TURKISH REPUBLIC OF NORTHERN CYPRUS
NEAR EAST UNIVERSITY
HEALTH SCIENCE INSTITUTE

MICROBIAL CONTAMINATION OF MOBILE PHONES

TARA SEDIQ ASAAD MANTIK

MASTER OF SCIENCE THESIS

MEDICAL MICROBILOGY AND CLINICAL MICROBILOGY
DEPARTMENT

ADVISOR

Prof. Dr. Tamer SANLIDAG

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Assist. Prof. Dr. Ayse SARIOGLU

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DECLARATION

Hereby, I declare that this thesis study is my own study, I had no unethical behaviors in all stages from planning of the thesis until writing there for, I obtained all the information in this thesis in academic and ethical rules, I provided reference to all of the information and comments which could not be obtained by this thesis study and took these references into the reference list; and, had no behavior of breeching patent rights and copyright infringement during the study and writing of this thesis

Tara Sediq Asaad MANTIK

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DEDICATION

To my parents…

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LIST OF ABBREVIATIONS

MRSA	Methicillin Resistant *Staphylococcus Aureus*
MSSA	Methicillin Sensitive *Staphylococcus aureus*
VRE	Vancomycin Resistant *Enterococci*
USA	United States of America
ICSB	International Committee on Systematic Bacteriology
KOH	Potasium Hydroxide
EIA	Enzyme Immunoassays
EUCAST	European Committee on Antimicrobial Susceptibility Testing
GMS	Gomori Methenamine Silver
UV	Ultraviolet
CDC	Centers For Disease Control
WHO	World Health Organization
EMB	Eosin Methylene Blue
CFU	Colony Forming Units
GPC	Gram-Positive Cocci
CNS	Coagulase-Negative *Staphylococci*
PCR	Polymerase Chain Reaction
LPCB	Lactophenol Cotton Blue
SPSS	Statistical Package Social Sciences

Microbial contamination of mobile phones

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ABSTRACT

Mobile phones are a source of dynamic microorganisms in homes and professional environments. The aim of this study was to determine the prevalence of bacterial contamination of the mobile phones identify bacterial isolates, assess their antimicrobial susceptibility patterns, and define the efficiency of use of disinfectant. This study included 233 students from Near East University, Faculty of Dentistry. The participants filled out a questionnaire with basic questions about the frequency of daily use of the phone, how often they wash their hands and clean their mobile phones. Swab samples (70% alcohol-based wipes) taken from mobile phones before and after disinfection were inoculated onto 5% sheep blood medium and eosin methylene blue medium and incubated aerobically at 37 ° C for 24-48 hours. Mold-growing mix cultures were sub-cultured on the sabouraud dextose medium and allowed to grow at room temperature. Conventional microbiological techniques and VITEK 2 automated identification system were used for bacterial identification and antimicrobial susceptibility testing. Antibiotic susceptibility tests were verified by Kirby-Bauer disc diffusion technique according to the European Antimicrobial Susceptibility Test Committee (EUCAST) criteria. Mold colonies were identified macroscopic and microscopically according to their phenotypic properties using lactophenol cotton blue stain. Microbial contamination of mobile phones was 81% (120953 cfu / ml) in swab samples taken without using alcohol-based wipes however, microbial contamination in swab samples taken after one-time disinfection was determined as 21% (201 cfu / ml). The most common microorganisms isolated were coagulase negative *Staphylococci* (69%) and *Aspergillus niger* (13%). All of the isolated bacteria were susceptible to all antibiotics used. This study represents the first data on the rate of microbial contamination on mobile phones and the efficiency of the use of alcohol to disinfect the mobile phones.

