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Comparison of Antibiotic Susceptibility of Bacterial Communities on Cell Phones Belonging to Health Care Workers and Non-Health Care Workers

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ABSTRACT

The frequent use of cell phones inside of health care facilities produces a risk of contamination of the phones with potentially pathogenic bacteria. The elevated use of antibiotics within these health care facilities may also contribute to heightened levels of antibiotic resistant strains on these devices. To assess this, bacterial samples were collected from health care workers' and non-health care workers' cell phones. The bacterial isolates were assessed for antibiotic resistance via the Kirby-Bauer method. Eleven out of nineteen of the bacterial isolates from the health care workers cell phones displayed resistance to at least one antibiotic. According to our study, the lower amount of resistance of the bacteria isolated from the health care worker samples compared to the non-health care worker samples leads us to conclude that there is not a higher prevalence of antibiotic resistant bacteria on health care workers' phones.

1 INTRODUCTION

Bacterial cells are found on every surface from cell phones to the kitchen counter. The average bacterial cell is 1–4 micrometers in diameter. This means that about one million bacterial cells will take up the same amount of area as one grain of sand. If one million bacterial cells can fit in the same area as a grain of sand then the amount of bacteria that can fit on a cell phone surface would be astronomical.

Sterile bacterial swabs of cell phones have been conducted and several colonies of bacteria have been isolated (Akinyemi et al., 2009). Furthermore, computer keyboards were swabbed for bacterial growth and produced results similar to those of cell phones (Sergio et al., 2000). Individuals are in contact with these two surfaces multiple times every day which could be leading to increased rates of bacterial infection.

Health care workers should be extremely careful when using their cell phones in the hospital because of their increased level of exposure to drug-resistant strains of bacteria. A study of 200 health care workers demonstrated that 94.5% of their cell phones exhibited evidence of bacterial contamination (Ulger et al., 2009) There is evidence that cell phones contain the same bacterial contamination that peoples hands do thus acting has successful fomites. Cell phones have been proven to be effective in transporting bacteria, which can be how these bacterial infections are spreading (Noskin et al., 1995).

Knowing that cell phones are effective mechanisms for bacteria transport, effective methods for cell phone disinfection should be studied. Previous work has shown that bacteria are able to survive on fingertips for at least 60 minutes (Pal et al., 2015), it is rational to believe that there is bacterial contamination all over cell phones. This was the focus of investigation in the following experiment. In this study, we isolated and cultured several species of bacteria from cell phones used in every day environments and compared the results to cell phones that are used within the healthcare environment. Upon determining the differences in colony morphologies, we tested the bacteria for resistance against two antibiotics. The two antibiotics used were erythromycin and ampicillin. Erythromycin is an antibiotic that affects gram-positive strains of bacteria much more efficiently than gram-negative strains. It was shown that the uptake of erythromycin by gram-positive species was 100 times greater than that of gram-negative species (Mao & Putterman, 1968). There was a close relationship between the accumulation of erythromycin and the ability to inhibit the growth of gram-positive bacteria. Ampicillin is considered to be a beta-lactam antibiotic and has been proven to treat both gram-positive and gram-negative species of bacteria. The ability for beta-lactam drugs to inhibit the growth of bacterial species is dependent upon binding to specific targets located in the cytoplasmic membrane of the bacteria (Knowles, 1985). Binding of beta-lactam drugs to target proteins results in the inability for bacteria to synthesize a peptidoglycan cell wall, ultimately causing cell rupture. More specifically, the acylation of a serine hydroxyl group at the active site is what results in inactivation of the cell-wall synthesizing protein (Knowles, 1985).

Antibiotic resistance is becoming an increasingly common feature of bacterial species. There are several ways that they can become resistant. First, the target enzymes may become less susceptible to acylation, which inhibits inactivation of the protein. Another way is through changes in the outer membrane permeability resulting in the inability for the drug to penetrate the cell wall and reach the target protein in the cytoplasm. However, the most common method of resistance is specific toward beta-lactam antibiotics. The appearance of the enzyme beta-lactamase results in destruction of the antibiotic before it can reach the target protein within the bacterial cell (Malouin & Bryan, 1986) In this study, we assessed whether or not the cellphones of healthcare professionals are more susceptible to becoming contaminated with drug-resistant bacteria than phones in community settings.

