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MICROBIAL CONTAMINATION OF MOBILE PHONES OF THEATRE STAFF AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

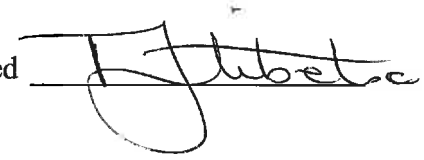
Tiisetso Dibetso

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

Johannesburg, 23rd October, 2018.

Declaration

I, Tiisetso Dibetso, declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

Signed 

On this 23 day of October, 2018

Dedication

My humble effort is dedicated to the memories of my grandfathers.

Dr Lepoqo Jonathan Molapo (1933 ─ 1998)

and

Mr Chabaesele Monzi Dibetso (1935 ─ 2017)

Acknowledgments

Firstly, I would like to thank God for providing me with the strength I needed to complete this report.

Secondly, I would like to thank the following people for their invaluable contribution, advice and assistance in compiling this report:

Juan Scribante and Helen Perrie: your knowledge and expertise assisted me immensely.

Professor Christina Lundgren: for providing structured research “blocks” and extra time to complete this project.

Jan Pretorius Research Fund, South African Society of Anaesthesiologists: for supplying the funding that allowed this project to take place.

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Professor E. Libhaber: for her statistical assistance.

Finally, I must express my very profound gratitude to my dear parents and to my beloved daughter for providing me with unfailing support and continuous encouragement. The completion of this research is as much their accomplishment as it is mine.

Abstract

Background

A number of concerns have been raised about the use of mobile phones (MP) in the clinical environment. Of these concerns, one of the most important is that MPs may serve as vehicles for microorganisms, as they are in close contact with the body, particularly the face and hands. Thus MPs have the potential to spread nosocomial infections. At Chris Hani Baragwanath Academic Hospital, MPs are frequently used by theatre staff, in the operating theatre (OT).

Method

A prospective, contextual, descriptive research design and convenience sampling were used for this study. A total of 66 MPs belonging to anaesthetists and OT nurses were swabbed for contamination. Additional information on the cleaning practices of the MPs was collected.

Results

All MPs grew microorganisms and 15% had a high level of contamination. Coagulase negative staphylococci (CNS) grew on 60.6% of the MPs, *Bacillus* sp. grew on 46.9% and 21.2% grew more than one species of microorganisms. Half of the theatre staff cleaned their MPs. Of these, 66.7% clean their MPs before leaving work. There was no significant difference in the level of contamination of MPs that were cleaned and those that were not.

Conclusion

This study demonstrated that 100% of MPs were contaminated with microorganisms. The most prevalent microorganisms isolated in this study were CNS and *Bacillus* sp. These bacteria are likely to reflect the normal flora of the people handling the MPs.

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Abbreviations

A. baumannii	***Acinetobacter baumannii***
AIDS	**Acquired Immunodeficiency Syndrome**
CFU	**Colony forming unit**
CHBAH	**Chris Hani Baragwanath Academic Hospital**
CNS	**Coagulase negative staphylococci**
E. coli	***Escherichia coli***
HCW	**Healthcare worker**
HIV	**Human Immunodeficiency Virus**
ICU	**Intensive Care Unit**
IT	**Information technology**
K. pneumoniae	***Klebsiella pneumoniae***
MP	**Mobile phone**
MRSA	**Methicillin-resistant *Staphylococcus aureus***
NHLS	**National Health Laboratory Services**
OT	**Operating theatre**
S. aureus	***Staphylococcus aureus***
S. epidermidis	***Staphylococcus epidermidis***
sp.	**Species (singular)**
spp.	**Species (plural)**
TPC	**Total plate count**
WHO	**World Health Organisation**

Section 1: Literature Review

1.1 Introduction

In this section, the literature regarding a brief history of mobile phones (MP), concerns regarding their use in the operating theatre (OT), nosocomial infections, hand hygiene and infection control, MPs as reservoirs of microorganisms as well as a description of the most commonly isolated microorganisms from MPs will be reviewed.

1.2 History of mobile phones

In Stockholm, the first cars fitted with telephones, took to the road in the 1950s. The first operators were "a doctor-on-call and a bank-on-wheels". These first car-phones were too heavy, bulky and costly to use by the general public. New gear using transistors was introduced to the market from the 1960s (1).

In 1969 the Nordic Mobile Telephone group had been established to establish a cellular telephone network and by 1981, a total of 20 000 mobile telephone subscribers existed in Sweden. No other country in Europe had this many mobile telephone subscribers (1).

Lacohee et al (1) stated that, "in the 1990s, technical trends, particularly miniaturisation and improvements in battery technology lead to a mobile world." As soon as powerful and portable batteries became available, MPs were no longer cumbersome and could effortlessly be carried around. There was a rapid change from car-phones to hand-phones and innovative, lighter, handy models proved appealing to new clientele. From this point on, MPs became the pervasive communications devices used today (1).

"A turning point in the history of telecommunications was marked in 2002 in that the number of mobile subscribers overtook the number of fixed-line subscribers on a global scale." Thus for voice communications, MPs prevailed (2). In the same year, the World Telecommunications Development Report stated that every sixth person in the world had a MP (1).

Just as MPs have revolutionised communication globally and in all areas of human life, so have they proven to be highly useful in communication in the hospital setting. There is widespread use of MPs among medical personnel in hospitals. Internationally, the trend is to integrate MPs as well as other wireless technology to improve healthcare in terms of cost effectiveness, efficiency and overall quality (3).

1.3 Concerns regarding mobile phones in the operating theatre

Concerns were raised regarding MPs in the OT about their safety in terms of interference with equipment and threats to privacy and dignity. Other concerns included noise and distraction in the clinical environment and data security (4).

In 2004, the Medical Devices Agency (5) in the United Kingdom declared that within one metre MPs could hinder 4% of medical equipment. Generally, the interference was a mere nuisance and was ultimately not detrimental to the patient. For instance, alarms were activated and electrocardiograph tracings had to be done again. Adverse outcomes on pacemakers, including the atrial sensing circuitry being disrupted can happen, but only once the patient places their MP against the chest. The effects stop once the MP is removed. It is warranted to exercise sensible caution when MPs are close to medical apparatus, but apprehensions regarding patient safety alone, do not rationalise the vehement implementation of no-phone zones. Ring tones can be bothersome, coupled with the tendency for patients to answer their MPs during a consultation. This, however, does not impose danger to patients and is equivalent to the invasive effect of radios and television sets (5).

There have been recommendations that phones with in-built cameras be disallowed in hospitals because they may compromise the confidentiality of patients and it has also been suggested that some ring tones might sound like medical device alarms and therefore cause unnecessary panic and confusion (5).

Of the several concerns regarding MP use in hospitals, it is troubling that MPs may aid the nosocomial transmission of microorganisms (4).

1.4 Nosocomial infections

Nosocomial infections are a key contributor to morbidity and mortality in hospitals. They can be defined as infections occurring after 48 hours of hospital admission, within three days of hospital discharge or 30 ─ 90 days of an operation (6). In developed countries, the liability of nosocomial infections is already substantial, where it impacts 5 ─ 15% of hospitalised patients in regular wards and at least half of patients in intensive care units (ICU) (7). In 2006, approximately one out of seven patients in South African hospitals was at risk of acquiring a nosocomial infection (8). In South Africa, reliable systems to identify nosocomial infections are lacking. Where they do exist, standardised definitions of nosocomial infections are not applied uniformly. Consequently, it is difficult to draw precise and consistent conclusions about the data obtained (9). Therefore, the magnitude of the problem remains unknown in this country.

Patients usually experience some degree of functional disability and emotional stress and nosocomial infections augment this state. In some cases, nosocomial infections impair the quality of life. Furthermore nosocomial infections are one of the prevailing causes of death. There are substantial economic expenses. The highest contributor to cost is increased length of stay in hospital for infected patients. A protracted stay increases direct charges to patients or payers and furthermore increases indirect expenses due to inability of patients to return to work. Other contributors to expenses are the amplified consumption of medications, the need for quarantine and the use of extra laboratory and other diagnostic investigations. Nosocomial infections add to the uneven resource distribution for primary and secondary healthcare by deterring scanty funds to the management of conditions which are potentially avoidable (10).

Infection control is of vital importance particularly in the OR as this is a workplace that requires the highest hygiene standards (11). It is universally accepted that the immunocompromised host is more susceptible to nosocomial infection than the healthy host (12). The factors associated with the occurrence of a nosocomial infection are immune deficiency, poor functional status, lengthy stay in hospital, use of antibiotics and frequent exposure to implantation of invasive intravascular medical devices (13).
The most common secondary cause of acquired immune deficiency is the human immunodeficiency virus (HIV) (14). Globally, South Africa has the largest and most high

profile HIV epidemic, with an approximated seven million people living with HIV in 2015. In the same year, 380 000 new infections emerged while 180 000 South Africans perished from AIDS-related illnesses. The HIV prevalence rate amongst South Africans aged between 15 ─ 49 years remains high at 19.2%. This is the fourth highest rate worldwide. It is therefore vital to control nosocomial infections in South Africa (15).

There is a necessity to comprehend the sources of nosocomial infections and their methods of transmission so that simple, effective and sensible infection control interventions can be developed. Transmission of nosocomial pathogens occurs mainly in three ways: contact, droplet and airborne spread (8). The most relevant of these with respect to MPs and hand hygiene is spread by contact. This involves contact of skin to skin and the direct physical transfer of microorganisms from one patient to another or by a healthcare worker (HCW). Hand washing is singly the most important, evidence-supported, intervention for the prevention of transmission of microorganisms via contact (8).

1.5 Hand hygiene and infection control

HCWs' hands denote the main means of transmission of nosocomial microorganisms. They are colonised perpetually by the resident flora and, subject to the specific description of the worker's tasks, they are colonised briefly by various pathogens not forming part of the resident flora. *Staphylococcus aureus (S. aureus)*, for instance, can persist for more than two hours on hands and is found in 10 ─ 78% of HCWs (16). Table 1.1 illustrates the persistence of common nosocomial pathogens on hands.

Table 1.1 Frequency and persistence of selected nosocomial pathogens on the hands of HCWs (16)

Pathogen	**Frequently associated pathology**	**Frequency on hands (%)**	**Persistence on hands (minutes)**
S. aureus	Surgical site infection, pneumonia, sepsis	10 ─ 78	≥150
Pseudomonas spp.	Lower respiratory tract infection	1 ─ 25	30 ─ 180
Escherichia coli	Urinary tract infection	Unknown	6 ─ 90
Yeasts including *Candida* spp.	Lower respiratory tract infection, urinary tract infection, sepsis	23 ─ 81	60
Rotavirus	Viral gastroenteritis, particularly in children	20 ─ 79	Up to 240
Clostridium difficile	Antibiotic-associated diarrhoea	14 ─ 59	Unknown

Better adherence to hand hygiene and proper use of alcohol-based hand rubs can decrease the rate of nosocomial infection by as much as 40%. Consequently one of the five leading objectives of the World Health Organisation's current worldwide Patient Safety Initiative is "the promotion of effective measures to improve hand hygiene" (16). However, the role MPs play in spreading nosocomial infections may still be a major problem as MPs harbour nosocomial pathogens which can contaminate clean hands.

