Mobile phone contamination by microorganisms in Quinnipiac university: comparing health science students and non-health science students

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Abstract: This research investigates the microbial contamination associated with mobile phones of Quinnipiac University students and the roleof mobile phones play as a fomite. Investigates the presence of four bacterial species including *Staphylococcus ,Streptococcus, Proteus mirabilis* and *Escherichia coli* on mobile phones. Mobile phones are easily contaminated with pathogenic bacteria and could be vehicles of transmission. The main objective of this study was to compare the contamination rate of mobile phones with pathogenic bacteria between health science and non-health science student's mobile phones. A fomite is an object that can carry microbes, which infect people and increase the incidence and the prevalence of the diseases. Mobile phones come in close contact with the body and serve as a ready surface for colonization. The goal of this study is to qualitatively and quantitatively investigate bacterial contamination of mobile phones. Cells phones from a variety of people were swabbed for bacterial culture. The level and type of bacterial contaminations were compared amongst health science students vs. non-health science students in an attempt to determine if the health science majors disinfect their phones more frequently because of their awareness of the role of fomites in the disease transmission. To determine the most prevalent type of bacteria in the cell phones, the high-risk group of the contamination, and analysis any associations between the students major and the level of the cell phone contamination.

Introduction

A mobile phone can act as a source that transmits microorganisms within the people who shared the mobile phones. They are considered fomites that are able to transfer a wide variety of pathogenic agents to others through indirect contact. These public health concerns are important for the health care workers to be aware of the role of mobile phones in transmitting of these contaminants into the patients. It is widely known that fomites play an important role in spreading of infections in both community and hospital settings, causing outbreaks of nosocomial infections such as Methicillin resistance *Staphylococcus aureus* (MRSA) and other nosocomial diseases. Fomites transmit bacteria, which thrive and multiply on their surfaces and might cause infections. It is

known that some diseases are more likely to be transmitted by fomites than others, including gastrointestinal and respiratory infections. The majority of the people use their mobile phones in high-contaminated environments such as restrooms and kitchens. Consequentially, this behavior increases the potential of mobile phone contamination and disease transmission. This act puts them at a high risk of transferring potentially pathogenic micro-organisms to their cell phones and to others. The biggest concern is cross contamination between mobile phones and foods. This concern is more important in children environments such as day cares, schools and other public settings because young kids are

vulnerable to disease. It's important to know and understand that most people rarely clean their mobile phones due to the lack of knowledge about the role mobile phones as a source of microbes' transmission. In addition, mobile phones come in close contact with body surfaces such as the face, ears and mouth, which can act as a good area for colonization and potential source of microorganisms transmission, therefore the micro-organisms can easily enter the mouth and ears where they can enrich and multiply and causing many diseases. Moreover, the majority of the people keep their mobile phones in their pockets and bags, which are warm environments that can act as an appropriate place for enriching rapid microorganisms growth and multipl-ication.The goal of this study was to investigate mobile phone contamination at Quinnipiac University to identify the colonization of four pathogenic microorganisms including *Staphylococcus aureus, Streptococcus, Escherichia coli* and *Proteus mirabilis*. The second goal was to determine the level and type of bacterial contamination of the mobile phones of Quinnipiac students and to identify if there is a significant relationship between the knowledge of hand hygiene, and cleanliness and mobile phone contamination. For this research, the hypotheses that have been investigated were the relationship between the major of the students and the level of mobile phone contamination. To identify if the hand hygiene and the awareness of the students about mobile phones as fomites could play significant role in the level and type of bacterial contamination.

