The Ever Increasing Reservoirs of Infection in the Health Care Environment – Time for a Sixth Moment of Hygiene

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Abstract

Objectives: The study was carried out to determine the extent and type of contamination of the hands and accessories of staff from different settings and also to determine the phenotypic similarity between the isolates recovered from the same staff.

Design: Prospective cross-sectional study.

Setting: Tertiary care center.

Participants: Health care workers (HCWs') and administrative staff.

Methods: Samples were collected and processed for bacteriology from the dominant hand, mobiles, aprons, stethoscopes and computer keyboards of 280 staff working in different settings after consent. Isolates were identified and antimicrobial susceptibility testing was carried out. A comparison of data sets was performed using chi square test. p value < 0.05 was considered significant.

Results: 817 samples were screened, 616 yielded growth. Contamination rate was found to be 75%. Of the 1254 isolates recovered, Gram positive and gram negative accounted for 80% and 18% respectively. Hands and accessories of HCWs from clinical settings showed significant contamination with potential pathogens as compared to the non-clinical settings. (p<0.0001) All computer keyboards and stethoscopes used by ICU doctors were contaminated. MRSA was recovered only from clinical settings. Two salmonella isolates were isolated from apron of laboratory health care workers. In 102 staff, similar isolates were recovered from hand and any accessory.

Conclusions: The risk of contamination of any accessory with potential pathogens is high in the clinical setting. The five moments of hand hygiene should be strengthened. A policy for decontamination of all accessories should be formulated.

Introduction

Health care associated infections carry the risk of increased morbidity and mortality apart from increased length of stay and cost of treatment.¹ The prevalence of these infections is estimated to be 5 to 10% in developed countries and 25% in developing countries.² Infected or colonized patients or health care workers (HCWs) may act as potential source or vector of transmission of nosocomial infections. From ‘Typhoid Mary’ to computer keyboard, the source has kept pace with technology.³,⁴ Mobile phones, personal digital assistants and computers are being used to increase the efficiency of health care delivery.⁵,⁶ The frequency of contamination of these devices with potentially pathogenic organisms makes them potential reservoirs and vectors of nosocomial infection.⁷,⁸

Studies published in literature have assessed the contamination of any single accessory and few have studied the contribution of the type of setting to the rate and...
The present study was conducted to determine the extent and type of contamination of the dominant hand and accessories, compare the results in different settings and also to determine the phenotypic similarity between the isolates recovered from the same staff.

**Material and Methods**

A prospective cross-sectional study was carried out after taking Institutional Ethics Committee permission, in an 1800 beds tertiary care, teaching hospital.

The sample size for the study based on standard formula at 95% confidence interval, taking into consideration an inherent error of 5% and an average contamination in health care setting for health care workers hands and accessories of 60% was found to be 369. Since this study was non-sponsored, the cost for conducting the study would be high. Therefore a convenient sample size of 280 staff was considered which included intensive care units (50), medical wards (40), surgical wards (40), microbiology laboratory (40), biochemistry laboratory (40) and administrative section (70).

Unannounced visits were made to the different settings to collect samples. After explaining the study, verbal consent of participants was obtained. Sterile swabs wetted with sterile normal saline were used. For each staff recruited, samples were collected from the dominant hand and mobiles of all staff, apron (pockets and cuff), and stethoscope depending on the setting and use. Computer keyboards in the areas of their work were also sampled. After collection, the samples were transported immediately to the laboratory and plated onto sheep blood agar (SBA), MacConkey’s agar and mannitol salt agar. The stethoscopes were also cultured by pressing the diaphragm and bell portion of the stethoscope for 5 seconds onto SBA and MacConkey’s agar.7 The plates were incubated aerobically at 37º C for 48 hours to detect presence or absence of growth. Any growth was identified up to species level as per standard protocol.15 Antimicrobial susceptibility testing, and methicillin resistance status of Staphylococci was carried out by the Kirby Bauer Disk Diffusion method as per CLSI standards.16

The data collected included (i) the type of setting of the subjects recruited in the study (Administrative or clinical setting such as ICU, ward, laboratory etc.) (ii) The item sampled such as hands and accessories (stethoscope, mobile phones, computer keyboard and apron) and (iii) the type of organism grown (potential pathogen or contaminant based on species identification). Based on the culture results, data was analyzed and a comparison of data sets was performed between settings, items sampled and organism isolated. The significance of any difference was determined using chi square test by using Graph pad software. p value <0.05 was considered significant.

For the present study, methicillin sensitive *S. aureus* (MSSA), methicillin resistant *S. aureus* (MRSA), methicillin resistant coagulase negative *Staphylococcus* (MRCoNS), *Enterococci*, Gram negative bacilli and Candida spp. were considered as potentially pathogenic organisms.