This point is illustrated by Badr et al (17) in 2012 in Egypt. Their aim was to determine the potential role of MPs in harbouring microorganisms and to gauge their role in the spread of microorganisms from the MP to the hands of 32 HCWs (17). Once HCWs had reached the end of their shifts, they were asked to sanitise their hands using an alcohol-based hand rub. All five fingertips were placed on blood agar plates, thereby obtaining cultures from the

fingers of both hands. Participants were then asked to make a call from their MPs and sampling was repeated using the hand that made the call. Each participant's MP was also swabbed (17). Culture samples collected subsequent to the use of the alcohol-based hand rub, revealed no growth from any of the HCWs' hands. Following the use of a MP, the rate of bacterial contamination of HCWs' hands increased to 93.7%. The rate of MP contamination was also 93.7%. Table 1.2 demonstrates the type and occurrence of microorganisms on the contaminated MPs and hands.

Table 1.2 Different microorganisms isolated from MPs and HCWs' hands after using a MP (17)

Isolated pathogens	**MPs contaminated n= 30**	**Hands contaminated n= 30**
Coagulase negative *Staphylococci*	10	10
S. aureus	5	7
Bacillus anthracoid	2	0
Klebsiella pneumonia	8	8
Serratia marsecens	2	2
Proteus mirabilis	3	3

The HCWs hands were contaminated by their MPs hence the same types and numbers of pathogens were isolated on both the hands and MPs.

The Centers for Disease Control and Prevention state that, "it is important to include computers, mobile devices and personal digital assistants used in patient care in policies for cleaning and disinfection of non-critical items." Although communal clinical equipment normally comes into contact with undamaged skin and is hence unlikely to introduce infection, it can act as a medium by which infectious agents are transferred amongst patients (18).

Table 1.3 outlines recommendations regarding minimum frequencies for routine cleaning of computers, keyboards and other non-critical items (18). It is applicable to all settings.

Table 1.3 Recommended cleaning schedule (18)

Environment Classification Level of Risk				
Very high risk	Outbreak in a zone that is high risk			
High risk	ICU, high dependency section, burns section, renal section, operating room			
Significant risk	General wards, Specialist Outpatient Clinics, Dental, Treatment zones			
Low risk	Rehabilitation, chronic care, offices			
Proposed Cleaning Program				
Component	**Minimum cleaning frequency**			
Non-critical items	**Very high risk**	**High risk**	**Significant risk**	**Low risk**
	Clean twice per day or when clearly dirty. Clean between patients.	Clean once per day or when clearly dirty. Clean between patients.	Clean once per day or when clearly dirty. Clean between patients.	Clean once per week or when clearly dirty. Clean between patients.

Infection Prevention and Control is a World Health Organisation (WHO) program whose mission is "to assist member states in reducing dissemination of infections associated with healthcare, by assisting with the assessment, planning, implementation and evaluation of national infection control policies." They have compiled best practice guidelines for cleaning and disinfection of information technology (IT) equipment (19). They define IT equipment as all electronic equipment including, but not limited to: computers, keyboards, accessories and peripherals (e.g. cables, ties, zip ties, wall mounts, and brackets), telephones, smart phones and pagers (19). They state that hand hygiene is the most critical component in averting transmission of microorganisms and therefore HCWs should access IT equipment with clean hands. HCWs should not routinely wear gloves when using IT equipment. In rooms with additional precautions (e.g. isolation) in place, HCWs should consider leaving mobile equipment outside the room. The following are recommendations providing detailed guidance (19).

- Follow the Manufacturer's Instructions for Use regarding how to clean and disinfect IT equipment.

- Use a soft, non-abrasive, lint free cloth. Avoid abrasive cloths, towels, paper towels, and similar items that may cause damage.

- Do not use cloths saturated with liquid. For example, use ready-to-use disinfectant products with excess moisture squeezed out of the wipe or a cloth dampened with disinfectant.

- Never spray or pour disinfectant directly onto IT equipment. Do not get moisture into openings. Keep liquids away from the equipment.

- Clean IT equipment prior to disinfection.

- Allow surfaces to dry before reuse.

- Do not use compressed air to clean IT equipment.

- Clean and disinfect IT equipment regularly and if it becomes contaminated, use established cleaning and disinfection frequencies and processes. Generally, the frequency for cleaning and disinfection is determined by the risk of cross contamination, the proximity of the equipment to the point of care and the usual amount of soiling.

- Choose equipment that is easy to clean and disinfect.

- Do not take equipment into “clients’ rooms” if it cannot be cleaned and disinfected.

- Position any mobile equipment taken into a “clients’ room” at least two metres away from the “client”.

- Use a surface disinfectant with a Drug Identification Number or Natural Product Number and a Material Safety Data Sheet.

1.6 Mobile phones as reservoirs of microorganisms

1.6.1 The prevalence of microbial contamination on MPs

The prevalence of microbial contamination on MPs from international studies varied from 42 ─ 100% (4, 11, 17, 20-31). A summary of this is illustrated in Table 1.4.

Table 1.4 Prevalence of microbial contamination on MPs

Study	Year	Place	Contamination rate (%)
White et al (26)	2012	United Kingdom	100
Lee et al (4)	2013	Republic of Korea	100
Selim et al (29)	2015	Egypt	100
Ustun et al (25)	2012	Turkey	97.8
Elkholy et al (22)	2010	Saudi Arabia	96.5
Zakai et al (31)	2016	Saudi Arabia	96.2
Ulger et al (11)	2009	Turkey	94.5
Badr et al (17)	2012	Egypt	93.7
Misgana et al (27)	2014	Ethiopia	86.4
Haghbin et al (30)	2015	Iran	77.1
Heyba et al (28)	2015	Kuwait	73.7
Kilic et al (20)	2009	Turkey	61.3
Trivedi et al (23)	2011	India	46.6
Sadat-Ali et al (21)	2010	Saudi Arabia	43.6
Saxena et al (24)	2011	India	42

The majority of studies show a high contamination rate of more than 60%. Only three studies revealed rates of less than 50%.

Studies have shown that 47 ─ 92% of HCWs do not clean their MPs or wash their hands after handling their MPs (3, 20, 22). Microbiologists suggest that continuous handling of MPs together with the heat created by MPs generates a favourable breeding field for a variety of microorganisms (23).

1.6.2 The identity of microbial contamination on MP

Table 1.5 summarises the identity of the most common microorganisms grown from MPs in international studies, starting with the most prevalent.

Table 1.5 Identity of microorganisms

Study	Year	Place	Identity of microorganisms
Ulger et al (11)	2009	Turkey	Coagulase negative staphylococci
			S. aureus
			Coliforms
			Streptococcus spp.
			Enterococcus spp.
Kilic et al (20)	2009	Turkey	Coagulase negative staphylococci
			S. aureus
			Bacillus spp.
			Corynbacterium spp.
			Escherichia coli
Sadat-Ali et al (21)	2010	Saudi Arabia	*S. aureus*
			Coagulase negative staphylococci
			Escherichia coli
			Acinobacter spp.
			Enterococcus spp.
Elkholy et al (22)	2010	Saudi Arabia	Coagulase negative staphylococci
			S. aureus
			Streptococcus spp.
			Enterococcus ssp.
Trivedi et al (23)	2011	India	Coagulase negative staphylococci
			S. aureus
			Klebsiella pneumoniae
			Escherichia coli
			Bacillus spp.
Saxena et al (24)	2011	India	*S. aureus*
			Coagulase negative staphylococci
			Klebsiella spp.
			Acinetobacter spp.

			Escherichia coli
Ustun et al (25)	2012	Turkey	Coagulase negative staphylococci
			Methicillin sensitive *Staphylococcus aureus*
			Escherichia coli
			Methicillin resistant *Staphylococcus aureus* (MRSA)
			Klebsiella spp.
Badr et al (17)	2012	Egypt	Coagulase negative staphylococci
			Klebsiella pneumoniae
			S. aureus
			Proteus mirabilis
			Serratia marcescens
White et al (26)	2012	United Kingdom	Coagulase negative staphylococci
			Micrococcus spp.
			MRSA
			Enterococcus spp.
			Coliforms
Lee et al (4)	2013	Republic of Korea	Coagulase negative staphylococci
			Micrococcus spp.
			S. aureus
			Acinetobacter baumannii
			Enterobacter cloacae
Misgana et al (27)	2014	Ethiopia	Coagulase negative staphylococci
			S. aureus
			Bacillus spp.
			Micrococcus spp.
			Serratia spp.
Heyba et al (28)	2015	Kuwait	Coagulase negative staphylococci
			Micrococcus spp.
			Viridans streptococci
			Acinetobacter spp.
			Diphtheroids
Selim et al (29)	2015	Egypt	MRSA
			Coagulase negative staphylococci

			Bacillus spp.
			Diphtheroids
			S. aureus
Haghbin et al (30)	2015	Iran	Coagulase negative staphylococci
			Diphtheroids
			S. aureus
			Viridans streptococci
			Bacillus spp.
Zakai et al (31)	2016	Saudi Arabia	Coagulase negative staphylococci
			Bacillus spp.
			S. aureus
			Viridans streptococci
			Pantoea spp.

In the majority of studies, the most prevalent microorganism grown was Coagulase negative staphylococci (CNS) (11, 17, 20, 22, 23, 25). The second most prevalent microorganism was *S. aureus* (11, 20-25, 27).

1.6.3 Describe current cleaning practices of MPs

As mentioned in section 1.3, a number of qualms have been mentioned about the use of MPs, as MPs increase in popularity. Of these several concerns, it is troubling that MPs may aid the nosocomial transmission of microorganisms (4), as they are in close proximity with the body, particularly the face and hands. The spread of nosocomial infections can be effectively restricted by adherence to strict hand hygiene however there is a risk that the microorganisms that reside on MPs can be transferred on to HCWs' hands and then to patients. Thus MPs have the potential to spread nosocomial infections.

This is illustrated by Trivedi et al (23) in India, where they assessed the possibility of spreading nosocomial infections due to usage of MPs by HCWs. A total of 300 samples were collected. Of these, 150 samples were gathered by rotating a swab over the palm and tip of fingers of the dominant hand. The other 150 swabs were collected by rotating a swab over the surface of both sides and keypad of MPs (23). Table 1.6 demonstrates the types and occurrence of microorganisms isolated from HCWs hands and their MPs.

Table 1.6 Types of microorganisms isolated from hands and MPs (23)

Bacteria	**Hands (n=150) (%)**	**MPs (n=150) (%)**
Staphylococcus epidermidis	78 (52)	60 (40)
S. aureus	5 (3.33)	10 (6.66)
Klebsiella sp.	2 (1.33)	3 (2)
Escherichia coli	8 (5.33)	2 (1.33)
Bacillus sp.	3 (2)	2 (1.33)
Enterococcus sp.	2 (1.33)	1 (0.66)
Acinetobacter sp.	2 (1.33)	1 (0.66)
Pseudomonas sp.	3 (2)	2 (1.33)

The types of microorganisms isolated from the HCWs' hands were similar to those isolated from their MPs. It is therefore important to know how to keep MPs clean and reduce their microorganism load.

