ORIGINAL ARTICLE

What bacteria are present on the mobile phones of students?

Bhumi Tailor, Neha Nikita, Ashley Naicker, Taina Naivalu and Reginald Arvind Jnr. Kumar

ABSTRACT

Background: Mobile phones are an essential component of modern life and used by almost everyone. They are increasingly being used in the hospital setting by health care workers and come in contact with various surfaces around the hospital. Thus, they are likely to get contaminated by a variety of organisms.

Aim: To investigate the colonisation of microorganisms on students' mobile phones at the College of Medicine, Nursing and Health Science, Fiji National University.

Methods: A sample of 50 swabs were collected from randomly selected individuals' mobiles and cultured on blood agar, MacConkey agar and Sabarauds dextrose agar. Isolation of the organisms was processed according to laboratory standard protocol and each organism was identified.

Results: All 50 of the students' mobile phones showed evidence of bacterial colonisation. The most common bacteria isolated was *Bacillus* species (82%), followed by *Acinetobacter lowffii* (26%), coagulase-negative *staphylococcus* (16%), inactive *Escherichia coli* (12%), *Enterobacter agglomerans* (10%), *Pseudomonas aeruginosa* and *Acinetobacter baumannii* (8% each), *Staphylococcus aureus* (6%), *Klebsiella pneumonia*, *Klebsiella oxytoca* (2%) and *Micrococcus* species (2%).

Conclusions: This study revealed that mobile phones are contaminated by microorganisms and may be a vector in spreading nosocomial or community-acquired infections in a hospital setting. In order to combat this issue, proper handwashing, decontamination and infection control procedures should be practised adequately.

Key words: mobile phones, health care workers, bacterial colonization, nocosomial, community-acquired infections.

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INTRODUCTION

Mobile phones have been around for more than thirty years since its introduction in the early eighties (1). In recent years there have been tremendous advancements and mobile phones nowadays are not only used for calling or messaging, but has evolved so that it can be used for basic tasks that were previously done on a computer. Although there are many advantages to the use of mobile phones, they are not usually cleaned or disinfected. Therefore, they serve as a reservoir for bacteria and may cause nosocomial infections. As mobile phones have evolved they have become an integral part of individuals daily lives and their potential to be hazardous to health is often overlooked (2,3). In hospitals, the use of mobile phones is a common sight, not just with patients or visitors but also with health care workers (1).

Studies have shown that mobile phones carried by dental and laboratory science students are at high risk of contamination as most times they are left in clinical coat pockets or laboratory benches that may be contaminated (1). Health care workers also touch their phones during or after patient examination, nursing care, sample processing and other such activities, which potentially leads to contamination or spread of pathogenic infections (4). Despite being used continuously, mobile phones are seldom cleaned or disinfected. Moreover, batteries keep mobile phones warm, thus making it ideal for bacterial growth and reproduction (5). Bacteria can easily be transmitted from mobile phones to an individual's face, eyes, mouth and even food. In addition to this, the sharing of mobile phones between health professionals and the community can transmit potential pathogens to the community (6). Smartphones have the potential of carrying more than 25,000 bacteria per square inch, of which most can be pathogenic to individuals, especially those who are immunocompromised (1).

Individuals are so accustomed to using mobile phones wherever they go and keeping their phones clean depends on personal hygiene and how often they disinfect their phones (1,7). Although mobile phones have been identified as a potential reservoir for microorganisms, very little research and awareness has been done to address this issue and provide evidence as to how contaminated cell phones can be (8). The aim of this study was to investigate the colonisation of microorganisms and the variety of bacteria present on students' mobile phones at the College of Medicine, Nursing and Health Science of the Fiji National University.

METHODS

A cross-sectional study was carried out by obtaining swabs from mobile phones of 50 randomly selected students of the College of Medicine, Nursing and Health Sciences. Informed consent was obtained from each individual. A sterile cotton swab was dipped into a nutrient broth then the mobile phones front, back and sides were swabbed. This was then reinserted in the nutrient broth test tube and incubated aerobically at 37^{o}C for 24 hours.

