* sp., *Acinetobacter* sp., *Sphingomonas* sp., and *Corynebacterium* sp. (Table 4). Seventy-three percent of 22 shared stethoscopes and 67% of 68 personal stethoscopes were colonized.

For the KAP, 97% of the respondents believed that stethoscopes are potential vectors of infection. Thirty percent of the respondents were aware of the maintenance recommendations provided in the brochure of their stethoscopes and 46% were aware of the Hospital ICC guidelines regarding stethoscope care. However, only 34% cleaned their stethoscopes more than once a day and only 33% had cleaned their stethoscopes in the past 24 hours. Thirty percent of the respondents cleaned their stethoscopes before or after every patient use. Sixty-two percent felt safe using their stethoscopes on their family or relatives without fear of making them ill. Twenty-two percent knew that stethoscopes are non-critical items but only 16% knew that only low level of disinfection is needed. Majority (88%) knew that cleaning stethoscope diaphragms reduces bacterial count effectively, 97% responded the same for alcohol as a cleaning agent. Ninety-seven percent knew that hands may be a source of infection and 67% knew that the single most important reason for healthcare workers to practice good hand hygiene and stethoscope cleaning is to prevent infections that patients may acquire from the hospital.

The answers of both the experimental and control group during the pre-test were comparable except for four of the 14 KAP questions. A greater number of respondents from the control group were more aware of the maintenance recommendations provided in their stethoscopes. However, more respondents from the experimental group answered correctly.
that stethoscopes may function as potential vehicles of infection. Forty-two percent of the experimental group cleaned their stethoscopes more than once a day as compared with the 26% of the control group. Forty percent of the experimental group cleaned their stethoscopes before or after patient use while only 23% did the same in the control group.

Post-intervention, the answers of the experimental group improved compared with the control. Most of the answers from the experimental group showed an improvement from the control except for 3 of 14 KAP questions. (Tables 5 and 6)

Using the McNemar test, Table 7 shows the summary of changes in the answers from pre-test to post-test. The intervention resulted in an improvement in the answers of the experimental group; almost no change was seen in the answers of the control group. In fact, the results for two questions on knowledge and one question on practice deteriorated for the control group post-intervention.

Table 5. KAP Questions for Which the Study Intervention Resulted in a Significant Difference in Positive Answers Between the Control and the Experimental Group

<table>
<thead>
<tr>
<th>Questions</th>
<th>Positive Answers Pre-intervention</th>
<th>Positive Answers Post-intervention</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total  n (%)</td>
<td>Experimental  n (%)</td>
<td>Control  n (%)</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance recommendations</td>
<td>51 (29.7%)</td>
<td>18 (22.5)</td>
<td>33 (35.9)</td>
</tr>
<tr>
<td>HICC policy awareness-Q6</td>
<td>79 (45.9%)</td>
<td>38 (47.5)</td>
<td>41 (44.6)</td>
</tr>
<tr>
<td>Re-usable item-Q18</td>
<td>37 (21.5%)</td>
<td>18 (22.5)</td>
<td>19 (20.7)</td>
</tr>
<tr>
<td>Level of disinfection-Q19</td>
<td>28 (16.3%)</td>
<td>12 (15.0)</td>
<td>16 (17.4)</td>
</tr>
<tr>
<td>Cleaning with soap and water-Q26</td>
<td>137 (79.7%)</td>
<td>61 (76.3)</td>
<td>76 (82.6)</td>
</tr>
<tr>
<td>Bacterial transmission-Q32</td>
<td>160 (93.0%)</td>
<td>77 (96.3)</td>
<td>83 (90.2)</td>
</tr>
<tr>
<td>Role of stet-Q33</td>
<td>106 (61.6%)</td>
<td>58 (72.5)</td>
<td>48 (52.2)</td>
</tr>
<tr>
<td>Important reason for stet cleaning-Q35</td>
<td>116 (67.4%)</td>
<td>58 (72.5)</td>
<td>58 (63.0)</td>
</tr>
<tr>
<td><strong>Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel safe to use stet for relatives-Q28</td>
<td>107 (62.2%)</td>
<td>49 (61.3)</td>
<td>58 (63.0)</td>
</tr>
<tr>
<td><strong>Practice</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of stet cleaning-Q11</td>
<td>58 (33.7%)</td>
<td>34 (42.5)</td>
<td>24 (26.1)</td>
</tr>
<tr>
<td>Stet last cleaned-Q12</td>
<td>57 (33.1%)</td>
<td>29 (36.3)</td>
<td>28 (30.4)</td>
</tr>
<tr>
<td>When stet is cleaned-Q15</td>
<td>53 (30.8%)</td>
<td>32 (40.0)</td>
<td>21 (22.8)</td>
</tr>
</tbody>
</table>