***Keywords*:** mobile phone, microbial contamination, dental students, Northern Cyprus

Cep telefonlarında mikrobiyal kontaminasyonun araştırılması

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ÖZET

Cep telefonları evlerde ve profesyonel ortamlarda mikroorganizmaların kaynağıdır. Bu çalışmanın amacı, cep telefonlarının bakteriyel kontaminasyon prevalansını belirlemek, bakteri izolatlarını tanımlamak, antibiyotik direnç durumlarını değerlendirmek ve dezenfektan kullanımının etkinliğini göstermektir. Bu çalışmaya Yakın Doğu Üniversitesi Diş Hekimliği Fakültesi'nden 233 öğrenci dahil edildi. Katılımcılar, telefonun kullanımı ve el hüjyeni ile ilgili anket formu doldurduktan sonra, cep telefonlarından sürüntü örnekleri aldılar. Yüzde 70'lik alkol bazlı mendillerle cep telefonlarının dezenfeksiyon işlemi yapılmadan önce ve yapıldıktan sonra alınan sürüntü örnekleri, %5 koyun kanlı ve eozin metilen mavisi besiyerlerine ekildi ve 24-48 saat 37°C'de aerobik olarak inkübe edildi. Küf üreyen karışık kültürler, sabouraud dekstoz agara pasajlanarak oda sıcaklığında bırakıldı. Bakteriyel tanımlama ve antimikrobiyal duyarlılık testleri konvansiyonel mikrobiyolojik teknikler ve VITEK 2 otomatik tanımlama sistemi kullanılarak gerçekleştirildi. Antibiyotik duyarlılık testleri, Avrupa Antimikrobiyal Duyarlılık Testi Komitesi (EUCAST) kriterlerine göre Kirby-Bauer disk difüzyon metodu ile doğrulandı. Küf kolonileri, makroskobik ve laktofenol pamuk mavisi kullanılarak mikroskobik olarak fenotipik özelliklerine göre tanımlandı. Alkol bazlı mendiller kullanılmadan alınan sürüntü örneklerinde cep telefonlarının mikrobiyal kontaminasyonu %81 (120953 cfu/ml), bir kez dezenfeksiyondan sonra alınan sürüntü örneklerinde mikrobiyal kontaminasyon %21 (201 cfu/ml) olarak belirlendi. En sıklıkla izole edilen mikroorganizmalar koagülaz negatif *Staphylococci* spp. (%69) ve *Aspergillus niger* (%13) idi. İzole edilen tüm bakteriler kullanılan antibiyotiklere duyarlı idi. Bu çalışma, Kuzey Kıbrıs'ta cep telefonlarının mikrobiyal kontaminasyon sıklığını gösteren ilk çalışma olup, cep telefonlarının dezenfekiyonunda alkol kullanılmasının etkinliğini göstermektedir.

***Anahtar Kelimeler*:** cep telefonu, mikrobiyal kontaminasyon, diş hekimliği öğrencileri, Kuzey Kıbrıs

SECTION ONE: INTRODUCTION

1.1. Aim and Scope

Mobile phones, which are widely used in the world, have been developed as an integral and indispensable equipment of many professional and social media and have become one of the most important devices of daily life. Mobile phones have become an essential accessory of individuals' social and professional life that provides a worldwide socializing network (Selim and Abaza, 2015). There was approximately 75 % of people globally contact to mobile phones. In addition, 1/3 of the world's use the mobile phone, this results in income to many company and lead to enhance in the production of more advanced mobile devices from the industrialized countries of the world. (Kamis, et al., 2015).

Today, many global populations use mobile devices due to wide range of applications and benefits for business, health care professionals and university students for rapid communication and access. As, mobile phones are used to make people's lives easier in the field of health and many other areas, many mobile operators serve in the sector. (Czapiński and Panek,2011).

Generally, mobile phones are used in medical and other departments of hospital and it is often touched during procedures and operations. Therefore, the risk of mobile phones being contaminated with microorganisms and even microorganisms that are very high drug resistant. (Jaya Madhuri, et al., 2015). Commonly the contamination of mobile phones has been documented, which are used by health care workers approximately (20 - 100%) as it is documented by numerous experimental detectives such as Deshkar, et al., 2016; Ramesh, et al., 2008; Ananthakrishnan, et al., 2006; Amer, et al., 2016; Tambe and Pai, 2012; Karthiga & Muralidaharan, 2016; Selim and Abaza, 2015. The drug resistant of microbial pathogens such as methicillin resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant *Enterococci*

(VRE) which were shown in many studies conducted on the mobile phones shows that the measures should be taken in order to prevent transmission (Mark *et al.*, 2015). However, there is no guidelines reported for taken care about disinfection of mobile phones that are used in the hospitals.

In Northern Cyprus, there are no data available in the literature on microbial contamination of mobile phones of dental students. Therefore, the aim of the study was to estimate the prevalence of microbial contamination of mobile phones used by dental students, to evaluate the antimicrobial susceptibility patterns of those pathogens and to emphasis the importance of disinfection of mobile phones in preventing cross transmission among users.