Microorganisms, with their diverse resistance methods, have been tremendously efficacious in outwitting the host, microbiologists and infectious disease physicians. To offset the development and multiplication of multidrug-resistant pathogens, the only plan that appears achievable is the application of a cohesive programme that comprises effective antimicrobial resistance surveillance, a sensible outline on the use of antimicrobials as well as infection prevention (9).

The risk of infection involved in using MPs in the OR and ICU has not yet been determined and yet MPs are used routinely and not cleaned properly and HCWs do not wash their hands as often as they should.

Recommendations by manufacturers of MPs on how to handle and clean MPs state that only a soft, clean, dry cloth should be used to clean the surface of the device. They also state that users of MPs must avoid exposing MPs to heat and moisture (32, 33). It is clear from their recommendations that MPs cannot be autoclaved or subjected to other commonly used hospital equipment cleaning techniques. Other manufactures recommend that swabs and cloths used should be soft and lint-free (34).

Contrary to the manufacturers' recommendations, there are suggestions that a disinfectant wipe or soft cloth dampened slightly with alcohol should be used to wipe a MP (35-37). Cleansers should be pure and mild (38). Evidence exists indicating that utilising alcohol swabs for cleaning can eradicate microorganisms from MPs (39).

Sumritivanicha et al (39) in 2010 established the prevalence and type of microorganisms isolated from 80 MPs of HCWs at a Thai hospital, before and one minute after being cleaned with 70% alcohol swabs. Three MPs had cultures positive for *Acinetobacter* spp. before alcohol cleaning. After alcohol cleansing, no microorganisms were discovered. This study indicated that utilising an alcohol swab for cleaning can eradicate microorganisms from MPs. (39)

The percentage of participants who cleaned their MPs in some studies, ranged from 8 ─ 33.5% (4, 11, 21, 22, 25, 28, 31). However, in these studies, it was not stated how often MPs were cleaned and in the majority, the method of cleaning was not specified. Many studies did not describe cleaning practices of MPs. In two studies, one by Sadat-Ali et al (21) and another by Heyba et al (28), participants used alcohol swabs to clean their MPs. In a study by Ustun et al (25), it was stated that participants used antiseptic wipes to clean their MPs. The nature of the wipes was not determined.

1.6.4 Microorganisms on MPs with touchscreens and those with keypads

One study was found comparing the contamination rate of probable pathogenic bacteria between smart phones and non-smart phones. Lee et al (4), carried out this study in three teaching hospitals in South Korea. The major determinant of smart phones seemed to be the presence of a full touchscreen with no keypad. In total, 203 HCWs participated in this study of whom, 56.7% used touchscreens and 43.3% used keypads. A questionnaire was utilised to inquire about demographics as well as frequency of use of MPs, reasons for use and cleaning of MPs (4).

The types of occupations were similar between both groups. The regularity of use, motives for using MPs, the number of participants who regularly kept their MPs clean and the rate at which hands were washed, did not differ (4).

Bacteria were isolated from all 203 MPs. More than two kinds of bacteria were cultured from 76.4% of MPs, two types from 19.2% of MPs and one type on all the remaining MPs. The most commonly isolated microorganism was CNS, which was isolated from 95.6% of MPs (4).

Potentially pathogenic bacteria were isolated from 58 (28.6%) MPs. Among likely pathogens, *S. aureus* was the most commonly isolated. It was present in 50 MPs. Of the 50 MPs contaminated with *S. aureus*, eight were contaminated with a methicillin-resistant strain. Five MPs bore *Acinetobacter baumannii* (4).

Although bacteria were found in all MPs, smart phones more frequently yielded microorganisms which are likely to be pathogenic (34.8% vs. 20.5% of non-smart phones, P=0.03). The total colony count of probable pathogens from smart phones was also greater (4).

It is uncertain why there was a greater contamination rate on smart phones with potentially pathogenic bacteria than on non-smart phones. The investigators in this study suggest two hypotheses to account for these results. Firstly, smart phones usually have broad screens, whereas non-smart phones have smaller screens with keypads. Microorganisms may have a better opportunity to contaminate wider screens. The other explanation relates to how frequently smart phones are used. Considering a single utilisation, smart phones are handled for extensive periods and need numerous touches in contrast to non-smart phones (4).

1.7 Most commonly isolated microorganisms from MPs

A description of the most commonly isolated microorganisms from MPs, will now follow.

1.7.1 *Staphylococcus epidermidis*

Staphylococci are Gram positive bacteria that occur in clusters. They are common bacterial colonisers of the skin and mucous membranes of humans and other mammals. *Staphylococcus epidermidis (S. epidermidis)* is the most frequently isolated species from human epithelia. It colonises predominantly the axillae, head and nares (40).

Whereas formerly viewed as an innocuous commensal microorganism on the human skin, *S. epidermidis* is now seen as a notable opportunistic pathogen. It is considered an important cause of nosocomial infections. In particular, *S. epidermidis* represents the most common source of infections on indwelling medical devices. This is likely due to the fact that *S. epidermidis* is a permanent and ubiquitous coloniser of human skin and therefore there is a high chance of device contamination during insertion (41).

S. epidermidis belongs to the group of CNS, which is distinguished from coagulase-positive staphylococci such as *S. aureus* by lacking the enzyme coagulase. The species shows a high degree of diversity with 74 identified sequence types (40).

S. epidermidis belongs to normal human flora and typically has a benevolent association with its host. In fact, it has been suggested that *S. epidermidis* prevents colonisation of more grave bacteria such as *S. aureus* and thus serves a probiotic function. Nonetheless, infections caused by *S. epidermidis* and mechanisms by which this bacterium advances disease, have acquired great attention. Among CNS, *S. epidermidis* causes the greatest sum of infections (40).

In clinical microbiology, CNS are often not further speciated because the major concern is in distinguishing *S. aureus* from other staphylococci. In addition, reports exist that have performed species identification and according to these, one can assume that a substantial majority of non-specified CNS infections are due to *S. epidermidis*. Principally, the most frequent microorganism implicated in infections of any type of indwelling medical devices, such as peripheral or central intravenous catheters is *S. epidermidis*. *S. epidermidis* accounted for at least 22% of bloodstream infections in ICU patients in the United States of America in 2009 (40).

Rarely do *S. epidermidis* infections progress into grave diseases however, the fact that they are recurrent as well as a tremendous challenge to treat, represent a serious weight for the health structure. “The costs related to vascular catheter-related bloodstream infections caused by *S. epidermidis* amount to an estimated $2 billion annually in the United States of America alone in 2009” (40).

1.7.2 *Staphylococcus aureus*

S. aureus is a widespread commensal of humans and its primary habitat is the moist squamous epithelium of the anterior nares. Roughly 20% of the population are always colonised with *S. aureus*, 60% are sporadic carriers and a remaining 20% never carry the organism (42).

S. aureus is responsible for a wide spectrum of human disease, including septicaemia, endocarditis, pneumonia and wound, bone, and joint infections (43).

In a sizeable bulk of infections by *S. aureus*, this species results in asymptomatic carriage. Nevertheless it does represent a serious health burden, particularly in the hospital setting, where clones resistant to methicillin and other classes of antibiotics are endemic (43).

Healthy individuals have a small and limited risk of developing an aggressive infection caused by *S. aureus* and this risk is increased among carriers. A drastically higher rate of infection is seen in hospitalised patients with indwelling catheters or those who have undergone surgery. In some developed countries, many nosocomial infections are caused by *S. aureus* strains that exhibit multiple resistance to antibiotics. These strains are known as MRSA (42).

1.7.3 *Escherichia coli*

Escherichia coli (E. coli) is named after Theodor Escherich (1857-1911), a German paediatrician, who examined the stools of healthy children, recognised the presence of this bacterium in the stools and termed it *Bacterium coli commune* (44). *E. coli* is the type species of the genus Escherichia that contains mostly motile Gram negative bacilli that fall within the family Enterobacteriaceae (45). It is the chief facultative anaerobe of the flora in the human colon. The organism routinely colonises a baby's gastrointestinal tract within hours of life. Thereafter *E. coli* and the host derive mutual value for decades (45). However, numerous highly modified *E. coli* clones exist that have attained specific virulence factors, which increase their ability to acclimatise to new areas and enable them to cause a wide continuum of diseases (45).

1.7.4 *Bacillus* spp.

Bacillus species (sp.) is a large, Gram positive spore-forming encapsulated rod. It is widely distributed in the environment although the primary habitat is the soil. Two *Bacillus* spp. are considered medically significant: *Bacillus anthracis*, which causes anthrax, and *Bacillus cereus*, which causes food poisoning, soft tissue infections and septicaemia (46).

Patients who come to theatre for operations are at a high risk of acquiring soft tissue infection because often their skin is traversed. The high presence of *Bacillus* sp. makes the risk even higher. Patients may develop wound sepsis, wound dehiscence and abscess formation (46).

1.7.5 *Klebsiella pneumoniae*

Klebsiella pneumoniae (K. pneumoniae) is among the most common Gram negative bacteria encountered by physicians worldwide. It is a common nosocomial pathogen, causing urinary tract infections, nosocomial pneumonia, and intra-abdominal infections. In humans, it may colonise the skin, pharynx, or gastrointestinal tract as well as sterile wounds and urine. *Klebsiellae* spp. may be regarded as normal flora in many parts of the intestinal and biliary tracts (47).

Nosocomial infections may affect adults or children however they occur more recurrently in preterm babies, patients in neonatal ICUs and hospitalised individuals whose immunity is suppressed. Medically the most important *Klebsiella* sp., *K. pneumoniae*, accounts for a significant proportion of hospital-acquired urinary tract infections, pneumonia, septicaemias and soft tissue infections. The gastrointestinal tract and the hands of hospital personnel provide principal pathogenic reservoirs for transmission of *Klebsiella* spp. Due to their ability to multiply quickly in the hospital environment, these bacteria often cause nosocomial outbreaks (47).

1.7.6 *Acinetobacter baumannii*

The genus *Acinetobacter* comprises Gram negative, strictly aerobic, non-fermenting, non-fastidious, non-motile, catalase-positive, oxidase-negative bacteria (48). Most clinically significant isolates belong to the species *A. baumannii* (49). *A. baumannii* can be found in

soil, and foods, including vegetables, meat and fish. Rarely, *A. baumannii* may be found colonising the skin of healthy human beings, typically at a low density and for a brief interval. Also uncommonly, colonisation of other body sites such as the throat, nares and the intestinal tract, has been discovered in well individuals (50).

Acinetobacter spp. have emerged in recent years as a major cause of nosocomial infections associated with significant morbidity and mortality. Interest in *Acinetobacter* spp. has expanded swiftly in the last 20 years, a fact ascribed to the worldwide growth of ICUs leading to an alteration in the type of infections caused by *Acinetobacter* spp., and the advent of multidrug-resistant strains (51).