† - significant

Table 6. KAP Questions for Which the Study Intervention Did Not Result in a Significant Difference in Positive Answers Between the Control and the Experimental Group

<table>
<thead>
<tr>
<th>Questions</th>
<th>Positive Answers Pre-intervention</th>
<th>Positive Answers Post-intervention</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total  n (%)</td>
<td>Experimental  n (%)</td>
<td>Control  n (%)</td>
</tr>
<tr>
<td><strong>Knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning with alcohol-Q26</td>
<td>168 (97.7%)</td>
<td>79 (98.8)</td>
<td>89 (96.7)</td>
</tr>
<tr>
<td>Hands as source for infection-Q31</td>
<td>166 (96.5%)</td>
<td>78 (97.5)</td>
<td>88 (95.7)</td>
</tr>
<tr>
<td><strong>Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stet as potential vector-Q30</td>
<td>167 (97.1%)</td>
<td>77 (96.3)</td>
<td>90 (97.8)</td>
</tr>
</tbody>
</table>

* - not significant
Table 7. Comparison of Change of KAP Answers Between the Experimental and the Control Group, Pre- and Post-intervention

<table>
<thead>
<tr>
<th>Questions on Knowledge</th>
<th>NA to A</th>
<th>Experimental A to NA</th>
<th>p-value</th>
<th>NA to A</th>
<th>Control A to NA</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance recommendations awareness-Q6</td>
<td>38</td>
<td>0</td>
<td>&lt;0.001†</td>
<td>13</td>
<td>11</td>
<td>0.84*</td>
</tr>
<tr>
<td>HICC policy awareness-Q17</td>
<td>37</td>
<td>0</td>
<td>&lt;0.001†</td>
<td>14</td>
<td>16</td>
<td>0.86*</td>
</tr>
<tr>
<td>Re-usable item-Q18</td>
<td>48</td>
<td>1</td>
<td>&lt;0.001†</td>
<td>14</td>
<td>3</td>
<td>0.01*</td>
</tr>
<tr>
<td>Level of disinfection-Q19</td>
<td>50</td>
<td>0</td>
<td>&lt;0.001†</td>
<td>12</td>
<td>8</td>
<td>0.50*</td>
</tr>
<tr>
<td>Cleaning with soap and water-Q25</td>
<td>15</td>
<td>1</td>
<td>&lt;0.001†</td>
<td>5</td>
<td>9</td>
<td>0.42*</td>
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<tr>
<td>Cleaning with alcohol-Q26</td>
<td>0</td>
<td>0</td>
<td>1.00*</td>
<td>1</td>
<td>0</td>
<td>1.00*</td>
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<tr>
<td>Hands as source for infection-Q31</td>
<td>2</td>
<td>1</td>
<td>1.00*</td>
<td>3</td>
<td>3</td>
<td>1.00*</td>
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<tr>
<td>Bacterial transmission-Q32</td>
<td>2</td>
<td>4</td>
<td>0.69*</td>
<td>4</td>
<td>10</td>
<td>0.18*</td>
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<tr>
<td>Role of stet-Q33</td>
<td>17</td>
<td>4</td>
<td>0.01†</td>
<td>2</td>
<td>11</td>
<td>0.02†</td>
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<tr>
<td>Important reason for stet cleaning-Q35</td>
<td>15</td>
<td>6</td>
<td>0.08*</td>
<td>3</td>
<td>22</td>
<td>&lt;0.001†</td>
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<th>Questions on Attitudes</th>
<th>NA to A</th>
<th>Experimental A to NA</th>
<th>p-value</th>
<th>NA to A</th>
<th>Control A to NA</th>
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<td>Feel safe to use stet for relatives-Q28</td>
<td>25</td>
<td>3</td>
<td>&lt;0.001†</td>
<td>9</td>
<td>11</td>
<td>0.82*</td>
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<tr>
<td>Stet as potential vector-Q30</td>
<td>2</td>
<td>1</td>
<td>1.00*</td>
<td>1</td>
<td>0</td>
<td>1.00*</td>
</tr>
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</table>

