Characterization and determination of antibiotic susceptibility pattern of bacteria isolated from some fomites in a teaching hospital in northern Nigeria

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Fomites are inanimate objects that can serve as vehicles for pathogens transfer. This study was conducted to determine the antibiogram of bacteria isolated from fomites in a teaching hospital in Nigeria. Exactly 35 samples were used for the study. Twenty three (65.7%) isolates were obtained; the ratio of Gram positive to Gram negative organisms was 12 to 11. The bacteria isolated were Staphylococcus aureus (21.7%), Staphylococcus epidermidis (8.7%), Streptococcus spp. (8.7%), Bacillus spp. (13.0%), Escherichia coli (26.1%), Pseudomonas spp. (8.7%) and Klebsiella spp. (13.0%). The isolated bacteria showed varying susceptibility pattern to the antibiotics used and were all susceptible to erythromycin and streptomycin.

Key words: Bacteria, fomites, antibiotics, susceptibility, teaching hospital, Nigeria.

INTRODUCTION

Fomites consist of either porous or nonporous surfaces or inanimate objects that when contaminated with pathogenic microorganisms can transfer them to a new host thereby serving as vehicles in transmission (Greene, 2009; Cramer, 2013). Fomites are associated particularly with hospital acquired infections (HAIs) that remain a major cause of patient morbidity and mortality (Weber et al., 2010; Nwankiti et al., 2012). An estimated 20 to 40% of HAIs have been attributed to cross infection via the hands of health care workers (HCWs), who have become contaminated from direct contact with the patient or indirectly by touching contaminated hospital environmental surfaces (Kelly, 2002; Christensen et al., 2007; Mangicaro, 2012). Fomites can therefore serve as reservoir with pathogens being spread from the inanimate environment to an animate (patient) environment via the hands of HCWs (Bhalla et al., 2004; Kramer et al., 2006; Ikeh and Isamade, 2011; Nwankiti et al., 2012).

Stethoscopes, neckties (Merlin et al., 2009; Williams and Davis, 2009), skin cells, hair, food, computer keyboards, pens, tables, artificial acrylic fingernails (McNeil et al., 2001), bedding and clothing are common hospital sources of pathogens (Boyce et al., 1997; Cramer, 2013). Up to 60% of hospital staff’s uniforms are usually colonized with potentially pathogenic bacteria, including drug-resistant organisms (Muñoz-Price et al., 2012). Intravenous fluid (IVF) tubes/stands, catheters, water systems and life support equipment can also be carriers, when the pathogens form biofilms on the surfaces (Willey et al., 2011; Cramer, 2013).

Identification of common fomites and associated pathogens in any hospital settings is important because the most important factor in prevention of a disease is to simply identify what has been transferring the disease in the first place (Cramer, 2013). Fomites are therefore an opportunity to interrupt the spread of infection.

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By recognizing them, avoiding them, disinfecting them, or cleansing the hands after touching them, the spread of many infections can be halted (Greene, 2009; Cramer, 2013). This study was therefore conducted to isolate bacteria from fomites in the Accident and Emergency (A&E) ward of Ahmadu Bello University Teaching Hospital, Zaria, Nigeria and to determine their antibiotic susceptibility pattern.

METHODOLOGY

A total of thirty-five (35) samples were collected from fomites (tables, chairs, stethoscopes, pens, uniforms, doorknobs and IVF stands) after the early morning cleaning and disinfection process in the A&E ward of Ahmadu Bello University Teaching Hospital, Zaria between the months of July and October 2010. The samples were collected using sterile swab sticks, transported immediately to the laboratory and cultured using the streak plate method on nutrient agar. Inoculums were prepared by standardizing using the McFarland’s standard. Standard antibiotic discs containing augmentin, ampiclox, seprin, ceftriaxone, ampicillin, ciprofloxa, erythromycin, lincomycin, nitrofurantoin, ofloxacin, streptomycin, tetracycline and gentamycin with concentrations of 30, 3, 250, 30, 15, 25, 10 m, 30, 200, 10, 10, 25, 10 mcg, respectively were used. The discs were placed on the plates which were inverted and kept in the refrigerator for 30 min and then incubated at 37°C for 24 h. A clear zone of growth inhibition around a disc determined the relative susceptibility of each isolate to the antibiotics.