Working in synergy with this budding resistance profile is the capability of *A. baumannii* to endure for lengthy periods all over a hospital setting, thus facilitating its proficiency in nosocomial spread (48). *A. baumannii* infections are classically seen in hospitalised patients. Specific features of impacted patients include advanced age, the presence of severe underlying diseases and a compromised immunity (50).

In the hospital situation, gravely sick patients in ICUs, in particular those needing mechanical ventilation, and patients with wounds or burns are exceptionally vulnerable to major problems caused by *Acinetobacter* spp. Infections linked with *Acinetobacter* spp. include ventilator-associated pneumonia, infections of the skin, soft tissue, wounds, the urinary tract and bloodstream as well as secondary meningitis. It is mostly constituents of the *A. baumannii* complex that cause these kinds of infections (49).

1.8 Summary

In this section, the literature regarding a brief history of MPs, concerns regarding their use in the OT, nosocomial infections, hand hygiene and infection control, MPs as reservoirs of microorganisms as well as a description of the most commonly isolated microorganisms from MPs was reviewed.

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Section 2: Author's instructions

This section highlights the guidelines which the author has followed with regards to the length and formatting of the research article.

The guidelines followed in creating the draft article were those of the Southern African Journal of Anaesthesia and Analgesia, which is the intended journal of publication.

The research report formatting complies with the Faculty of Health Sciences Style Guide for Theses, Dissertations and Research Reports. Please note that the formatting of the draft article may differ from the rest of the research report in order to comply with the author's instructions.

Southern African Journal of Anaesthesia and Analgesia guidelines to authors

Article sections and length

The following contributions are accepted (word counts exclude abstracts, tables and references)

Original research (2800 – 3200 words/ 4-5 pages)

FULL AUTHOR GUIDELINES

Title page

All articles must have a title page with the following information and in this particular order: title of the article; surname, initials, qualifications and affiliation of each author; the name, postal address, e-mail address and telephonic contact details of the corresponding author and at least 5 keywords.

Abstract

All articles should include an abstract. The structured abstract for an Original Research article should be between 200 and 230 words and should consist of four paragraphs labelled: Background, Methods, Results, and Conclusions.

It should briefly describe the problem or issue being addressed in the study, how the study was performed, the major results, and what the authors conclude from these results. The abstracts for other types of articles should be no longer than 230 words and need not follow the structured abstract format.

Keywords

All articles should include keywords. Up to five words or short phrases should be used. Use terms from the Medical Subject Headings (MeSH) of Index Medicus when available and appropriate. Key words are used to index the article and may be published with the abstract.

Acknowledgements

In a separate section, acknowledge any financial support received or possible conflict of interest. This section may also be used to acknowledge substantial contributions to the research or preparation of the manuscript made by persons other than the authors.

References

Cite references in numerical order in the text, in superscript format (Format> Font> Click superscript). Please do not use brackets or do not use the footnote function of MS Word. In the References section, references must be typed double-spaced and numbered consecutively in the order in which they are cited, not alphabetically. The style for references should follow the format set forth in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (http://www.icmje.org) prepared by the International Committee of Medical Journal Editors. Abbreviations for journal titles should follow Index Medicus format. Authors are responsible for the accuracy of all references. Personal communications and unpublished data should not be referenced. If essential, such material should be incorporated in the appropriate

place in the text. List all authors when there are six or fewer; when there are seven or more, list the first three, then "; et al."; When citing URLs to web documents, place in the reference list, and use the following format: Authors of document (if available). Title of document (if available).URL (Accessed [date]).

The following are sample references:

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More sample references can be found at:
http://www.nlm.nih.gov/bsd/uniform_requirements.html"

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Tables should be self-explanatory, clearly organised, and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and numbered in Roman numerals (I, II, etc) in order of its appearance as called out in text. Tables must be inserted in the correct position in the text. Authors should place explanatory matter in footnotes, not in the heading. Explain in footnotes all non-standard abbreviations. For footnotes use the following symbols, in sequence: *, †, ‡, §, ||, **, ††, ‡‡

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All figures must be inserted in the appropriate position of the electronic document. Symbols, lettering, and numbering (in Arabic numerals e.g. 1, 2, etc. in order of appearance in the text) should be placed below the figure, clear and large enough to remain legible after the figure has been reduced. Figures must have clear descriptive titles.

Photographs and images

If photographs of patients are used, either the subject should not be identifiable or use of the picture should be authorised by an enclosed written permission from the subject. The position of photographs and images should be clearly indicated in the text. Electronic images should be saved as either jpeg or gif files. All photographs should be scanned at a high resolution (300dpi, print optimised). Please number the images appropriately.

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Manuscripts are initially examined by the editorial staff and are usually sent to independent reviewers who are not informed of the identity of the author(s). When publication in its original form is not recommended, the reviewers' comments (without the identity of the reviewer being disclosed) may be passed to the first author and may include suggested revisions. Manuscripts not approved for publication will not be returned.

Ethical considerations

Papers based on original research must adhere to the Declaration of Helsinki on "; Ethical Principles for Medical Research Involving Human Subjects"; and must specify from which recognised ethics committee approval for the research was obtained.

Conflict of interest

Authors must declare all financial contributions to their work or other forms of conflict of interest, which may prevent them from executing and publishing unbiased research. [Conflict

of interest exists when an author (or the author's institution), has financial or personal relationships with other persons or organizations that inappropriately influence (bias) his or her opinions or actions.]**Modified from: Davidoff F, et al. Sponsorship, Authorship, and Accountability. (Editorial) JAMA 2001: 286(10). The following declaration may be used if appropriate: "I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in writing this paper."

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1. Please consult the “Uniform requirements for manuscripts submitted to biomedical journals” at www.icmje.org

2. Please consult the guide on Vancouver referencing methods at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=citmed.TOC&depth=2

3. The submission must be in UK English, typed in Microsoft Word or RTF with no double spaces after the full stops, double paragraph spacing, font size 10 and font type: Times New Roman.

4. All author details (Full names, Qualifications and affiliation) must be provided.

5. The full contact details of corresponding author (Tel, fax, e-mail, postal address) must be on the manuscript.

6. There must be an abstract and keywords.

7. References must strictly be in Vancouver format. (Reference numbers must be strictly numerical and be typed in superscript, not be in brackets and must be placed AFTER the full stop or comma.)

8. It must be clear where every figure and table should be placed in the text. If possible, tables and figures must be placed in the text where appropriate. If too large or impractical, they may be featured at the end of the manuscript or uploaded as separate supplementary files.

9. All photographs must be at 300dpi and clearly marked according to the figure numbers in the text. (Figure 1, Table II, etc.)

10. All numbers below ten, without percentages or units, must be written in words.

11. Figure numbers: Arabic, table numbers: Roman

Section 3: Draft article

Title: **Microbial contamination of mobile phones of theatre staff at Chris Hani Baragwanath Academic Hospital**

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Keywords: Mobile phones, Microorganisms, Contamination.

Abstract

Background

A number of issues have been mentioned about the use of mobile phones (MPs) in the clinical environment. Of these issues, one of the most troubling is that MPs may aid the nosocomial transmission of microorganisms, as they are in close contact with the body, particularly the face and hands. At Chris Hani Baragwanath Academic Hospital (CHBAH), MPs are frequently used by theatre staff, in the operating theatre (OT).

Method

A prospective, contextual, descriptive research design and convenience sampling were used for this study. A total of 66 MPs belonging to anaesthetists and OT nurses were swabbed for contamination. Additional information on the cleaning practices of the MPs was collected.

Results

All MPs grew microorganisms and 15% had a high level of contamination. Coagulase negative staphylococci (CNS) grew on 60.6% of the MPs, *Bacillus* sp. grew on 46.9% and 21.2% grew more than one species of microorganisms. Half of the theatre staff cleaned their MPs. Of these, 66.7% clean their MPs before leaving work. There was no significant difference in the level of contamination of MPs that were cleaned and those that were not.

Conclusion

This study demonstrated that 100% of MPs were contaminated with microorganisms. The most prevalent microorganisms isolated in this study were CNS and *Bacillus* sp. These bacteria are likely to reflect the normal flora of the people handling the MPs.

Introduction

Merely 20 years ago, mobile phones (MPs) were rare and exorbitant pieces of equipment used predominantly by the business elite. They have now become widespread low-cost personal objects.[1] These devices are useful when it comes to swift communication in many hospital settings. Smartphones in particular can provide rapid access to medical information.[2]

As MPs increase in popularity, many issues have been mentioned such as noise and disturbance in the clinical setting, compromising privacy of patient information and data safety. Amongst these several issues pertaining to the use of MPs in hospitals, one of the most troubling is that MPs may serve as reservoirs for nosocomial transmission of microorganisms,[2] as they are in close contact with the body, particularly the face and hands. There is a risk that the microorganisms that reside on MPs can be transferred on to healthcare workers' (HCW) hands and then to patients, contributing to the spread of nosocomial infections.[3]

Nosocomial infections account for an important burden to patients, HCWs and health facilities. Factors influencing the development of nosocomial infections include multiple hospital admissions, prolonged hospital stay, patients who are immunocompromised or have an underlying disease as well as inappropriate use of antimicrobials.[4] East and Southern Africa are the regions that are the most affected by the human immunodeficiency virus (HIV). In 2015, 40% of the region's new infections occurred in South Africa. Globally, South Africa has the largest and most high profile HIV epidemic, with an approximated seven million people living with HIV in 2015. In the same year, 380 000 new infections emerged while 180 000 South Africans perished from AIDS-related illnesses. The HIV prevalence rate amongst South Africans aged between 15 ─ 49 years remains high at 19.2%. This is the fourth highest rate globally.[5] HIV infection is the most common cause of acquired secondary immune deficiency [5] therefore a large number of South Africans are at risk of developing nosocomial infections.

The spread of nosocomial infections can be effectively restricted by adherence to strict hand hygiene. Failure to consistently and diligently practice hand hygiene is deemed the chief cause of nosocomial infections, leading to an increase of multi-resistant organisms and is recognised as an important contributor to outbreaks of infection.[6] The World Health Organisation (WHO) acknowledged the encouragement of hand hygiene practices in

healthcare as an urgent undertaking and the building block to enhance infection control. In April 2006, the WHO World Alliance for Patient Safety issued the Advanced Draft of the WHO Guidelines on Hand Hygiene in Health Care.[7] The Centers for Disease Control and Prevention recently outlined the recommended minimum frequencies for routine cleaning of computers, keyboards and other non-critical items, including mobile devices. It is applicable to all settings.[8] In addition, Infection Prevention and Control have compiled best practice guidelines for cleaning and disinfection of information technology (IT) equipment.[9] Evidence exists indicating that the use of an alcohol swab for cleaning can eradicate microorganisms from MPs.[10, 11] However, only individuals who perceive their MPs as a potential threat to hygiene would undertake this practice. There is also evidence that supports that even after hands have been cleaned, microorganisms can be transferred on to hands from handling of MPs.[3]

International studies have shown the occurrence of contamination of MPs by microorganisms to range from 42 – 100%.[2, 3, 11-23] In a study in 2010 by Elkholy et al,[19] in a hospital in Saudi Arabia, it was revealed that 96% of MPs belonging to HCWs in an intensive care unit were contaminated by bacteria and other microorganisms. Some of the microorganisms isolated are known to cause nosocomial infections.[19] The most common microorganisms cultured from international studies are *Staphylococcus epidermidis* (*S. epidermidis*), *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*).[2, 11, 12, 15]

A study was therefore undertaken with the aim of describing the occurrence and identity of microorganisms on MPs of HCWs at CHBAH.