Materials and methods

A questionnaire consisting of eight questions was conducted in this research experiment data not shown. A total of 151 samples were collected from both health science and non-health science students at Quinnipiac University.74 samples were collected from health sciences students including biomedical science students and biology majors, and 77 samples were collected from non-health sciences students including accounting majors, communication majors, and law students. All the samples were collected with the aseptic technique. Mobile phones were swabbed with moist cotton emended in Trypticase soy broth (TSB). Set of 6 tubes of 9 ml TSB were previously prepared labeled and placed on the tube rack. A serial dilution were performed by transferring 1ml of the original sample to the tube labeled $^{-1}$ with vortex, and 1ml of the first TSB tube transferred into the second one, second to third, etc. Set of Trypticase soy agar (TSA) plates were labeled same as the serial dilution with three plates for each dilution. 0.1 ml of each dilatation was transferred into 3TSA plates, spread the diluents over the TSA surface and incubate all plates at 37 degrees Celsius for 48 hours. The original TSB samples were also inoculated at the same time into Mannitol salt agar and MacConkey agar and incubated at 37 degrees Celsius for 24 hours. The characteristic bacteria isolates from each selective media plates wereGram stained to identify Gram-positive bacteria, ssp. The *Staphylococcus* ssp. is Gram-positive cocci, seen in clusters under the microscope, while *Streptococcus* ssp. is Gram-positive cocci, seen in chains under the microscope. However, the Gram-negative rods are seen red in color under the microscope. The biochemical tests needed for further identification and differentiation of the isolated bacteria. These tests included catalase, coagulase for the Gram-positive bacteria, which grown on MSA, while the urease, idole,

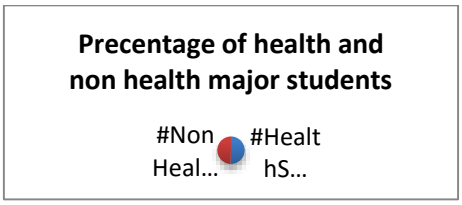
oxidase, citrate and methyl red and Voges-proskauer tests used for gram-negative bacteria, which grown on MacConkey.

Staphylococcus spp. can cause a variety of skin infections including boils and furuncles. The most important fact is that there is a strain of Staphylococcus that can be resistant to the first line antibiotics used in treatment to this kind of diseases including methicillin, and oxacillin. Streptococcus spp. is associated with many diseases such as rheumatic fever, rheumatic heart disease, and nephritic disease. Moreover, Escherichia coli can cause severe gastrointestinal illness, urinary tract infections and even renal failure. In addition, Proteus mirabilis can cause urinary tract infections, renal stones and renal failure.

Results

Based on the survey analysis, the numbers of health science students were74(49%) students equal to (49%), that are slightly less than number of non-health science student who were (51%) figure (1).

Figure 1: Percentage of health science vs non -health science students



The most interesting outcome in the survey analysis was out of 151students that participant in the study only 30 (19%) students disinfected their phones. Among these students, 23 (76%) students were health sciences students. This result showed that a significant number of students were never disinfected their phones in both groups.

Figure 2: % of students who disinfected their phones vs. % of students who did not disinfected their phones

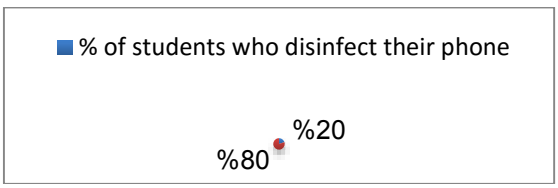
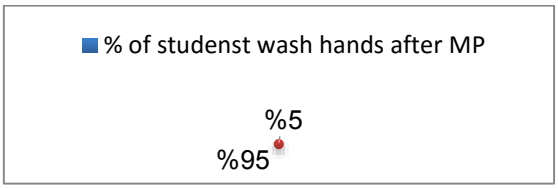


Figure 3: % of students who wash hands after Mobile phone use



The survey revealed that among all Quinnipiac students who were participants in this study, only 7(4.6%) students cleaned their hands after use the mobile phone; all of those students were health science students figure (3). Based on the bacterial count(spread plate technique) analysis,the average colonies forming unit in the health science students mobile phones was 1.306×10^4while the average number of colonies forming unit in the mobile phones of non-health science students was 1.62×10^4.

Table 1: The average of CFU in health science vs non health science students

The average #of colony forming unit (CFU)	Health science students	Non health science students
	1.306×10^4	1.62×10^4.