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<tr>
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<th>NA to A</th>
<th>Experimental A to NA</th>
<th>p-value</th>
<th>NA to A</th>
<th>Control A to NA</th>
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<tbody>
<tr>
<td>Frequency of stet cleaning-Q11</td>
<td>22</td>
<td>3</td>
<td>&lt;0.001†</td>
<td>2</td>
<td>12</td>
<td>0.01†</td>
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<tr>
<td>Stet last cleaned-Q12</td>
<td>41</td>
<td>0</td>
<td>&lt;0.001†</td>
<td>6</td>
<td>8</td>
<td>0.79*</td>
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<tr>
<td>When stet is cleaned-Q15</td>
<td>18</td>
<td>3</td>
<td>0.001†</td>
<td>2</td>
<td>7</td>
<td>0.18*</td>
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*not significant †significant NA-not appropriate A-appropriate

The respondents ranked high workload (48%) and lack of awareness of the impact of stethoscope cleaning (30%) as the two top reasons for non-adherence to stethoscope care recommendations. These same factors were perceived as applicable in the respondent’s current hospital setting (Table 8).

**DISCUSSION**

The stethoscope is considered the most important and basic clinical paraphernalia used by health care personnel in examining patients. However, studies have implicated stethoscopes as potential vehicles of infection.7,8,9,18,22,23 Organisms can spread via stethoscopes following direct contact with colonized or infected patients or from transient hand carriage by clinical staff touching a contaminated stethoscope.

In this study, 69% of 90 stethoscopes had microbial growths. This rate was lower compared with most of the studies done abroad in which the contamination rates of stethoscopes ranged from 80% to 100%.3,7,8,9,10,14,23 However, this rate was higher compared with the result of a local study done by Purino et al., in 2000, in which only 57% of the stethoscope samples were colonized.18

Shared stethoscopes had lower contamination rates compared to personal stethoscopes. This is likely to reflect the wider patient contact and more frequent use of personal stethoscopes by medical staff as deduced by Waghorn et al.22

Doctors’ stethoscopes were contaminated more frequently than the nurses’. Other studies have found similar results.5,8

Eighty-eight percent of stethoscopes used in the NICU were contaminated. This was higher than what Wright et al. reported in 1995 wherein 71% of the stethoscopes in the NICU of a hospital in UK were contaminated.21 In 2004, Melanson et al., reported a 97% contamination rate of stethoscopes used in the ER of St. Luke’s Hospital in Bethlehem.10,11 Our study showed a lower rate of contamination at 69%.

Table 8. Barriers to Stethoscope Care Recommendations Applicable to the Respondent’s Hospital Setting

<table>
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<tr>
<th>Barriers</th>
<th>Yes (%)</th>
<th>No (%)</th>
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<tbody>
<tr>
<td>Accessibility of cleaning agents</td>
<td>39</td>
<td>131</td>
</tr>
<tr>
<td>High workload</td>
<td>113</td>
<td>58</td>
</tr>
<tr>
<td>Insufficient knowledge of recommended guidelines</td>
<td>66</td>
<td>104</td>
</tr>
<tr>
<td>Lack of awareness of the impact of stethoscope cleaning</td>
<td>88</td>
<td>83</td>
</tr>
<tr>
<td>Forgetfulness</td>
<td>56</td>
<td>114</td>
</tr>
<tr>
<td>Lack of time</td>
<td>50</td>
<td>122</td>
</tr>
</tbody>
</table>
Ten species and 27 subspecies were isolated in our study. Similar to previous studies, *Staphylococcus* sp. was the most frequently cultured organism. Other potentially pathogenic organisms that were cultured included *Acinetobacter* sp., *Bacillus* sp., *Sphingomonas* sp., *Pseudomonas* sp., and *Burkholderia* sp.

Most of these isolates were found on doctors’ stethoscopes. These findings are consistent with those of other studies suggesting that stethoscopes are potential sources of infection.

Post-intervention, only 87 stethoscopes were cultured. Three respondents who had personal stethoscopes failed to have their stethoscopes sampled again. A significant decrease in stethoscope contamination rates from 71% to 11% in the experimental group was seen regardless of the unit where the stethoscopes were used. This absolute difference of 60% between pre- and post-intervention contamination rates is more substantial than the 41% reported by Melanson et al.10 On the other hand, the post-intervention reduction in contamination rates were similar for the stethoscopes of resident physicians and for the shared stethoscopes in the control and experimental groups.