Methodology

A prospective, contextual, descriptive research design was used for this study. Approval from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand and other relevant authorities to conduct the study at CHBAH was obtained. The study population was MPs used by anaesthetists and operating theatre (OT) nurses in OTs at CHBAH.

CHBAH has approximately 3 200 beds and is a central hospital affiliated to the University of the Witswatersrand. The hospital is in the Soweto area of Johannesburg, South Africa. It has 25 OTs and does 65 000 surgeries per year.[24]

The sample size for similar studies is between 32 and 500.[3, 25] Due to financial constraints, the sample size of this study was limited to 66 samples. A convenience sampling method was used for this study. Exclusion criteria for this study were any breach in the aseptic technique during the collection and transportation of samples by the researcher and anaesthetists and OT nurses who declined to be part of the study.

All of the data were collected by one author (TD), over a three month period, from July to September 2016 on days that were convenient to the author but unknown to theatre staff. Information was collected from the owners of the MPs. This included date and time of data collection, demographics, the types of MPs (touchscreen or keypad) and if the MPs were cleaned, how they were cleaned and how frequently. The owners of MPs had a choice of whether or not they wanted results regarding contamination of their MPs.

Swabs were taken from the MP in a standardised manner. One author (TD) donned sterile gloves before each MP was swabbed. The MPs were swabbed with moistened sterile swabs, dipped in Ringer's Lactate solution. Each of the MPs was swabbed twice. Firstly, one half of the MP was swabbed for a total plate count (TPC). The other half was swabbed for culture and identification. The swab for TPC was kept in Ringer's Lactate solution. It was denoted 'swab A'. The swab for culture and identification was returned to its casing, which contained Amies transport medium. It was denoted 'swab B'. The swabs were taken using a continuous rolling technique from the front and back of the MP as illustrated in Figure I.

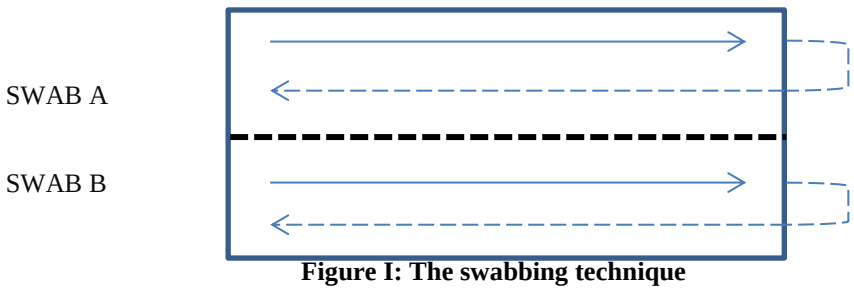


Figure I: The swabbing technique

The samples were labelled using the National Health Laboratory Services' (NHLS) standardised request form. Samples were stored at a temperature of 4 °C in a cooler box with ice packs. This was transported by the author (TD) to the NHLS within six hours. Upon reaching the laboratory, the swabs that were kept in Ringer's Lactate

solution were used to obtain a TPC. The swabs that were kept in the Amies medium were placed on 5% sheep blood agar plates. The swabs were then incubated aerobically for 48 hours. Thereafter colonies were observed.

The level of microbial contamination was assessed semi quantitatively. A positive culture was considered if there was any growth on the culture medium. Only aerobic bacteria were isolated and identified. All samples and isolates were observed, quantified and identified by experienced microbiology laboratory personnel using standard laboratory procedures.

Data capturing was done using a Microsoft Excel 2010 spread sheet and statistical analysis was done using Stata 15 (StataCorp, USA). Descriptive and inferential statistics were used in consultation with a biostatistician. Frequencies and percentages were used where applicable. A p value of ≤ than 0.05 was considered statistically significant.

Results

A total of 40 anaesthetists and 26 OT nurses took part in this study. Of these, 18 (27.3%) were males and 48 (72.7%) were females with a mean age of 37.3 years (SD 8.8). Of the HCWs, 89.4% were aware that their MPs may carry pathogenic microorganisms.

Table I shows the identity and prevalence of microbial contamination on MPs and demonstrates that eight different microorganisms were isolated on MPs. The most prevalent microorganisms were Coagulase negative staphylococci (CNS) and *Bacillus* sp. Some MPs grew more than one microorganism.

Table I: Identity and prevalence of bacteria isolated from MPs

Microorganism	MPs n (%) (n=66)	Touchscreen n (%) (n=60)	Keypad n (%) (n=6)
Coagulase negative staphylococci	40 (60.6)	37 (61.7)	3 (50.0)
Bacillus sp.	31 (46.9)	27 (45.0)	4 (66.7)
Streptococcus group B	3 (4.5)	3 (5.0)	0 (0)
Staphylococcus aureus	3 (4.5)	3 (5.0)	0 (0)
Enterobacter cloacae	2 (3.0)	2 (3.3)	0 (0)
Streptococcus group G	1 (1.5)	1 (1.7)	0 (0)
Enterococcus sp.	1 (1.5)	0 (0)	1 (16.7)
Pantoae sp.	1 (1.5)	1 (1.7)	0 (0)

All MPs grew microorganisms. Of these, 15 MPs (22.7%) grew more than one species of microorganisms. Both CNS and *Bacillus* sp. were isolated on ten MPs. The remaining 5 MPs had the following combination of microorganisms isolated: CNS and Streptococcus group B, CNS and Streptococcus group G, *Bacillus* sp. and *Enterobacter cloacae*, *Bacillus* sp. and *Pantoae* sp. as well as CNS, *Bacillus* sp. and Streptococcus group B. Table II shows the cleaning practices of MPs by participants.

Table II: Cleaning practices of MPs by participants

	Number of MPs (n=66)	**%**
Cleaning technique		
• Dry cloth	1	1.5
• Alcohol swab	30	45.5
• Other	2	3.0
• None	33	50.0
	Number of MPs cleaned (n=33)	**%**
Timing of cleaning		
• Before theatre	1	3.0
• Before home	22	66.7
• After use	4	12.1
• Numerous times	6	18.2

Half of the MPs were cleaned and the majority of anaesthetists and OT nurses used alcohol swabs to clean their MPs. Of those who cleaned their MPs, the majority of anaesthetists and OT nurses cleaned their MPs before going home. The microorganisms grown on MPs belonging to anaesthetists and MPs belonging to OT nurses were similar. Table III shows the microbial growth on MPs of anaesthetists and OT nurses.

Table III: Microorganisms on MPs of anaesthetists and OT nurses

Microorganism	**Anaesthetists** **n (%) (n=40)**	**OT Nurses** **n (%) (n=26)**
Coagulase negative staphylococci	27 (67.5)	13 (50)
Bacillus sp.	16 (40)	15 (57.7)
Streptococcus group B	2 (5.0)	1 (3.8)
Staphylococcus aureus	1 (2.5)	2 (7.7)
Enterobacter cloacae	1 (2.5)	1 (3.8)
Streptococcus group G	1 (2.5)	0 (0)
Enterococcus sp.	0 (0)	1 (3.8)
Pantoae sp.	0 (0)	1 (3.8)

The author (TD) used the TPC to quantify the level of microbial contamination. A low level of contamination is defined as a TPC of 0 ─ 99 colony forming units, an intermediate level, 100 ─ 300 and a high level, >300. It was found that 45 MPs (68.2%) had a low level of contamination, 11 (16.7%) had an intermediate level of contamination and 10 (15.1%) had a high level of contamination. When comparing the level of contamination between MPs that were cleaned and those that were not, no statistically significant difference was found (p=0.24).

Discussion

Our study demonstrated that 100% of MPs grew microorganisms. Similar results were illustrated in a number of international studies.[2, 3, 14, 15, 18, 19, 21, 22] Of these studies, three illustrated the same contamination rate as that in our study. In 2014, Selim et al[22] investigated the microbial contamination of MPs in a hospital in Egypt. Swab samples were collected from 40 MPs of patients and HCWs. All of the tested MPs (100%) were contaminated.[22] Lee et al[2] conducted a study in 2013 to compare the contamination rate of bacteria with pathogenic potential between smart phones and non-smart phones. A total of 203 MPs from three teaching hospitals were swabbed. Bacteria were isolated from all 203 MPs. White et al[18] did a study in 2012 to determine the cross-contamination potential of MPs. No device was found to be free of growth.

Three studies showed contamination rates different from our study.[12, 13, 20] Saxena et al[12] carried out a study in 2011 to assess the presence of pathogenic organisms on the rings (worn on fingers) and MPs carried by HCWs and the public. A total of 100 MPs used by HCWs were swabbed and of these, 42% were found to be contaminated. Trivedi et al[20] in 2011 conducted a study to assess the possibility of spreading nosocomial infections due to usage of MPs by HCWs working in OT, intensive and cardiac care units. It was found that of the 150 MPs swabbed, 46.6% were contaminated with bacteria. Sadat-Ali et al[13] did a study in 2010 to find the types of bacterial flora on MPs of HCWs. The study found that of the 288 MPs swabbed, 43.6% were contaminated with bacteria.

The two most prevalent microorganisms in our study were CNS which grew on 60.6% of MPs and *Bacillus* spp. which grew on 46.9% of MPs.

In many international studies, CNS was in the top two most commonly grown microorganisms.[3, 11-17, 19-23] This is in keeping with results from our study. This can be explained by the fact that this bacterium is a normal commensal of the skin. It has a carriage rate on the skin of approximately 100% and is spread by contact.[26]

Generally, in CNS infections, *S. epidermidis* is the most widespread species. *S. epidermidis* is ubiquitous and thus necessitates a decision, each time it is detected in clinical specimens, on whether it represents true infection or only colonisation.[27] Today, CNS, as characteristic of opportunists, represents one of the major nosocomial pathogens, bearing a substantial brunt on human life and wellbeing.[27] It is especially related to the use of indwelling or implanted foreign bodies, which are crucial and innovative in medicine.[27] The principal source of endogenous infections by CNS is colonisation of various parts of the skin and mucous membranes of the host. However, it is spread chiefly by medical and/or nursing techniques. Medical advancements have led to more elderly, multimorbid and immunocompromised patients surviving for longer and there is also an amplified use of implanted foreign bodies. These factors have added to the progressively increasing magnitude of CNS in healthcare. Furthermore, as is typical of nosocomial pathogens, escalating rates of antibiotic resistance regarding CNS limit our therapeutic options.[27] It causes numerous diseases as well as nosocomial infections including catheter related sepsis, urinary tract infection and infection of artificial joints.[26] Hand hygiene reduces the spread of CNS, however, MPs harbouring CNS may be handled after hand washing and increase the spread of CNS.