2 MATERIALS AND METHODS

Bacterial samples were collected from cell phones that were frequently used inside of a long term health care facility (labeled Hospital). The samples were collected from 8 volunteers who perform various tasks such as cleaning and observing patient-doctor interactions. Also samples from various phones that are

not normally in contact with these facilities (labeled Not Hospital) were taken. Samples were taken from the cell phone screen using a sterile cotton swab. Eight cell phones were swabbed for each treatment. The bacteria were collected on nutrient agar and incubated at 37 °C for twenty-four hours. Bacterial CFUs and colony morphologies were recorded. The colony morphologies for each sample were isolated on nutrient agar using the quadrant streak technique and incubated at 37 °C for twenty-four hours. Isolates were further analyzed using the Kirby-Bauer disk diffusion assay. This test was conducted on Mueller-Hinton agar using ampicillin and erythromycin disks. The plates were inoculated using aseptic technique and the antibiotic disks were placed on the plates using sterile tweezers. The plates were incubated at 37 °C for twenty-four hours. Zones of inhibition were measured and the level of resistance was calculated for each isolate. Three antibiotic disks were used for each plate and the mean of each set of zones of inhibition was used to determine the level of resistance.

3 RESULTS

There were a total of 792 Colony forming units (CFUs) grown from the bacterial sources. Fifty-six percent of these CFUs came from the Hospital sources. Twenty-eight bacterial morphologies were isolated from these sixteen sources. Nine of these morphologies came from the Non-Hospital sources and nineteen of the morphologies were isolated from Hospital sources.

Source	Non-hospital	Hospital
Ampicillin	11%	42%
Erythromycin	67%	26%
Morphologies	9	19
Total CFUs	345	447

Table 1. Resistance of Isolates. This table shows the percentage of resistant morphologies to each antibiotic tested. The number of morphologies and CFU counts is also included.

One of the nine (11%) morphologies isolated from the Non-Hospital samples was resistant to Ampicillin. Eight out of nineteen (42%) of the Hospital isolates were resistant to Ampicillin. Six out of nine (67%) of the Non-Hospital isolates were resistant to Erythromycin. Five out of nineteen (26%) of the Hospital isolates were resistant to Erythromycin.

4 DISCUSSION

Based on percentage, a higher amount of ampicillin resistant morphologies were found from hospital sources and the opposite was true for the erythromycin resistant morphologies (Table 1). This suggests that ampicillin resistant strains of bacteria are more likely to be found inside of hospitals and erythromycin resistant strains of bacteria are more likely to be found outside of them. The number of morphologies isolated from the Hospital sources was more than double that of the Non-Hospital sources. This suggests that a greater variety of bacterial species can be found on cell phones that are frequently inside of long-term health care facilities. This may be due to health care workers touching the cell phones after patient examinations and handling specimens without washing their hands (Arora et al., 2009).

Furthermore, because these long term health care facilities care for patients who have been infected with various types of bacteria, the likelihood of a worker in the health care facility to come in contact with bacteria is much higher than the community setting. The higher amount of CFUs found from the Hospital sources also suggests that a greater amount of bacteria are found on cell phones that are frequently inside long-term health care facilities. There is a chance that some of these bacteria can be pathogenic and may be transported to various clinical environments within hospitals due to the frequent use of them by doctors and other health care workers (Chawla et al., 2009). A study conducted in New York suggested that as many as one-fifth of cell phones carry pathogenic microorganisms (Akinyemi et al., 2009). The prevalence of antibiotic resistance among these bacteria combined with a nearly universal mode of transport could be a potential vector for disease transmission in society. Health care workers can improve current sanitation techniques by instilling regular cleaning of cell phones since they are frequently used inside of the hospitals.

The higher percentage of resistance to erythromycin in the Non-Hospital isolates rejects the hypothesis that more drug resistant bacteria would be found on phones that are frequently inside of hospitals than those that are not. The data does suggest, however, that a greater variety of bacteria are found on the Hospital sources. Further studies could assess the resistance levels of more antibiotics and collect samples from more than one hospital. This would provide more insight into the plight of increasing antibiotic resistance among bacterial communities and reveal the effectiveness of current sanitation regulations in hospitals.

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