The next day the swab was cultured onto blood agar, MacConkey's agar and Sabouraud dextrose agar. Blood agars were incubated anaerobically at 37^{o}C for 24 hours while MacConkey's agars and Sabouraud dextrose agars were incubated aerobically. After 24 hours, each of the plates was observed for growth and a Gram stain smear was made from the different colonies from each plate. The growth pattern on the culture plate, i.e. the type of colonies, haemolysis shown, and heavy, moderate or light growth was noted. A standard laboratory protocol was followed for the identification of all organisms. Figure 1 below shows the scheme followed for the identification of Gram positive and Gram negative organisms.

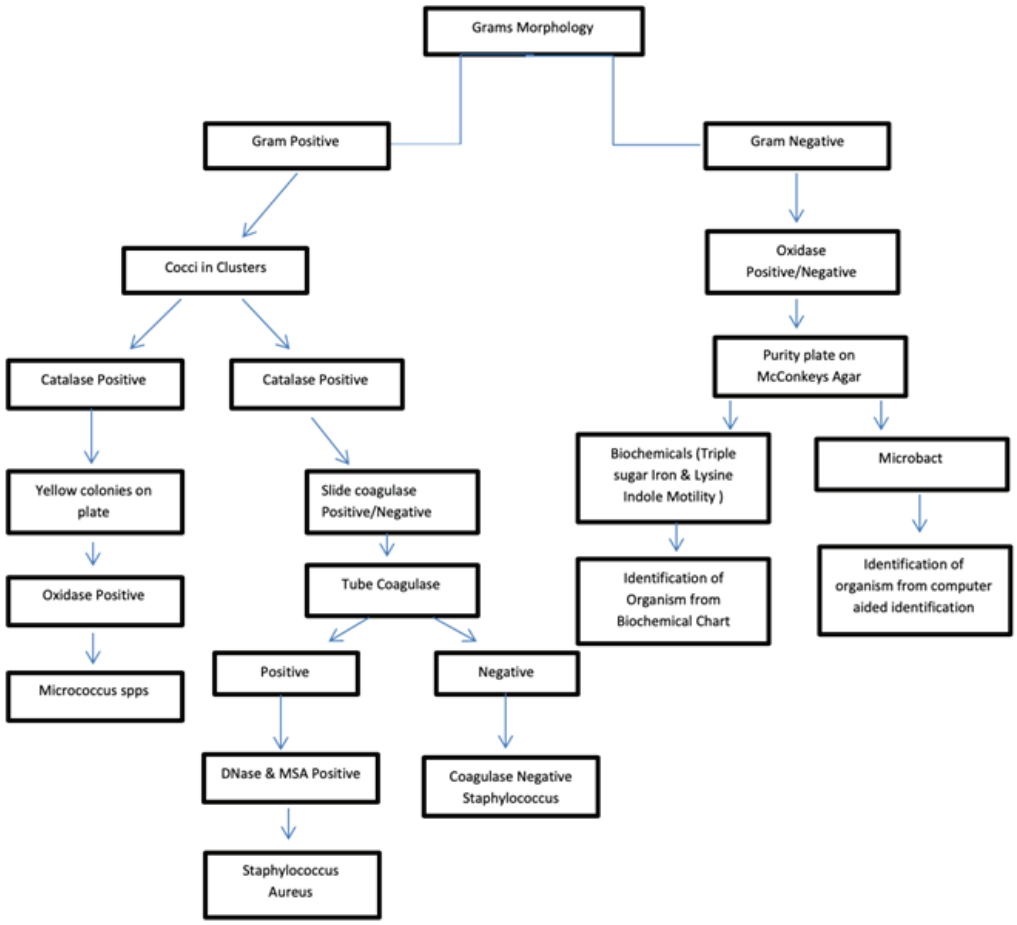

Figure 1. Schematic of identification of Gram-positive and Gram-negative bacteria.

RESULTS

All the 50 mobile phones that were swabbed and cultured showed growth and evidence of bacterial contamination. With regards to the bacterial contamination, 20 (40%) showed pure growth, 19 (38%) showed mixed growth of two types of bacteria and 11 (22%) showed diverse growth of three types of bacteria. The most common class of bacteria isolated morphology were Gram-positive bacilli (47%), followed by Gram-negative bacilli (39%) and the least common were Gram-positive cocci (14%).