There was also a high growth of *Bacillus* sp. In studies where *Bacillus* sp. was isolated, it was not as prevalent as in our study.[16, 17, 20, 22, 23, 28, 29] *Bacillus* sp. was the second most prevalent microorganism in one international study.[21] Zakai et al[21] in Saudi Arabia in 2015, aimed to examine the presence of pathogenic bacteria on the surfaces of 105 MPs that are used frequently by second and third year medical students. CNS was the most abundant isolate (68.6%) followed by *Bacillus* sp. (19%).[21] Although, it was the second most prevalent microorganism cultured, it was still not as high as in our study.

In three studies, *Bacillus* sp. was the third most prevalent microorganism isolated.[11, 22, 23] Kilic et al[11] investigated the microbiological colonisation of 106 MPs used by HCWs at three hospitals in Turkey in 2008. The most frequent bacteria were *S. epidermidis* (39.8%) followed by *S. aureus* (7.5%) and *Bacillus* sp. (1.9%).[11] Misgana et al[23] in 2014 in Ethiopia, determined the level of bacterial contamination of 66 MPs of HCWs. CNS was the most abundant microorganism (60.6%) followed by *S. aureus* (25.7%) and *Bacillus* sp. (13.6%)[23]. Selim

et al[22] in 2015 investigated the bacterial contamination of 40 MPs used by patients and HCWs in a hospital in Egypt. MRSA was detected in 53% of the samples, followed by CNS (50%) and *Bacillus* sp.(43%).[22]

Bacillus sp. is a large, Gram positive spore-forming encapsulated rod. It is widely distributed in the environment although the primary habitat is the soil. Two *Bacillus* spp. are considered medically significant: *Bacillus anthracis*, which causes anthrax, and *Bacillus cereus*, which causes food poisoning, soft tissue infections and septicaemia.[26] Patients who come to theatre for operations are at a high risk of acquiring soft tissue infection because often their skin is traversed. The presence of *Bacillus* sp. makes the risk even higher. Patients may develop wound sepsis, wound dehiscence and abscess formations. They may require numerous extra surgeries to manage such complications which is costly and unpleasant to the patient. It also increases morbidity and mortality rates.[26]

Other microorganisms grew on 4.5% or less of the MPs, in our study. These were Streptococcus group B, *S. aureus*, *Enterobacter cloacae*, Streptococcus group G, *Enterococcus* sp. and *Pantoae* sp.
On 15 MPs, more than one microorganism was isolated. Of these, 10 grew CNS and *Bacillus* sp. Other international studies also revealed some MPs contaminated with more than one microorganism.[2, 3, 11, 12, 14-19, 21-23]

In our study, 89.4% of HCWs were aware that their MPs may carry pathogenic microorganisms; however, half of the HCWs cleaned their MPs. Of the MPs that were cleaned, 90.9% were cleaned with an alcohol swab. Alcohol is known to be an effective disinfectant and as such would be the obvious choice for cleaning MPs.[30] Of interest is the timing of cleaning. Before leaving work, 66.67% of HCWs cleaned their MPs. This suggests that HCWs are not as conscious about spreading infection at the workplace, to patients and other colleagues as they are about spreading infection to their family, friends and the community. Also noteworthy is that 89.3% of HCWs in this study claimed to be aware that their MPs were potential harbours of microorganisms and yet of these, only 55.9% cleaned their MPs.

In addition to the culture and identification tests being done on the swabs from the MPs, a TPC was also performed. A total of 68.2% of MPs demonstrated a low level of contamination, this being the presence of less than 100 colony forming units. A possible explanation for this finding could be that MPs are kept mostly in pockets and bags and so are constantly rubbing against these items.

No significant difference existed in the level of contamination between MPs that were cleaned and those that were not. This is likely due to the fact that the majority of HCWs who cleaned their MPs, did so at the end of the day, before leaving work. Therefore during the day which is when the sample collections were made, their MPs would have been as contaminated as those not cleaned.
A total of 56 (84.8%) HCWs use their MPs frequently at work. MPs are used for various reasons ranging from communicating to accessing electronic mails and downloading information.

The results of this study may not be generalised as this study was done contextually at CHBAH. The study sample was small and only aerobic bacteria were tested for. It is therefore suggested that a larger, multisite study, testing for all pathogens be conducted although from a bacterial perspective aerobic bacteria are the most relevant pathogens to test for in terms of contact driven spread.

Conclusion

It is evident from this study that MPs are vehicles for microorganisms, all of which can cause disease as well as nosocomial infections particularly in immunocompromised patients. Globally South Africa has the largest HIV epidemic; therefore a large number of South Africans are at risk of developing nosocomial infections. Some of the microorganisms isolated cause disease relevant to operating rooms such as postoperative wound infections, intra-abdominal infections, osteomyelitis, catheter related sepsis and infection of artificial joints.

Conflict of interest

The authors declare that we have no financial interests or personal relationships which may have inappropriately influenced us in writing this paper.

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Section 4: Appendices

Appendix 1: Graduate Studies Committee approval

UNIVERSITY OF THE
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09 January 2015
Person No: 772641
PAG

Dr TJ Dibetso
9 Burnham Drive
Mulbarton
2091
South Africa

Dear Dr Dibetso

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *Microbial contamination of mobile phones of theatre staff at Chris Hani Baragwanath Academic Hospital* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 2: Human Research Ethics Committee (Medical)

R14/49 Dr Tiisetso Dibetso

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M140128

NAME: (Principal Investigator)	Dr Tiisetso Dibetso
DEPARTMENT:	Department of Anaesthesiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Microbial Contamination of Mobile Phones of Theatre Staff at Chris Hani Baragwanath Academic Hospital
DATE CONSIDERED:	31/01/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Mrs Juan Scribante
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	22/06/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review in January and will therefore be due in the month of January each year.

Principal Investigator Signature

Date 03/10/2016

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Section 5: Proposal

5.1 Introduction

Merely 20 years ago, mobile phones (MPs) were rare and exorbitant pieces of equipment used predominantly by the business elite. They have now become widespread low-cost personal objects (52). These devices are useful when it comes to swift communication in many hospital settings. Smartphones in particular can provide rapid access to medical information (4).

As MPs increase in popularity, many issues have been mentioned such as noise and disturbance in the clinical setting, compromising privacy of patient information and data safety. Amongst these several issues pertaining to the use of MPs in hospitals, one of the most troubling is that MPs may serve as reservoirs for nosocomial transmission of microorganisms (4), as they are in close contact with the body, particularly the face and hands. There is a risk that the microorganisms that reside on MPs can be transferred on to healthcare workers' (HCW) hands and then to patients, contributing to the spread of nosocomial infections.

Nosocomial infections account for an important burden to patients, HCWs and health facilities. Factors influencing the development of nosocomial infections include multiple hospital admissions, prolonged hospital stay, patients who are immunocompromised or have an underlying disease as well as inappropriate use of antimicrobials (10). East and Southern Africa are the regions that are most affected by the human immunodeficiency virus (HIV). In 2015, 40% of the region's new infections occurred in South Africa. Globally, South Africa has the largest and most high profile HIV epidemic, with an approximated seven million people living with HIV in 2015. In the same year, 380 000 new infections emerged while 180 000 South Africans perished from AIDS-related illnesses. The HIV prevalence rate amongst South Africans aged between 15 ─ 49 years remains high at 19.2%. This is the fourth highest rate globally (15). HIV infection is the most common cause of acquired secondary immune deficiency (15), therefore a large number of South Africans are at risk of developing nosocomial infections.

The spread of nosocomial infections can be effectively restricted by adherence to strict hand hygiene. Failure to consistently and diligently practice hand hygiene is deemed the chief cause of nosocomial infections, leading to an increase of multi-resistant organisms and is recognised as an important contributor to outbreaks of infection (53). The World Health Organisation (WHO) acknowledged the encouragement of hand hygiene practices in healthcare as an urgent undertaking and the building block to enhance infection control. In April 2006, the WHO World Alliance for Patient Safety issued the Advanced Draft of the WHO Guidelines on Hand Hygiene in Health Care (54). Recently, the Centers for Disease Control and Prevention as well as a WHO program known as Infection Prevention and Control, have compiled guidelines regarding how to clean MPs (17). Evidence exists indicating that the use of an alcohol swab for cleaning can eradicate microorganisms from MPs (20, 39). However, only individuals who perceive their MPs as a potential threat to hygiene would undertake this practice. There is also evidence that supports that even after hands have been cleaned, microorganisms can be transferred on to hands from handling of MPs (17).

International studies have shown the occurrence of contamination of MPs by microorganisms to range from 42 ─ 100% (4, 11, 17, 20-31). In a study in 2010 by Elkholy et al (22), in a hospital in Saudi Arabia, it was revealed that 96% of MPs belonging to HCWs in an intensive care unit were contaminated by bacteria and other microorganisms. Some of the microorganisms isolated are known causes of nosocomial infections (22). The most common microorganisms cultured from international studies are *Staphylococcus epidermidis* (*S. epidermidis*), *Staphylococcus aureus* (*S. aureus*) and *Escherichia coli* (*E. coli*) (4, 20, 24, 25).

At Chris Hani Baragwanath Academic Hospital (CHBAH), it is currently unknown what the occurrence and type of microorganisms on MPs is.

5.2 Problem statement

MPs have become almost indispensable. HCWs make use of MPs considerably in day to day life. Communication and contact within healthcare institutions has become speedy and more swift due to the availability of MPs (25). However, MPs are reservoirs of nosocomial pathogens (4, 11, 17, 20-25, 55-57).

Research has shown that 47 ─ 92% of HCWs do not clean their MPs or wash their hands after handling their MPs (3, 20, 22). Research has also revealed that microorganisms found on HCWs' hands are the same as those found on their phones (17, 22, 23). At the time of the study, no recommendations that meet healthcare infection control standards regarding the cleaning of MPs were found.

Nosocomial infections are an important problem in all hospitals (11). Globally South Africa has the largest HIV epidemic (58) therefore a large number of immunocompromised patients are at risk of developing a nosocomial infection.

The microbial contamination of MPs and how these MPs are cleaned by theatre staff at CHBAH is unknown.

5.3 Aims and objectives

5.3.1 Aim

The aim of this study will be to describe the microbial contamination of MPs of theatre staff at CHBAH.

5.3.2 Objectives

The primary objectives of this study will be to:

- describe the occurrence and identity of microbial contamination on MPs
- describe current cleaning practices of MPs.

The secondary objectives of this study will be to:

- describe the microorganisms on MPs belonging to anaesthetists and OT nurses
- quantify the level of microbial contamination

- show the level of contamination between MPs that were cleaned and the MPs that were not cleaned.

5.4 Research assumptions

The following definitions are used in this study.

Mobile phone: will be divided into touchscreen phones with no keys and keypad phones.

Theatre staff: this will consist of anaesthetists (consultants, registrars, medical officers, medical interns) and OT nurses (professional, enrolled, assistants).

Sample: the specimens that will be collected during the study and cultured for microorganisms.

Contamination: a low level is contamination is defined as a total plate count of 0 ─ 99 colony forming units, an intermediate level, 100 ─ 300 and a high level, >300.

5.5 Demarcation of study field

This study will be conducted in the OTs in CHBAH.