RESULTS AND DISCUSSION

A total of 23 (65.7%) bacterial growths were obtained from the culture with uniforms and IVF stands showing highest number of growth each (80%: 4/5), followed by tables, stethoscopes, pens, door knobs and chairs each having 60% (3/5) (Table 1). The percentage of growth obtained was lower than the 99% obtained in a previous study in Nigeria (Ikeh and Isamade, 2011). Majority of the isolates were Gram positives organisms (52.2%: 12/23) as compared to the Gram negative (47.8%: 11/23). Staphylococci were isolated from all the fomites; S. epidermidis (8.7%: 2/23) from IVF stand and stethoscope and S. aureus (21.7%: 5/23) from the other fomites (Table 2).

Isolation of more Gram positive organisms is consistent with previous reports (Neely and Maley, 2000; Chikere et al., 2008) and agree with the statement that Gram-positive bacteria have overtaken the Gram-negative as the predominant bacteria isolated from fomites (Inweregbu et al., 2005). Gram-positive organism have earlier been noted to be causing more serious infections than ever before in surgical patients, who are increasingly aged, ill and debilitated (Barie, 1998). In a more recent study, only Gram positive organisms were isolated (Ikeh and Isamade, 2011).

Isolation of more Gram positive organisms is probably because they are members of the body flora of both asymptomatic carriers and sick persons. These organisms can be spread by the hand, expelled from the respiratory tract or transmitted by animate or inanimate objects (Chikere et al., 2008). Their main source(s) of colonization on the fomites might likely be nasal carriage by hospital personnel (Graham et al., 2006), likely facilitated by hand-to-mouth or hand-to-nose contact while using these fomites, and/or by poor hand-washing habits (ASM, 2005).

Isolation of Staphylococcus aureus from almost all the fomites show their ubiquitous nature and that they can be sources of infection to patients as previously noted (Hartmann et al., 2004; Inweregbu et al., 2005; Ikeh and Isamade, 2011). Although the strains of the isolated S. aureus were not determined in this study, methicillin resistant Staphylococcus aureus (MRSA) strains have been shown to be transmissible from many fomites to skin (Desai et al., 2011). For example, an earlier study showed that one in three stethoscopes tested to harbour Staphylococcus aureus and that 15% of all stethoscopes tested were contaminated with MRSA (Williams and Davis, 2009).

Table 1. Distribution of growth and organisms isolated from fomites in the A&E ward of ABUTH, Zaria-Nigeria.

<table>
<thead>
<tr>
<th>Fomite</th>
<th>Total no. of sample</th>
<th>Number with growth (%)</th>
<th>Organism(s) isolated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table</td>
<td>5</td>
<td>3 (60)</td>
<td>S. aureus, Bacillus spp.</td>
</tr>
<tr>
<td>Stethoscope</td>
<td>5</td>
<td>3 (60)</td>
<td>S. epidermidis, E. coli Klebsiella spp.</td>
</tr>
<tr>
<td>Uniform</td>
<td>5</td>
<td>4 (80)</td>
<td>S. aureus, E. coli, Streptococcus spp.,</td>
</tr>
<tr>
<td>Pen</td>
<td>5</td>
<td>3 (60)</td>
<td>S. aureus, Bacillus spp, E. coli</td>
</tr>
<tr>
<td>IVF Stand</td>
<td>5</td>
<td>4 (80)</td>
<td>Streptococcus spp., S. epidermidis, Klebsiella spp, Pseudomonas spp.</td>
</tr>
<tr>
<td>Door knob</td>
<td>5</td>
<td>3 (60)</td>
<td>S. aureus, E. coli</td>
</tr>
<tr>
<td>Chair</td>
<td>5</td>
<td>3 (60)</td>
<td>S. aureus, E. coli Bacillus spp.</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>23 (65.7)</td>
<td></td>
</tr>
</tbody>
</table>

S. epidermidis (8.7%: 2/23) from IVF stand and stethoscope and S. aureus (21.7%: 5/23) from the other fomites (Table 2).
Table 2. Frequency of isolation of bacteria from fomites in the A&E Ward of ABUTH, Zaria-Nigeria (N = 23).