Table 1 shows the different types of microorganisms cultured from mobile phones and the percentage of mobile phones on which they were present. The most common bacteria isolated was *Bacillus* species (82%), followed by *Acinetobacter lowffii* (26%), coagulase-negative *staphylococcus* (16%), inactive *Escherichia coli* (12%), *Enterobacter agglomerans* (10%), *Pseudomonas aeruginosa* and *Acinetobacter baumannii* (8% each), *Staphylococcus aureus* (6%), *Klebsiella pneumonia*, *Klebsiella oxytoca* (2%) and *Micrococcus* species (2%).

Table 1. Types of bacteria isolated .

Bacteria	Number of bacteria isolated	% of mobile phones
Gram-positive bacilli (47%)		
Bacillus species	41	82%
Gram-positive cocci (14%)		
Coagulase-negative *staphylococcus*	8	16%
Staphylococcus aureus	3	6%
Micrococcus species	1	2%
Gram-negative bacilli (39%)		
Inactive *Escherichia coli*	6	12%
Enterobacter agglomerans	5	10%
Pseudomonas aeruginosa	4	8%
Acinetobacter baumannii	4	8%
Klebsiella pneumoniae	1	2%
Klebsiella oxytoca	1	2%
Acinetobacter lowffii	13	26%

Figure 2 shows the number of mobile phones colonised by isolated bacteria. Out of the 11 types of bacteria that were isolated, seven (64%) were identified as harmful, while the remaining four (36%) were ubiquitous and not as harmful as the rest. The organisms that were classified as less harmful include *Bacillus* species, coagulase-negative *Staphylococcus*, *Micrococcus* species and *Acinetobacter lowffii.*

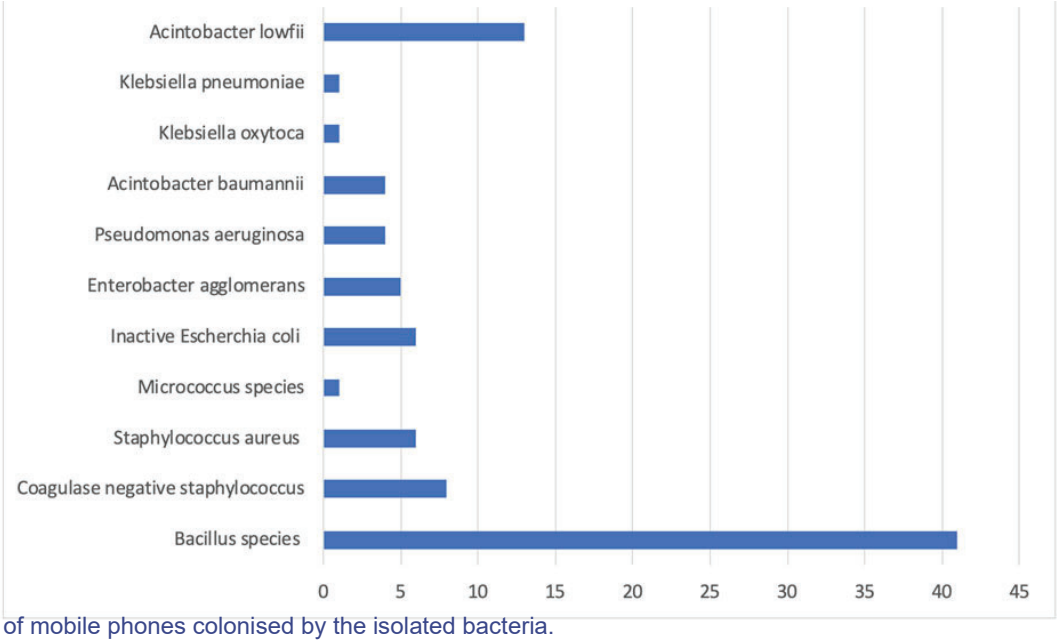

Figure 2. Number of mobile phones colonised by the isolated bacteria.

DISCUSSION

Mobile phones are the primary means of communication today and it is often overlooked that they may be a vector for causing infection. In recent times this has been a significant concern as microorganisms can be transmitted from one person to another or from non- human subject to people. Non-human items, such as stethoscopes and computers, or in this instance mobile phones, can be associated with hospital-acquired infections.