Knowledge is defined as the capacity to acquire, retain, and use information; it is a mixture of comprehension, experience, discernment, and skill. Knowledge criteria center on the sense that allows us to distinguish between right and wrong, as studied by logic and the scientific method. Education is the prerequisite of knowledge. Attitude refers to inclinations to react in a certain situations, to see and interpret events according to certain predispositions, or to organize opinions into coherent and interrelated structures. Practice refers to the application of rules and knowledge that leads to action.1

This study used lecture-demo, performance feedback, handouts, and flyers to effect change in the experimental group’s KAP. Lecture-demo type of teaching method has the advantage of being a convenient method of instructing a large group of people. It presents factual materials in direct and logical manner and stimulates thinking to open discussion. It is used to present materials that would be difficult for the listeners to get.

Time constraints, however, may limit the discussion period. The author had difficulty in organizing the experimental group to attend the lecture-demo because some of the participants did not want to report to the hospital when they were not on duty even when the schedule was set and coordinated by the unit head. On the other hand, some of the participants were too preoccupied with work to attend. From the original eight scheduled lectures, four more lectures were added to accommodate the rest of the experimental group. In our study, the pre-test KAP answers of the control and experimental groups were similar. After the intervention, improvement of most of the answers of the experimental group was noted.

The risk factors for non-compliance with infection control programs have been determined objectively by observational studies and by programs to improve compliance. Factors influencing reduced compliance have been identified in two studies. These factors include inaccessible cleaning agents, high workload, insufficient knowledge of recommended guidelines, lack of awareness of the impact of the infection control program, forgetfulness, and insufficient time.16,17 In our study, high workload and lack of awareness of the impact of stethoscope cleaning to infection control were ranked as the topmost reasons for a healthcare provider’s failure to comply with stethoscope care recommendations.

While a significant reduction in the contamination rates of stethoscopes and improvements in the KAP answers were seen post-intervention, long-term continued effects and observational studies are recommended. Prospective studies using other educational interventions should also be determined. Factors associated with non-adherence to stethoscope care recommendations are related not only to the individual worker, but also to the group to which he or she belongs and, by extension, to the parent institution.

The authors also recommend that interventions aimed at improving compliance with stethoscope care recommendations must be based on the various levels of behavior interaction. The interdependence of individual factors, environmental constraints, and institutional climate should be considered in the strategic planning and development of any infection control program.

**Conclusion**

The contamination rate of the stethoscopes of healthcare providers in the study decreased from a baseline of 68.9% to 27.6% after an educational intervention, which consisted of lecture-demo, performance feedback, handouts, and flyers. KAP
answers improved after the intervention. High workload and lack of awareness of the impact of stethoscope cleaning to infection control were identified as barriers to non-adherence to stethoscope care. Overall, the educational intervention significantly reduced the contamination rate of stethoscopes coinciding with an improvement of the KAP answers of the experimental group as compared to the control.

REFERENCES


24. 3M Health Service. General use and maintenance of Littmann stethoscope.
QUESTIONNAIRE

1. General Data:
   - Name (optional)
   - Department (Pediatrics ___ Internal Medicine ___)
   - Age/sex
   - Hospital Unit/Section you are currently assigned (Floors/ICU/NICU/ER, etc, pls specify) ___________
   - Role as health care provider (pls check):
     ___ Consultant
     ___ Resident
     ___ Intern
     ___ Nurse
   - Length of practice in the TMC hospital (number of years/months) ___________
   - Number of hours of patient contact/care (state number of hours)
     How many hours in 24 hours? ______
     How many hours in 1 week? ______

   Please encircle your answer for the questions with the following choices and put a check mark or write your answers on the questions with blanks:
   0 - never
   1 - sometimes or 25% of the time
   2 - often or 50% of the time
   3 - almost always or 75% of the time
   4 - always or 100% of the time

2. Do you use your own stethoscope when examining patients? (pls check one)
   0 1 2 3 4

3. Do you borrow a stethoscope when examining patients? (pls check one)
   0 1 2 3 4

4. Do you use a unit/hospital stethoscope?
   ___ yes  ___ no

   *If you answered YES, please answer 4a-4c; if you answered NO, please proceed to question no 5.