<table>
<thead>
<tr>
<th>Bacteria Isolated</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>5</td>
<td>21.7</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td>Streptococcus spp.</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td>Bacillus spp.</td>
<td>3</td>
<td>13.0</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>6</td>
<td>26.1</td>
</tr>
<tr>
<td>Pseudomonas spp.</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>3</td>
<td>13.0</td>
</tr>
</tbody>
</table>

was isolated with the lowest frequency in this study. Though these strains of staphylococci are known to be non-pathogenic on the body, when they harbor antimicrobial resistance genes they constitute serious health hazard. This coagulase negative Staphylococci have been isolated from keyboards on multiple user computers (Hartmann et al., 2004) and increased virulence of this organism resulting from the acquisition of methicillin resistance has been recognized (Ben-Saida et al., 2006).

Other bacteria isolated were Streptococcus spp. (8.7%: 2/23) from IVF stand and uniforms, Bacillus spp. (13.0%: 3/23) from pens, tables and chairs, Escherichia coli (26.1%: 6/23) from all the fomites except table and IVF stand, Klebsiella spp. (13.0%: 3/23) from IVF stand and stethoscopes and Pseudomonas spp. (8.7%: 2/23) from only IVF stand.

Bacillus spp., the only Gram positive bacilli encountered in this study has been isolated with the highest frequency in some studies in Nigeria: 84 (Nwankiti et al., 2012) and 90% (Ikeh and Isamade, 2011). This organism forms endospores, which, probably from the air can settle on the surface of fomites in the hospital, explaining why they were isolated mainly from tables and chairs.

Although, Gram positive organisms were more frequently isolated in this study, the Gram negative bacterium Escherichia coli was the most prevalent. E. coli were isolated from almost all the fomites except IVF stands and tables probably due to fecal contamination as a result of improper hand washing after the use of toilet. This is evident in its isolation from pens, stethoscopes and doorknobs which are usually held and touched by hands.

As previously reported (Williams and Davis, 2009), the Gram negative bacteria Klebsiella spp. and Pseudomonas spp. were isolated from stethoscopes and IVF stand in this study. Gram-negative bacteria are responsible for a high proportion of HAIs, particularly among the critically ill and those in hospital for long periods (Gould and Chamberlain, 1994).

The isolated bacteria showed varying susceptibility pattern to the antibiotics used (Table 3). All the S. aureus and S. epidermidis isolates were sensitive to erythromycin and streptomycin (100%). Streptococcus spp. were most sensitivity (100%) to ciprofloxacin, septrin, erythromycin, streptomycin and ampiclox. All the isolated E. coli were susceptible to gentamycin, cephalaxin and chloramphenicol while all the isolated Pseudomonas spp. were susceptible to gentamycin and ofloxacin. Similarly, all the Klebsiella spp. isolates were susceptible to gentamycin, ceftriazone, chloramphenicol and ampicillin.

Susceptibility of all the organisms isolated to Erythromycin and Streptomycin does not necessary imply that these antibiotics may represent therapeutic options for infections caused by these organisms. S. aureus and S. epidermidis showed similar susceptibility pattern being

<table>
<thead>
<tr>
<th>Organism</th>
<th>CN</th>
<th>OFX</th>
<th>CPX</th>
<th>CRO</th>
<th>SXT</th>
<th>E</th>
<th>L</th>
<th>S</th>
<th>APX</th>
<th>AG</th>
<th>COX</th>
<th>C</th>
<th>N</th>
<th>PM</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
<td>40</td>
<td>40</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>100</td>
<td>80</td>
<td>100</td>
<td>80</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S. epidermidis</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Streptococcus spp.</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<td>50</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>Bacillus spp.</td>
<td>33.3</td>
<td>33.3</td>
<td>66.7</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>66.7</td>
<td>66.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E. coli</td>
<td>100</td>
<td>50</td>
<td>83.3</td>
<td>66.7</td>
<td>83.7</td>
<td>50</td>
<td>100</td>
<td>83.3</td>
<td>100</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pseudomonas spp.</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Klebsiella spp.</td>
<td>100</td>
<td>100</td>
<td>33.3</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>66.7</td>
<td>66.7</td>
<td>100</td>
<td>66.7</td>
<td>100</td>
<td>66.7</td>
<td>66.7</td>
</tr>
</tbody>
</table>