Data analysis table 3 also showed that gram-positive bacteria were among the highest percentage of bacteria that have been found on Quinnipiac student's mobile phones, which found on the 63.5% of mobile phones, while gram negative rod being discovered on 47% of mobile phones. Based on gram staining, catalase and coagulase test, the result indicated that 48 (31%) samples out of 151 samples were harbored with *Staphylococcus aureus*, 40 (26%) samples were grow *Staphylococcal epidermis* and 6 (3.9%) samples were contaminated with *streptococcal* ssp. The data show that14 (9%) samples of gram-negative isolates were *E.coli* based on the biochemical testing, and 10 (6.6%) were *Proteus marbilis.*

In comparison of the study major in the table (2), the data revealed that 18 (37%) out of 48 *Staphylococcal aureus* isolates were present at mobile phones of health major, 14 (35%) out of 40 of *Staphylococcal epidermis* were found on mobile phones of health major, 3(50%) out of 6 of *Streptococcal* isolate were found in the mobile phone of health major 7 (50%) out of 14*E. coli* were health science students, and 3(30%) out of 10 of *Proteus* were present on health science students' mobile phones. This is clearly, pointed out to the fact that was less contamination level in the mobile phones of health science students in compared to the non-health students' mobile phones.

Table 2: Bacteria isolates from mobile phones of Quinnipiac University students

Isolates	Health science mobile phones, n = 74	Non- health science mobile phones, n = 77
Staphylococcal aureus	18(37%)	30(63%)
Staphylococcal epidermis	14(35%)	26(65%)
Streptococcal spp.	3(50%)	3(50%)
Escherichia coli	7(50%)	7(50%)
Proteus	3(30%)	7(70%)

The results support research hypothesis that was health science student's mobile phone would have less bacterial contamination due to their awareness of the mobile phone as a fomite. The antibiotic sensitivity test was conducted in this research to all samples that had bacterial growth to detect if there were any resistant strains associated with mobile phones. The result as seen shows the percentage of each bacteria strain and their susceptibility to the six antibiotics. It compares the sensitivity of both gram-positive strains and gram-negative strain for the six antibiotics have been used in the research. This data revealed that only 10.5 % of gram-positive bacteria were susceptible to erythromycin, and 8.3% of gram negative was susceptible to the same antibiotic. 80.9% of gram-positive bacteria were susceptible to tetracycline, compared to 66% of gram negative were susceptible to the tetracycline. The data indicated that 85.2% of gram-positive isolates were ciprofloxacin sensitive and 77% of gram-negative isolates were sensitive to ciprofloxacin. In contrast, in case of oxacillin there was only 2.2% of all bacteria isolates were sensitive to it and no strain of gram-negative was sensitive to it. Ceftriaxone was the most sensitive antibiotic for both gram negative and positive bacteria as the data revealed that 75% of gram-negative species were susceptible to it and 91.5% of gram positive were also sensitive to it. The data also indicate that clindamycin was one of the less sensitive antibiotic after the oxacillin with only 4.9%, and 8.3% sensitive of both gram positive and gram negative strain respectively. The results recorded by comparing the zone of inhibition around each antibiotic to the diameter interpretative standards for the bacteria of interest. Overall, the result showed that gram-positive bacteria were more susceptible to all used antibiotics in comparison to the gram-negative bacteria except the clindamycin, in which the gram negative strain were more susceptible to it. Further analysis of data explain that the most susceptible antibiotics for all bacterial species that were investigated are ceftriaxone, ciprofloxacin, and tetracycline; in contrast the more resistant antibiotics areoxacillin, clindamycin, and erythromycin.

In conclusion, this research finding revealed that the most common bacteria isolates on mobile phones were *Staphylococcal aureus*, *Staphylococcal epidermis*, *Streptococcal* spp. *E. coli* and *Proteus*. The overall contamination of mobile phone was 93%. The highest total Viable Count was observed in non-health science student' mobile phones compared to the health science students' mobile phone. This is indicating poor personal hygiene. The higher prevalence of microbiota in the mobile phones was found on the mobile phones of the non-health science students, this could be

attributed to the poor hygienic and sanitary practices associated with their lack of awareness about mobile phone as a fomite. The research findings indicates that mobile phones can act as an important source of pathogenic organisms for human and can serve as vehicle for cross-transmission. The research has some limitations that couldinvestigate if the gender is associated with the level of contamination.The research may also investigate other bacterial species such as *Bacillus* spp. and *Pseudomonas aeroginosa* that shown to be associated with mobile phone contamination. This study strongly recommend public to follow simple hygiene practice include washing hands after rest room use, and disinfect mobile phones with alcohol wipes can reduce the level of mobile phone contamination significantly. And emphasizes that mobile phones may act as a carriers in spread of pathogenic microorganisms in the community.

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