4a. How often do you use the unit/hospital stethoscope?
   0 1 2 3 4

4b. How often is the unit/hospital stethoscope cleaned?
   (provide an estimate number)
   ___ x/day  ___ x/week  ___ x/month
   ___ i don’t know
   Others, pls specify: ______

4c. Who is the person responsible for cleaning the unit/hospital stethoscope? (please check)
   ___ the healthcare provider using it
   ___ housekeeping
   Others, pls specify: ______

5. What is the brand of the stethoscope you are currently using?_______________________

6. Are you aware of the maintenance recommendations provided in the brochure of your stethoscope?
   ___ yes  ___ no

7. How long have you been using your current stethoscope? (provide numbers)
   ___ weeks  ___ months  ___ years
   Others, pls specify: ______

8. How many hours do you use your stethoscope? (Pls answer one)
   ___ hours/day  ___ hours/week
   Others, pls specify: ______

9. Have you previously owned a stethoscope other than what you currently own?
   ___ yes  ___ no

   *If you answered YES, please answer 9a-9b; if you answered NO, please proceed to question no 10.

9a. How often do you replace your stethoscope? (Please answer one)
   ___ x/month  ___  x/year
   Others, pls specify: ______

9b. For what reason did you replace your stethoscope? _______________________

10. How many stethoscopes do you currently own? ______

   *If you answered more than 1, please answer 10a-10b; if you answered just one, please proceed to question no 11.

10a. do you use a different stethoscope for each patient that you see? (choose one)
   0 1 2 3 4

10b. Do you use a different stethoscope for the following settings:
   Hospital patients:  yes ___ no ___
   Private clinic:  yes ___ no ___
   Family/relatives:  yes ___ no ___

   *If the answer is yes, state the reason why: ______

11. How many times do you clean your stethoscope? (please answer one)
   ___ x/day  ___ x/week  ___ x/month
   Others: ______

12. When did you last clean your stethoscope? (check one)
   ___ hours ago (how many?)
   ___ days ago (how many?)
   ___ 1 week ago
   ___ 2-4 weeks ago
   ___ more than 1 month
   ___ never
   Others, pls specify: ______

13. What agent do you use to clean your stethoscope?
   ___ soap and water
   ___ alcohol
   Others, pls specify: ______

14. Do you clean your stethoscope after seeing each patient?
   0 1 2 3 4
15. When do you clean your stethoscope? (Check one)
   ___ after examining 1 patient
   ___ after examining 5 patients
   ___ at the end of your tour of duty
   Others, pls specify: ______

16. Do you use a disposable chest piece for your stethoscope?
   ___ yes   ___ no

   *If you answered YES, please answer 15a-15c; if you answered NO, please proceed to question no 16

15a. why do you use a disposable chest piece? _______

15b. what is the function of a disposable chest piece? _______

15c. How often do you replace your disposable chest piece?
   ___ after each patient
   ___ x/day
   ___ x/week

17. Are you aware of the hospital infection control policies/recommendations regarding care and maintenance of stethoscopes and other medical equipments?
   ___ yes   ___ no

18. Stethoscopes are considered what kind of re-usable item?
   ___ critical
   ___ semi-critical
   ___ non-critical

19. Stethoscopes need what level of disinfection?
   ___ low level
   ___ intermediate level
   ___ high level

20. How often do you wash your hands after seeing each patient?
    0          1          2          3          4

21. Do you carry an alcohol or hand sanitizer inside your pocket?
   ___ yes   ___ no

   If yes, how often do you use this pocket alcohol/hand sanitizer to disinfect your:
   a. Hands?
      0          1          2          3          4
   b. stethoscope?
      0          1          2          3          4

22. Do you feel that you can improve your compliance with stethoscope care recommendations?
   ___ yes   ___ no   ___ possibly

23. What do you think are the possible hindrances/barriers for a healthcare provider to comply with the stethoscope care recommendations?
   (Please rank, 1-most likely reason; 6-least likely reason)
   ___ accessibility of cleaning agents
   ___ high workload
   ___ insufficient knowledge of recommended guidelines
   ___ lack of awareness of the impact of stethoscope cleaning on prevention of infection spread
   ___ forgetfulness
   ___ insufficient or lack of time
   Others, pls specify: ______