CN = Gentamycin; OFX = ofloxacin; CPX = ciprofloxacin; CRO = ceftriazone; SXT = cotrimoxazole; E = erythromycin; L = lincomycin; S = streptomycin; APX = ampiclox; AG = augmentin; COX = cephalaxin; C = chloramphenicol; N = nitrifurantoin; PM = ampicillin; T= tetracyclin.
highly susceptible to Streptomycin and resistant to Augmentin. Augmentin may therefore not be a drug of choice for treatment of infections caused by these organisms. The Gram positive isolates were resistant to gentamycin and ofloxacin while the Gram negative isolates were resistant to Cotrimozazole, indicating that these antibiotics might not be very effective in the treatment of HAIs that might result from infection with these pathogens. Similar weakness and susceptibility in activity of antibiotics against bacteria from clinical specimens have been shown (Chikere et al., 2008). As more bacteria become resistant to antibiotics, the ability to control the spread of these bacteria with antibiotic treatments decreases.

The isolation of potential pathogenic such as S. aureus and Strepococcus spp. from IVF stands and uniforms of HCWs in the A&E ward confirms the possibility of cross infections from workers to patients. This implies that these fomites might act as vehicles for transfer of these pathogens hence etiologic agents for infectious pathogens. Many studies have shown uniforms to be potential reservoirs for hospital organisms, potentially re-infecting the hands of HCWs (Boyce et al., 1997; Snyder et al., 2008; Munoz-Price et al., 2012). Trealke et al. (2009) showed a large proportion of HCWs' white coats to be contaminated with S. aureus, including MRSA and postulated that white coats may be an important vector for patient-to-patient transmission of S. aureus. Potential pathogens such as S. aureus, Acinetobacter spp. and enterococci have been recently isolated from hands that were used to touch uniforms (Munoz-Price et al., 2012). Similarly, isolation of E. coli from door knobs simply implies that they can be easily transmitted to anybody that opened the door to the A&E ward. One can therefore easily postulate how these fomites could become vectors for the spread of pathogenic organisms in the A&E ward as a HCW moves from one patient to another and these fomites contacts different patients.

In the A&E Ward of ABUTH, we observed that reusable cleaning cloths soaked in bucket of water containing OmoR detergent are used irregularly to clean door knobs and tables; while methylated spirit is used to clean the IV stands once or twice a week. Floors are cleaned with mops dipped in diluted SalvonR every morning and evening while JikR is used only when there is contamination with blood. The cloths and mops used in cleaning are however not adequately cleaned and disinfected, as most often, the water containing the disinfectant is not changed until the cleaning is completed. It has been shown that if water-disinfectant mixture used in cleaning is not changed regularly, the mopping procedure actually can spread heavy microbial contamination throughout the health-care facility (Mangicaro, 2012). Irregular cleaning and effective disinfection of door knobs to the A&E ward, tables, chairs and IV stands in the ward may allow pathogens that contaminate them by settling on them or by hand, to survive and be transmitted to patient or HCWs. Although surface cleaners play a role in reducing the spread of infections, not all disinfectants work equally well at killing all pathogens (Boskey, 2011). Some pathogens are more susceptible to specific detergents than others. Therefore, the need for regular cleaning and effective disinfection of fomites identified to be easily contaminated with specific pathogens is very crucial. The effective use of disinfectants constitutes an important factor in preventing HAIs and improved cleaning/disinfection of environmental surfaces and hand hygiene have been shown to reduce the spread of hospital acquired pathogens (Rutala and Weber, 2001; Nicolle, 2002; Christensen et al., 2007; Weber et al., 2010; Boskey, 2011).

Conclusion and recommendation

The isolation of pathogenic bacteria from fomites in this study indicates that they can be vehicles for disease transmission. In the light of this, there is need therefore for thorough disinfection and conscientious contact control procedures to minimize the spread of these pathogens in the A&E ward where interaction between patients, HCWs and caregivers is very common and frequent. It is also necessary to encourage the effective use of disposable hand gloves between patients and to avoid touching fomites with gloved hands, which may be acting as sources of infection.

Limitation of study

Small sample size and inability to determine if the S. aureus isolated were MRSA.

ACKNOWLEDGEMENTS

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REFERENCES