CHBAH has approximately 3 200 beds and is a central hospital affiliated to the University of the Witwatersrand, situated in Johannesburg, South Africa. The hospital has 25 OTs and does 65 000 surgeries per year.

5.6 Ethical considerations

Applications will be submitted to the Human Research Ethics Committee (Medical) and Graduate Studies Committee, Faculty of Health Sciences, University of the Witwatersrand for approval of the study. Permission will be obtained from the Medical Advisory Committee to conduct research at CHBAH (Appendix 1). The theatre matron will be informed of this study.

Theatre staff will be invited to participate. Those who agree to participate will be given an information letter (Appendix 2) and asked to sign informed consent (Appendix 3). Should participants wish to know the culture on their MP, these results will be made available to them. The names of participants and their study number will be on a sheet of paper which will be filed separately and will only be available to the researcher. Confidentiality will be maintained as only the researcher and supervisors will have access to the raw data.

This study will be conducted in compliance with the Declaration of Helsinki (59) and the South African Good Clinical Practice Guidelines (60).

The raw data will be stored safely for six years after completion of the study.

5.7 Research methodology

5.7.1 Research design

A prospective, contextual, descriptive research design will be used for this study.

A prospective study is defined as a study in which data are first collected and the outcomes are then measured (61). In this study swabs from MPs will be collected and cultured for the presence of microorganisms.

Context is described as a "small scale world" such as a hospital or clinic (62). This study is contextual as it will be conducted in the OTs at CHBAH.

A descriptive study provides an accurate portrayal or account of the characteristics of a particular individual, event or group in real life situations for the purpose of discovering new meaning, describing what exists, determining the frequency with which something occurs and categorising information (63). This study will illustrate the growth of microorganisms on MPs.

5.7.2 Study population

The study population will be MPs used by theatre staff in the OTs at CHBAH.

5.7.3 Study sample

Sample size

Studies have shown the presence of microorganisms on HCWs MPs with prevalence rates ranging from 42 ─ 100% (4, 11, 17, 20-31) The sample size in studies investigating microbial contamination is between 32 and 500 (17, 57). Due to financial constraints the sample size of this study will be limited to 66 samples.

Sampling method

A convenience sampling method will be used for this study.

Convenience sampling is defined as choosing the most readily available persons to participate in a study (63). In this study, theatre staff who are readily available at the times of data collection will be invited to take part in the study.

Inclusion and exclusion criteria

An inclusion criterion for this study will be MPs used by theatre staff in OTs at CHBAH.

Exclusion criteria for this study will be:

- any breach in the aseptic technique used during the collection and transportation of samples by the researcher
- theatre staff who declined to be part of the study.

5.7.4 Data collection

Data collection process

All of the data will be collected by the researcher, over a three month period, from July to September 2016, in the OTs at CHBAH. The researcher will invite theatre staff to participate in the research. Should they consent to partake in the research, an information letter and written consent will be obtained (Appendix 3). Each MP will be given a study number.

The following data will be collected from the owners of the MPs, on a data collection sheet (Appendix 4):

- date and time of data collection
- demographics (age, gender, profession)
- the types of MPs
- how frequently the MPs are used at work
- if the MPs were cleaned, how, when and frequency of cleaning.

Sample collection

Swabs will be taken from the MP in the following standardised manner.

- The researcher will don sterile gloves before each MP is swabbed.
- The MPs will be swabbed with moistened sterile swabs by the researcher. The swabs will be dipped in Ringer's Lactate solution.

- Each of the MPs will be swabbed twice. Firstly, one half of the MP will be swabbed for a total plate count (TPC). The other half will be swabbed for culture and identification.

- The swab for TPC will be kept in Ringer's Lactate solution. It will be denoted 'A'.

- The swab for culture and identification will be returned to its casing, which contains Amies transport medium. It will be denoted 'B'.

- The swabs will be taken using a continuous rolling technique from the front and back of the MP as illustrated in Figure 1.

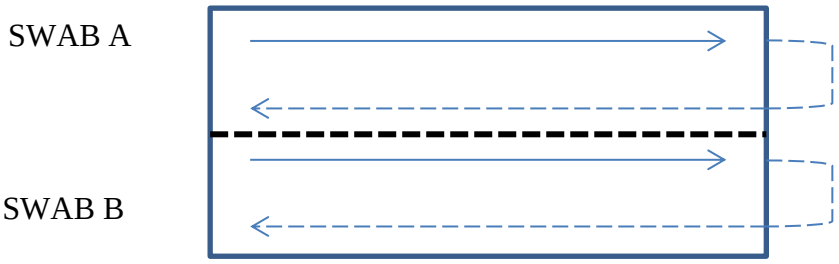


Figure 1 The swabbing technique

Sample labelling

The samples will be labelled using the National Health Laboratory Services' (NHLS) standardised request form for public health samples (Appendix 5). The form will be labelled as follows:

Sample type: Swab from mobile phone.

Identification: MP 01A. MP will refer to the mobile phone from which the swab was taken. 01 is an example of a number which will denote the number of the specimen. "A" will denote TPC and "B" will denote culture and identification.

Description: Moistened swab from MP. Please do MC&S (Microscopy, Culture and Sensitivity).

Sample storage and transportation

Samples will be stored at a temperature of 4 °C in a cooler box with ice packs. This will be transported by the researcher to the NHLS, an acrredited research laboratory, as soon as possible.

Sample processing

Swab A will be used to attain the level of microbial contamination (TPC). This will be assessed semi quantitatively.

Swab B will reach the laboratory in an Amies medium. It will be placed on 5% sheep blood agar plates. This will be the culture medium for microorganism growth. The sample will then be incubated aerobically for 48 hours. Thereafter colonies will be observed. A positive culture will be considered if there is any growth on the culture medium. Only aerobic bacterial and fungal pathogens will be isolated and identified. Once growth is observed, microorganisms will be identified by an experienced microbiologist. In the event that no organism growth occurs on the agar plate after 48 hours, it will be considered as a no growth sample and disposed of according to laboratory protocol. All samples and isolates will be observed, quantified and identified by experienced microbiology laboratory personnel using standard laboratory procedures.

Data analysis

Data capturing will be done using a Microsoft Excel 2010 spread sheet. The statistical program used will be Stata 15 (StataCorp, USA). Descriptive and inferential statistics will be used in consultation with a biostatistician. Frequencies and percentages will be used where applicable. Chi square will be used to find associations between growth of microorganisms and whether the phone has been cleaned or not. A p value of $\leq$ than 0.05 will be considered statistically significant.

5.8 Significance of study

As MPs increase in popularity, many issues have been mentioned such as noise and disturbance in the clinical setting, compromising privacy of patient information and data safety. Amongst these several issues pertaining to the use of MPs in hospitals, one of the most troubling is that MPs may serve as reservoirs for nosocomial transmission of microorganisms (4).

Nosocomial infections are a major contributor to morbidity and mortality in hospitals (10). Nosocomial infections increase functional disability and intensify the emotional strain of the patient. In some cases, incapacitating conditions may develop that result in the quality of life diminishing. Furthermore nosocomial infections are one of the prevailing causes of death. The economic costs associated with nosocomial infections are considerable (10). The incident of a nosocomial infection is related to factors such as immune deficiency, weak functional level and prolonged stay at a healthcare facility (13). South Africa has the largest HIV epidemic in the world (58). HIV is the leading cause of acquired immune deficiency (14) putting those infected at a risk of developing a nosocomial infection.

Numerous studies have shown the presence of microorganisms on HCWs MPs with prevalence rates ranging from 42 ─ 100% (4, 11, 17, 20-31). Some of the microorganisms isolated are known to cause nosocomial infections. Yet, at the time of the study, no recommendations that meet healthcare infection control standards regarding the cleaning of MPs were found.

The significance of this study is that there will be knowledge about the growth of microorganisms on HCWs' MPs at CHBAH. This study may make OT staff more aware of the potential of their MPs to spread infection. This may lead to the individual improving their hygienic management of MPs as well as lead to the development of infection control guidelines for cleaning MPs in Wits affiliated OTs.

5.9 Validity and reliability of the study

Validity refers to a measure of the truth or accuracy of a claim (63). “Reliability denotes the consistency of measures obtained” (63).
The researcher will collect, label, store and transport all the samples in a standardised manner.

All the specimens will be analysed at NHLS. The processing of the samples and identification of the microorganisms will be done by qualified laboratory personnel using standard microbiological laboratory equipment and procedures.

A biostatistician will be consulted for assistance with data analysis.

5.10 Potential limitations

The following limitations are anticipated.

The study will be done contextually in CHBAH and the results from the study may not be generalised to other departments or hospitals, however this study will address an important issue in the CHBAH OTs.

Anaesthetists and OT nurses may start cleaning their MPs if they become aware of this study and this could alter research outcomes. This limitation will be avoided by collecting data on random days and at random times which will be convenient for the researcher.

Due to financial constraints, this study will be limited to 66 samples and only microbial contamination with aerobic bacteria will be investigated. Contamination of the samples with blood and other microorganisms (anaerobic bacteria, viruses, protozoa) will not be assessed.

5.11 Project outline

Time frame

	Oct 2013	Nov	Jan 2014	July 2016	Aug	Sept	Nov	April 2017	May	Feb 2018
Chapters 1, 2, 3										
Proposal										
Ethics assessment										
Post graduate submission										
Data collection										
Data analysis										
Article										
Edit final										
Submit										

Financial budget

Item	Rands (R)	Amount of item	Total (Rands)
Cultures	74.00	100 cultures	7400.00
Gram negative organism identification	175.80	35 organisms	6153.00
Gram negative organism identification	37.00	35 organisms	1295.00
Gram positive organism identification	37.00	35 organisms	1295.00
Candida species culture	52.90	35 organisms	1851.50
Candida species identification	183.50	35 organisms	6422.50
Gloves (per box)	57.00	Two boxes	104.00
Printing of proposal, Data collection and Literature review	0.60	1750 pages	1050.00
		Total	25571.00

A quote was received from the NHLS (Appendix 6). When the samples were collected, a year later, this quote had expired and the researcher in fact was only able to collect 66 samples. An application for the financial costs of this study will be submitted to the South African Society of Anaesthesiologists Jan Pretorius fund. The costs of paper and printing will be incurred by the Department of Anaesthesiology.

5.12 Appendices

Appendix 1: Letter to the Medical Advisory Committee of CHBAH

Dr TJ Dibetso

Department of Anaesthesiology

University of the Witwatersrand

11th May, 2016

The Medical Advisory Committee

I am a registrar in the Department of Anaesthesiology. I am currently doing my research for the Master of Medicine in Anaesthesiology. My research entails describing the microbial contamination of mobile phones belonging to theatre staff, specifically anaesthetists and nurses in operating theatres at CHBAH.

I would like to request your permission to carry out my research in this hospital.

Thank you for taking the time to read this letter. I will await your response.

Sincerely

Dr Tiisetso J. Dibetso

Anaesthetic Registrar

Mobile number 0722404731

tjlibetso@yahoo.co.za

Appendix 2: Information letter to theatre staff

Study Title: Microbial contamination of mobile phones of theatre staff at Chris Hani Baragwanath Academic Hospital.