24. Among the possible hindrances/barriers to stethoscope care recommendations listed above, which do you think are applicable in TMC? (pls check)
   ___ accessibility of cleaning agents
   ___ high workload
   ___ insufficient knowledge of recommended guidelines
   ___ lack of awareness of the impact of stethoscope cleaning on prevention of infection spread
   ___ forgetfulness
   ___ insufficient or lack of time
   Others, pls specify: ______

25. Cleaning stethoscope diaphragms with soap and water reduces bacterial count effectively (pls check one)
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t know/uncertain

26. Cleaning stethoscope diaphragms with 70% alcohol reduces bacterial count effectively (pls check one)
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t know/uncertain

27. In your observation, disinfection after each stethoscope use is not an established practice by TMC healthcare providers (pls check one)
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t know/uncertain

28. I feel safe to use the stethoscope I’m using now, in its current state, to examine my family/relatives without the fear of making them ill
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t know/uncertain

29. I feel that medical practitioners should use a different stethoscope for each patient
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t know/uncertain

30. I believe that stethoscopes are potential vectors of infection
   ___ strongly agree
   ___ agree
   ___ disagree
   ___ strongly disagree
   ___ don’t care/uncertain

31. When a healthcare worker touches a patient who is colonized, but not infected with resistant microorganisms, the healthcare worker’s hands are a source for spreading these microorganisms to other patients.
___strongly agree
___agree
___disagree
___strongly disagree
___don’t care/uncertain

32. Bacteria can be transmitted even if the patient source is not infected.
___strongly agree
___agree
___disagree
___strongly disagree
___don’t care/uncertain

33. What role do a stethoscopes play in the transmission of infectious agents? (pls check one)
___source
___host
___vector

34. After examining a patient, you noticed that your stethoscope diaphragm has been stained with mucus secretions, what will you do first? (Pils check one)
___wipe material away with tissue paper
___go to the nearest sink and wash material with soap and water
___enter another patient’s room and use the stethoscope to examine your next patient
___wipe the material using 70% alcohol

35. What is the single most important reason for healthcare workers to practice good hand hygiene and stethoscope cleaning? (pls. check one)
___to remove visible soiling from hands/stethoscope
___to prevent transfer of bacteria from the home to the hospital
___to prevent transfer of bacteria from the hospital to the home
___to prevent infections that patients may acquire from the hospital

36. How often do you clean your hands after touching a patient’s intact skin during examination?

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37. Estimate how often your co-workers clean their hands after examining a patient

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38. Estimate how often your co-workers clean their stethoscope after each patient use

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Did you know?

- Bacterial contamination of stethoscopes have been implicated in the transmission of infections which can contribute to hospital mortality and morbidity.
- Studies have shown that only 0-3% of health care providers clean their stethoscopes regularly.
- Studies have shown that stethoscope cleaning practices are not only sub-optimal but also show that most health professionals are stubbornly resistant to change these practices.
- Culture studies involving stethoscope contamination have isolated coagulase negative staph aureus, alpha-hemolytic strep, Bacillus, Enterococcus, Aspergillus, Candida spp, Neisseria as among the more frequent contaminants.
- Levels of bacterial contamination rise from 0-69% after more than 1 day without cleaning one's stethoscope.
- Studies have shown that cleaning stethoscope diaphragms decreases bacterial count by 94% using alcohol swabs, 90% with non-ionic detergents, and 75% with antiseptic soaps.

Stethoscope Care:

Stethoscopes are considered non-critical items (those that come in contact with intact skin but not mucous membranes) and needs low level of disinfection. Cleaning them with agents such as 70% ethyl or isopropyl alcohol solution, or soap and water are sufficient.

General cleaning tips:

- Your stethoscope can be disinfected with any of the above agents mentioned but it is important that you never immerse your stethoscope in liquid solvents and oils or subject it to any sterilization process, or extreme heat and cold.
- Periodically remove the ear tips and clean them thoroughly.
- It is NOT advisable to wear your stethoscope around your bare neck as this may cause further contamination and stiffening of your stethoscope tubing.
- If possible, follow manufacturer’s care and maintenance instructions specific to their equipment.

When cleaning your stethoscopes, it is advisable to:

- Wash your hands thoroughly with soap and water before cleaning your stethoscope.
- Clean your stethoscopes before use on every patient, every time they become soiled with blood or body fluids, or whenever you have any doubts as to the possibility of contamination.
- Use the earlier mentioned recommended disinfecting agents clean your stethoscope using a circular pattern with application of firm pressure.
- Always clean your stethoscopes before storing it with other clean equipment.