**Results**

817 samples were screened as shown in Table 1. Of these, 616 yielded growth of 1254 organisms, giving a culture positivity rate of 75%. 24% (146/616) samples showed mono-microbial growth. Of 280 staff members sampled, one or all the accessories were contaminated in most. In 29 (21 from administration and 8 from biochemistry), none of the samples were found contaminated. The growth detected on hands and other accessories in the different settings is as shown in Table 1. The contamination rate for hands, mobile, stethoscope’s, aprons, and keyboards were 79%, 66%, 91%, 75% and 100% respectively. The hands of health care workers from clinical settings showed a higher contamination rate (92%, 119/130) as compared to other settings (p=0.0001). All the aprons worn by HCW in the ICU setting were found contaminated. The difference in rate of contamination was found to be statistically significant (p=0.0013). The contamination rate of mobile phones varied from 43% (administration) to 88% (HCWs in medical ward) (p<0.0001). All the computer keyboards were contaminated. The difference in the rates of contamination of mobile phones, aprons and hands between the different settings was found to be statistically significant. (Clinical setting vs administration p=0.0001, Clinical setting vs laboratory staff p=0.001).

The microorganisms isolated in the different settings are presented in Table 2. Gram positive cocci (GPC) and Gram negative bacilli (GNB) accounted for 80% and 18%
2% (25/1254) of the isolates were Candida spp. The predominant isolate differed in the different settings. Micrococci and CoNS were the predominant Gram positive isolates [24% (244/1007) and 22% (226/1007)] while Acinetobacter spp was the predominant GNB [49% (109/222)]. MRSA accounted for 17% (44/263) of the potential gram positive isolates and was recovered from clinical settings and microbiology laboratory. The proportion of potential pathogens was maximum in clinical settings. The difference in the rate of contamination with potential pathogens in the different settings was found to be statistically significant (P=0.0001).

An analysis of the isolates recovered from the different samples is given in Table 3. The predominant species for the different types of samples were different. The frequency of contamination with MRSA was more on aprons and hands of health care workers. The proportion of potentially pathogenic organisms recovered from hands, mobiles, stethoscopes, aprons and keyboards were 38%, 38%, 46%, 49% and 36% respectively.

A further analysis was carried out to determine the proportion of HCWs who carried similar organisms (same species with similar antibiogram) on their hands and any of their accessories (Table 4). In 102 staff, potentially pathogenic isolates were recovered belonging to the same species. Hand and mobile correlation was found in 42, hand and stethoscope in 10, hand and apron in 30, hand, mobile, and apron in 12, hand, mobile and stethoscope in 5, hand, apron and stethoscope in 3. Multi-drug resistant Acinetobacter spp. was recovered only as a hand-apron isolate.

**Discussion**

Accessories such as stethoscopes,
hand hygiene has demonstrated reduction in health care associated infection rates.\(^9\) Though the present study did not attempt to determine compliance with hand hygiene, the higher rates of contamination in the clinical settings and the higher proportion of potentially pathogenic organisms carried by HCWs in these settings maybe attributed to reduced compliance with hand hygiene and calls for urgent measures to improve hand hygiene and identify factors responsible for reduced compliance.

The rate of contamination of aprons with known potential pathogens was 49% which is high in comparison with other accessories. In the present study, *Acinetobacter* spp. and MRCoNS were the predominant potential pathogens (25% and 19%). MRSA accounted for 12% of the potential pathogens. High level of contamination of white coats with MRSA has been reported by Gaspard et al and Treakle et al.\(^{10,12}\) In the present study, two *Salmonella* spp. were isolated from the white coats of two laboratory health care workers of microbiology department, of which one developed enteric fever (unpublished data). Isolation of *Salmonella* spp. from hospital environment has been documented in previous studies.\(^{13}\) Material for culture was obtained from apron pockets and cuffs. The pockets of HCWs are touched many times during the day, as they contain items which are of frequent use. In such situations even if hands are washed adequately, they will get contaminated once apron pockets are touched. Snyder et al have documented that disposable gowns and gloves provide a more useful barrier to transmitting antibiotic-resistant organisms among patients in an inpatient setting rather than linen based aprons.\(^{20}\) In areas where the likelihood of contamination is higher such as laboratories and ICUs, disposable or impervious, disinfectant resistant gowns should be worn. In other areas, white coats if worn, should be cleaned daily.