Dear colleague
Good day, my name is Tiisetso. I am a registrar in the Department of Anaesthesia. I would like to invite you to participate in my study.

My study involves the swabbing of theatre staff's mobile phones for microorganism growth. This should take no longer than 10 minutes. During this time, information about your mobile phone cleaning practices will be gathered and your mobile phone will be swabbed on the front and back. I will send the swab to the microbiology laboratory where the identification and quantification of microorganisms will take place. Should you wish to know what microorganisms are found on your mobile phone, I will need to take your name and link it to your study number. This information will be kept on a separate sheet which only I will have access to.

Every effort will be made to ensure confidentiality. Only my supervisors and I will have access to the raw data. There is no direct benefit to you, however as mobile phones are shown to harbour nosocomial pathogens, the results could assist you in decreasing the spread of nosocomial infections.

I have received post graduate and ethics clearance (M140128) to conduct this study.

Participating in this study is voluntary and no penalty or discrimination will be incurred if you do not participate. Should you have any queries you may contact me at 072 240 4731. You may also contact Prof Cleaton-Jones, the chair of the Human Research Ethics Committee at the University of Witwatersrand at 011 717 1234.

Many thanks
Tiisetso.

Appendix 3: Written consent

Consent form for participants

I, _____, have read and understood the information letter given to me by the researcher and consent to participate in this study. I was given a chance to ask questions and all the questions were answered.

Date:

_____

Participant's Signature:

_____

Appendix 4: Data collection sheet

Date: Time: Study number:

Section A – Background information

1. Gender

Male	
Female	

2. Age (in complete years)

3. Profession

Anaesthetist	Nurse

4. Are you aware that your mobile phone could carry pathogenic bacteria?

Yes	No

Section B – Mobile phone information

5. Do you use your mobile phone frequently at work?

Yes	No

6. Is your mobile phone a full touchscreen or does it have a keypad?

Full touchscreen	Keypad

7. Do you clean your mobile phone?

Yes	No

If you answered yes to question 7, please proceed to question 8 and 9.

8. When do you clean your mobile phone?

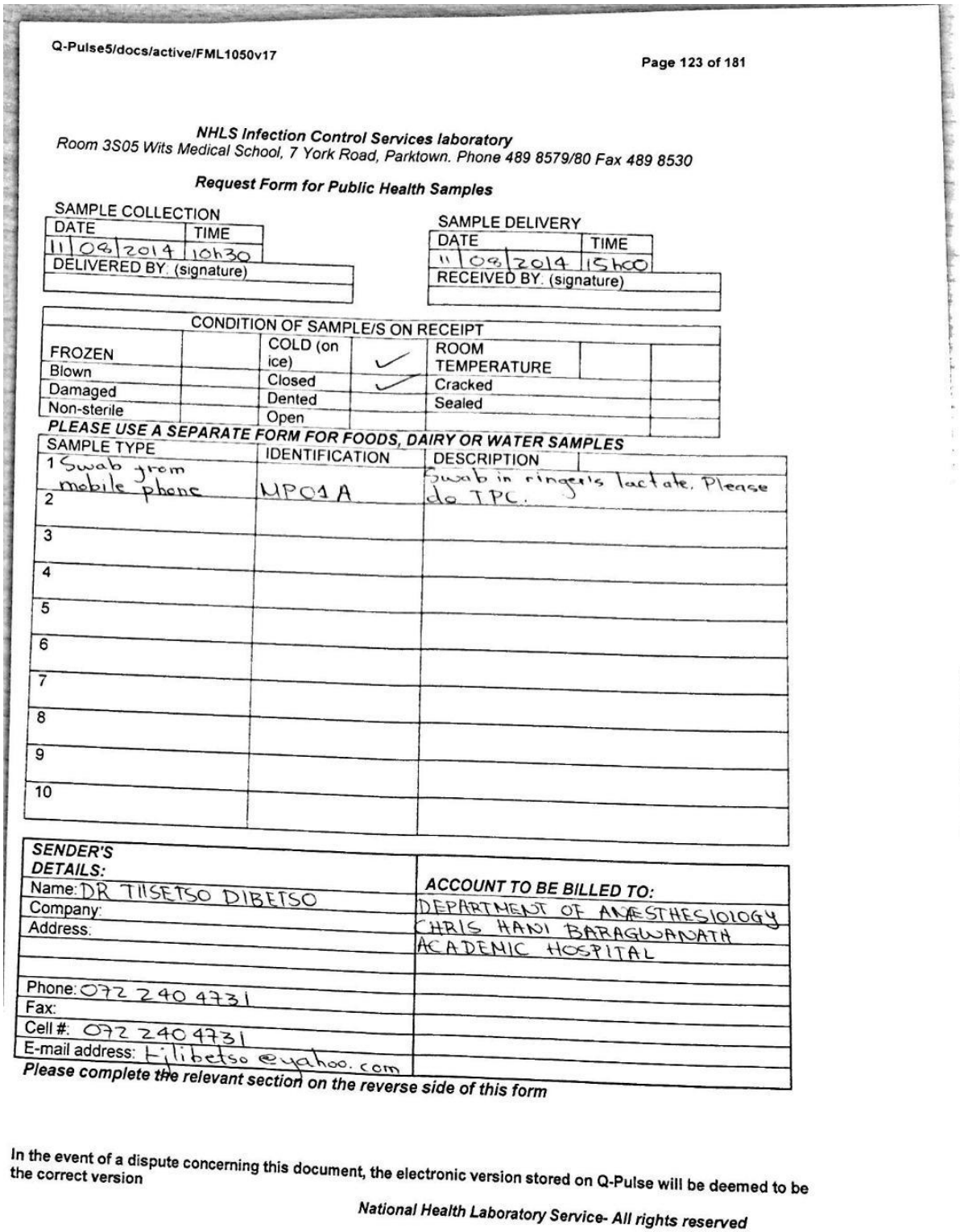
Before entering theatre	Before knocking off	After handling the mobile phone	Numerous times during the day

9. What do you clean your mobile phone with?

Dry cloth	Alcohol swabs	Other

If other, please specify

Appendix 5: Sample of National Health Laboratory Services' standardised form



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NHLS Infection Control Services laboratory

Room 3S05 Wits Medical School, 7 York Road, Parktown. Phone 489 8579/80 Fax 489 8530

Request Form for Public Health Samples

SAMPLE COLLECTION

DATE	TIME
11/08/2014	10h30

DELIVERED BY. (signature)

SAMPLE DELIVERY

DATE	TIME
11/08/2014	15h00

RECEIVED BY. (signature)

CONDITION OF SAMPLE/S ON RECEIPT

FROZEN		COLD (on ice)	✓	ROOM TEMPERATURE		
Blown		Closed	✓	Cracked		
Damaged		Dented		Sealed		
Non-sterile		Open				

PLEASE USE A SEPARATE FORM FOR FOODS, DAIRY OR WATER SAMPLES

SAMPLE TYPE	IDENTIFICATION	DESCRIPTION
1 Swab from mobile phone	UP01A	Swab in ringer's lactate. Please do TPC.
2		
3		
4		
5		
6		
7		
8		
9		
10		

SENDER'S DETAILS:	***ACCOUNT TO BE BILLED TO:***
Name: DR TIISETSO DIBETSO	DEPARTMENT OF ANAESTHESIOLOGY
Company:	CHRIS HANI BARAGWANATH
Address:	ACADENIC HOSPITAL
Phone: 072 240 4731	
Fax:	
Cell #: 072 240 4731	
E-mail address: t.jibetso@yahoo.com	

Please complete the relevant section on the reverse side of this form

In the event of a dispute concerning this document, the electronic version stored on Q-Pulse will be deemed to be the correct version

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NHLS Infection Control Services laboratory

Room 3S05 Wits Medical School, 7 York Road, Parktown. Phone 489 8579/80 Fax 489 8530

Request Form for Public Health Samples

SAMPLE COLLECTION	
DATE	TIME
11/08/2014	10h30
DELIVERED BY: (signature)	
Tibela	

SAMPLE DELIVERY	
DATE	TIME
11/08/2014	15h00
RECEIVED BY: (signature)	

CONDITION OF SAMPLE/S ON RECEIPT

FROZEN		COLD (on ice)	✓	ROOM TEMPERATURE			
Blown		Closed	✓	Cracked			
Damaged		Dented		Sealed			
Non-sterile		Open					

PLEASE USE A SEPARATE FORM FOR FOODS, DAIRY OR WATER SAMPLES

SAMPLE TYPE	IDENTIFICATION	DESCRIPTION
1 Swab from mobile phone	MP01B	Moistened swab from mobile phone. Please do MCTS.
2		
3		
4		
5		
6		
7		
8		
9		
10		

SENDER'S DETAILS:	**ACCOUNT TO BE BILLED TO:**
Name: DR TIBETSO DIBETSO	DEPARTMENT OF ANAESTHESIOLOGY
Company: DEPARTMENT OF ANAESTHESIOLOGY	CHRIS HANI BARAGWANATH
Address: CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL	ACADEMIC HOSPITAL
Phone: 072 240 4731	
Fax:	
Cell #: 072 240 4731	
E-mail address: tjlibetsoe yahoo.com	

Please complete the relevant section on the reverse side of this form

In the event of a dispute concerning this document, the electronic version stored on Q-Pulse will be deemed to be the correct version

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Appendix 6: Quotation for laboratory cost of the study



National Health Laboratory Service
University of the Witwatersrand, Johannesburg
INFECTION CONTROL SERVICES
Department of Clinical Microbiology and Infectious Diseases
Division of Hospital Epidemiology and Infection Control

Medical School Room 3T11, Level 3, Wits Medical School, 7 York Rd Parktown, Johannesburg 2193, Republic of South Africa.
PO Box 2115, Houghton 2041, South Africa Tel: (011) 489 8510 / 8578 / 8579. Fax: (011) 489 8530
PR5200296

TO: Dr T Dibetso
Department of Anaesthesiology, University of Witwatersrand

FROM: Rob Stewart (rob.stewart@nhls.ac.za)
NHLS Infection Control Services lab

SUBJECT: Quote for Research Project

DATE: 17 September 2015

Dear Dr Tiisetso

We are able to do the testing for your project which entails swabbing of 100 mobile phones.

The estimated price for this testing is as follows:

100 Cultures	(100 x R74.00)	R7400.00
35 Organism identifications Gram negative MS (35 x R175.80)		R6153.00
35 Organism identifications Gram negative (35 x R37.00)		R1295.00
35 Organism identifications Gram positive (Staph or Strept) (35 x 37.00)		R1295.00
35 Organism cultures Candida species (35 x R52.90)		R1851.50
35 Organism identifications Candida species (35 x R183.50)		R6422.50
TOTAL		**R24417.00**

Notes:

1. The NHLS has deregistered from VAT.
2. We will request a final invoice from the NHLS on the completion of the work.
3. You will only be billed for work carried out. Whenever possible the most cost-effective ID system will be used.
4. Please discuss optimal times for delivery of cultures with lab personnel.

Please contact me if I can be of further assistance.

Regards
Rob Stewart

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