In our study we have shown that all 50 [100%] of the mobiles phones had bacterial colonisation. This finding is similar to that of Tagoe et al. (9) but comparatively higher than other studies that did not show 100% but still showed a high rate, which were between 90.98%, to 95% (4,10,11). This indicates that the presence of bacteria on mobile phones could be a possible mode of transmission of pathogens, potentially causing infections.

The most common bacteria isolated from students' mobile phones were *Bacillus* species [82%], similar to studies by Tagoe et al. (9) Kumar et al. (12) and Auhim (13). The high isolation of *Bacillus* species confirms the ubiquitous nature of this species giving it greater colonisation ability as well as the ability of its spores to resist environmental changes, withstand dry heat and certain chemical disinfectants for reasonable periods (13). The second most common bacteria isolated was *Acinetobacter lowffii (*26%) which is also due to its ubiquitous status in nature, and it is seen as a member of the normal flora that inhabits the oropharynx, human skin and the perineum in approximately 20 to 25% of healthy individuals (14).

In contrast, coagulase-negative *staphylococcus* was the most common bacteria isolated in studies from India (78%) ,Ethiopia (47.5%) and Nigeria workers (1,5,6). however, in the current study CNS isolation was 16% which is in agreement with a study by Datta et al. (13.19%) (15). The combination of constant handling and heat generated by cell phones creates a prime breeding ground for microorganisms that are typically found on our skin (1). Sepehri et al. reported that CNS such as *Staphylococcus epidermis* has emerged as a significant causative agent of nosocomial infections, which constitute the main component of the normal skin and are particularly responsible for catheter and other medical device-related infections (16).

Isolation of *Staphylococcus aureus* (6%) was low compared to the studies done by Tambekar *et al.* and Datta *et al.* who found *Staphylococcus aureus* as dominant bacteria present on mobile phones (15,17). *Staphylococcus aureus* is found on the skin and in the noses of up to 25% of healthy people and animals and can cause illnesses from pimples and boils to pneumonia, meningitis, and is a close relative of MRSA (7). Trivedi et al. (11) and Ulger et al. (18) documented that 50% of *Staphylococcus aureus* they isolated from mobile phones were MRSA. However, those studies were carried out on a limited scale and no further antimicrobial testing was done to identify methicillin-resistant strains thus it cannot be said that the 6% of *Staphylococcus aureus* isolated were MRSA negative (11,18).

Other bacterial isolations were inactive *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella species*, *Enterobacter agglomerans* and *Acinetobacter baumannii*. The role of these agents in spreading nosocomial infections is well established (19). In medical schools, students go for clinics and attachments to the hospital, which can play a critical role in the transmission of organisms associated with nosocomial infections. Micro-organisms can be transferred from person to person or from inanimate objects (such as stethoscopes, bronchoscopes, pagers, ballpoint pens, patient hospital charts, computer keyboards, mobile phones and fixed telephones) to hands and vice versa (16). Hence the present findings imply that mobile phones may serve as a vehicle of transmission of bacteria causing diseases, such as diarrhoea, pneumonia, boils and abscesses (20). *Pseudomonas aeruginosa* had been reported in the United States by the Centre for Diseases Control and prevention to be the most isolated nosocomial pathogen accounting for 10.1% of all hospital-acquired infections and has been implicated in gastrointestinal infection, primarily in immunocompromised individuals (19).

Acinetobacter baumannii was present on 8% of the mobile phones of the students in our study. Arora et al. isolated *Acinetobacter* species from the cell phones of two clinicians working in ICU of their hospital (21). A similar study done at a tertiary care hospital in Israel identified multidrug-resistant *Acinetobacter baumannii* in the hands and cells phones of health care workers and patients in ICU (22). The ability of *Acinetobacter* to contaminate cell phone is expected as this is an multidrug-resistant water and soil organism and is responsible for infection in predisposed patients in the hospital (21).