The results of the present study confirm previously reported findings that majority of the stethoscopes tend to be contaminated and CoNS were the predominant isolates.\(^{21,22}\) Stethoscopes come in direct contact with the patient’s skin and therefore, organisms can be transmitted from stethoscope to the skin and vice-versa. There is also the possibility that the organisms thus deposited on the skin can be transferred to other susceptible sites of the patient. Both *S. aureus* and *Acinetobacter* spp. the predominant isolates of present study are capable of causing infection when skin is non intact. A regular decontamination of stethoscope diaphragm with alcohol wipes should be a component of infection prevention.\(^{23}\)

66% of mobile phones sampled in the present study were found to be contaminated of which 38% were due to potential pathogens. Higher contamination rates have been reported in a recent study.\(^{14}\) The difference observed may be because of differences in implementation of infection prevention strategies. Moisture and optimum temperature of human body especially of the palm, with constant handling of mobile phones, facilitates growth. The recovery of *Acinetobacter* spp. as against the other Gram negative bacilli indicates the capability of this bacterium to persist even in dry conditions. Mobiles belonging to administrative staff showed least contamination. There is thus a high risk of contamination with potential pathogens when mobiles are used in a clinical setting. Mobile phones and aprons are an integral part of a HCW’s daily need. Use of computers in health care setting is on the rise for data entry and other activities. Contamination of any of these items with potential pathogens can be detrimental to their health, the patients they care for and house hold members. The present study on the rate of contamination of hands and accessories carried or used by HCWs demonstrated a high rate of contamination of all items with the rate differing between the type of setting and the item. Overall contamination and contamination with known potential pathogens was significantly higher in clinical settings. This may be attributed to inherent factors such as the occurrence of higher number of sources, environmental contamination with nosocomial pathogens which persist better and possible acquired factors such as reduced compliance with both hand hygiene and environmental hygiene. High rate of contamination of various accessories has also been reported in literature.\(^{8,9,10,11,14,17}\)

In the present study, CoNS 22% (226/1007) were the predominant gram positive isolate. *S. aureus* and *Acinetobacter* spp accounted for 22% (114/510) and 21% (109/510) of the potential isolates. Transiently colonized HCWs’ hands have reportedly caused episodes of bacteraemia and/or sepsis. Transient hand flora can be successfully taken care of by routine hand hygiene measures as demonstrated first by Dr Semmelweis in the mid-19\(^{th}\) century.\(^{18}\) However, compliance to hand hygiene varies from 5-89% with an average of 38.7%.\(^{19}\) Improving compliance with

### Table 4: Recovery of similar isolates from hands and any accessory

<table>
<thead>
<tr>
<th>Correlation in accessories</th>
<th>ICU</th>
<th>SW</th>
<th>MW</th>
<th>BL</th>
<th>ML</th>
<th>ADMIN</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand and mobile</td>
<td>12</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>10</td>
<td>3</td>
<td>42</td>
</tr>
<tr>
<td>Hand and stethoscope</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Hand and apron</td>
<td>8</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Hand, mobile, and apron</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Hand, mobile and stethoscope</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Hand, apron and stethoscope</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>16</td>
<td>18</td>
<td>7</td>
<td>22</td>
<td>3</td>
<td>102</td>
</tr>
</tbody>
</table>
phone manufactures do not provide instructions for decontamination. Since these are electronic devices, the choice of agent would have to be carefully selected such that they do not compromise their structural integrity and functionality. Decontamination efficacy of 70% isopropyl alcohol was found to be 93%.21 Mobile phone covers with antimicrobial/antimicrobial properties would be an interesting option.

12 computer keyboards were sampled and all were found contaminated. Contamination with *Acinetobacter* spp. and *Pseudomonas* spp. was 27% and 23% respectively. In patient care areas, keyboards act as reservoirs of pathogens.4,7,23,24 Depending on the environmental condition, pathogens may remain infectious for weeks to months on surfaces. Neglecting the cleaning and disinfection of keyboards increases the risk of HAIs. Rutala et al have documented that keyboards can be successfully decontaminated with disinfectants and have recommended that these should be disinfected daily or when visibly soiled or if they become contaminated with blood.  

The limitations of present study are that, no attempt was made to quantify the number of isolates recovered from each sample, and the relationship of a contaminated accessory to the incidence of nosocomial infection was not investigated. Relatedness of isolates was not determined by molecular methods.

We observed that accessories were frequently contaminated, often touched before and during a procedure and rarely cleaned. They could serve as reservoirs and vectors of potentially pathogenic multi-drug resistant bacteria which can be transmitted between patients, between hospital and home setting and even colonize the health care workers intestinal tract if appropriate measures of hygiene and decontamination are not followed. The high rate of contamination in the ICU setting mandates the implementation of stringent measures to eliminate all possible source of infection and block transmission routes effectively. Different studies have documented the ability of alcohols as an effective decontamination for keyboards and stethoscopes.7,23 The Centers for Disease Control and Prevention (USA) recommends the use of cleanable covers over keyboards and mobile phones to reduce contamination and subsequent transfer of organisms.25 Since the level of contamination can be high in clinical settings and laboratories, the Infection Control Committee of each hospital should formulate its own policies on decontamination of accessories and sensitize healthcare workers on these policies. HCWs on their part should adopt such practices. We suggest that either accessories be considered as belonging to ‘patient surrounding’ and be a part the fifth moment of hand hygiene or add a sixth moment of hand hygiene for ‘after touching accessories’.

**References**