Escherichia coli is present in about 0.1% of gut flora and faecal-oral transmission is the major route through which pathogenic strains of this bacteria cause disease (1). The presence of *Escherichia coli* suggests faecal contamination of these phones and suggests poor hygiene and lack of proper handwashing practices by students. In our study there were 12% of the strain inactive *E. coli* which is similar to Auhim study, which was 12.5% (13). These findings are different compared to Famurewa et al. who had *E. coli* as one of the most frequently isolated organisms (23).

In addition, two of the student's mobile phones isolated different species of *Klebsiella*, one *K. pneumonia* and the other *K. oxytoca*, both have been considered as opportunistic pathogenic *Klebsiella* species (24). The low occurrence of *Klebsiella* species was similar to a study by Kawo and Musa, they documented that *Klebsiella* species might be associated with the fact that this bacterium is present in the respiratory tract and faeces of about 5% of healthy individuals, this could be a reason for isolating *Klebsiella* from student's mobile phones in our study (25). The role of this organism in both nosocomial and community-acquired infection has been well documented, *Klebsiella* species has been variously responsible for septicaemia, pneumonia, UTI and soft tissue infection with Podschun and Ullmann reporting that hospitalised, immunocompromised patients with underlying diseases is the main target of these bacteria (24).

The presence *of Enterobacter agglomerans* in our study was found to be 10%. Cataño et al. also isolated *Enterobacter agglomerans* from mobile phones of health care workers in Columbia (26). *Enterobacter agglomerans* is known to be a plant organism and was considered unimportant clinically until the mid-1960s, when it was identified in hospital-acquired infections in debilitated patients (especially those receiving broad-spectrum antibiotics) as causing postoperative wound infections and urinary tract infections after instrumentation, Al-Damluji et al. stating *Enterobacter agglomerans* as a new cause of primary pneumonia (27).

The overall implication is that mobile phones, which make communication easy and accessible, also form a carrier of pathogenic agents for disease transmission. If care is not taken, they could even be used as vehicles for the transmission of biological weapons. As most students attend clinics and are attached in the hospital, the use of personal mobile phones could cause harm to hospitalised patients. Heyba et al. documented that the use of mobile phones by health care workers in the intensive care unit, burns ward and operative rooms may have more severe hygiene consequences because, unlike fixed phones, mobile phones are often used close to the patient (28). ICU patients and burn patients are most vulnerable to infectious diseases, so the risk of transmission of the organism associated with nosocomial infection is increased (7).

There were some limitations to our study. Our study was small in numbers as only 50 cell phones were studied. Larger sample size would have increased workload, but the results would have been more valid, and more information could have been collected. Due to resource availability gloves could not be changed after taking each sample, thus gloves were changed after every five samples. To ensure that gloves did not contaminate other phones, they were wiped with SVM after every sample and replaced after five samples. Antibiotic sensitivity was not done as our budget was not sufficient to support this. Thus, the resistant mechanism of different bacteria was not able to be determined.

In conclusion, our study has shown that mobile phones are contaminated by microorganisms and may be a vector in spreading nosocomial or community-acquired infections in a hospital setting. Since mobile phones are used in close proximity to sensitive parts of the human body, such as the face, ears, lips and hands, this can lead to transmission of infections. Mobile phones were made for communications purposes, however, due to ignorance, lack of personnel hygiene and sanitation measures, such as hand washing and phone decontamination, mobile phones are slowly taking the path to becoming pathogenic agents of bacterial transfer.

We recommend the training of medical students and healthcare personnel on strict infection control procedures, hand hygiene and environmental disinfection. Since the restrictions of the use of mobile phones by health care workers may prove impractical in a public setting, strategies for preventing disease transmission are needed. Restrictions of mobile phone use can be used as a preventative measure. There are other recommendations, such as cleaning mobile phones and maintaining good personnel hygiene and sanitation measures for decreasing rates of bacterial contamination on mobile phones. It is essential to create awareness on the use of mobile phones being a possible vector for infection in a hospital setting and strict infection control procedures should be practised. Hand washing is considered the single most important intervention to prevent transmission of bacteria and viruses from the hands of a health care worker. Hand washing is also essential after using the bathroom as one can contaminate one's cell phone, due to the popularity of the use of mobile phones in the bathroom and there could also be the faecal-oral transmission of bacteria. Health facility could also provide alcohol hand wash or hand sanitisers in all wards and departments of the hospital.

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