2. General Information

2.1. History

The microorganisms were first discovered and described by Robert Hooke and Antoni van Leeuwenhoek in 1665 and 1678 respectively, both of whom came from different science backgrounds. Their discovering microorganism by using of microscope devise which make change in medical side and life histories. Following historical financial records Leeuwenhoek was frequently defined as the ″first of the microbe hunters″. This cited his renowned letters of the 9 October in 1676 as charitable the first un-mistakable explanations of microbial (bacteria).

The Robert Hooke scientist open-minded to microscopy toward recognition of small living things that's way he considered as the backbone of microbiology, moreover he was the first to check explanations of Leeuwenhoek scientist, and he was considered to be dubious by many colleagues. Re-examination of the proceedings and publications of the Royal Culture from 1665 to 1678 expression that Robert Hooke

and Antoni van Leeuwenhoek both were the most important discoverers of the microbial in the world (Gest, H., 2004; Ainsworth, G. C., 1976; Weiss, R. A.. 2001).

2.2. Microbiology

Microbiology is the branch of general biology that deals with different types of microorganisms as well as the scientific study of the structure and function of microorganism (source/www.thefreedictionary.com/Microbiology). Microorganisms and their happenings are very important to essentially in all processes on world width. Microorganisms are main cause of infections and it is considered to be disturb each feature of our daily lives whatever they are in us and/or on us in addition to everywhere human body. The term of microbiology is used to the study of all active organisms which described as a too small to be visible without microscope. The microorganisms include bacteria, archaea, viruses, fungi, protozoa and algae. These microbes play important roles in nutrient cycling, biodegradation/bio deterioration, climate change, food spoilage, the cause and control of disease, and biotechnology. The microbes can be place to labor in many ways in order to make life more keeping at saving in side of drugs and production of biofuels, housework washing active contamination, and creating handling food, cooked, and drink. Moreover the study of microorganisms which termed medically (microbiologists) are deal with learning different types of microorganism, there are certain of greatest significant is the detections that have underpropped contemporary culture have been caused after investigation of well-known microbiologist like (Jenner) who was the pioneer of vaccine against the smallpox virus, Fleming with his discovery of penicillin, moreover the Marshall who had documentation the connection among bacteria (*Helicobacter pylori*) which deal with stomach complication (Ulcer), the author named zur Hausen who has been recognized the link between both of papilloma virus which is associated with cervical women cancer. The researches conducting in side of the microbiology has remained to dominant to facing numerous of present international aspirations, moreover, many of the experiments like preserving food

types, water pollution and energy safety aimed at a healthy people in an inhabitable environment (https://microbiologysociety.org/why-microbiology-matters/what-is-microboil-ogy.html) (Wood, B. J., 2012; Schlegel, H. G., & Zaborosch, C., 1993)

2.3. Microbial contamination and mobile phones

The important of these issues are there is no exact obligatory guidelines for taken care about disinfection of mobile phones that encounter hospital. The mobile phones as well being used normally all day extended as work hours even daily, likelihood this small device entertainment as a vector for increasing spread of various microbes to dissimilar department of health upkeep skill and also outside of hospital (Parhizgari, et al., 2013). Because of using mobile phone, it provides essential way to make life collaboration this uses made by touches devise may be more than 100 times per day we touch our mobile phone and this may result in transferring many of the microbe to it from our skin and vice versa, in addition putting our mobile in to many place including dirty surface with microbes and this may result in migrate of microorganisms to mobile hand phone (Jeske *et al.*, 2007; Akinyemi *et al.*,2009). There are multi user on one mobile phone in many places especially in hospital sections. This may also constantly lead to transmit of microorganisms between health care facilities, particularly those individuals related to dermis owing to the humidity and optimal temperature of body particularly inner part of hand palms.

The mobile phones act as reservoir of many microbial pathogens as they touch many parts of body such as lips, ear and fingers of dissimilar workers of different environments relate to healthy. There are also many reasons which lead to these microbes to promote in their growth better such as protection the mobile phones in our pouches, handbags in addition the snug pockets rise the opportunity of microbial multiplying. Warmth and temperature situations of mobile phones donate to harboring many microbes in populations on mobile devices (Tagoe, et al., 2011; Jaya Madhuri, et al., 2015; Goeland Goel, 2009). Because of the mobile phones are rarely disinfected

and these issues depend of the regard of their hygiene particularly associated with phone devices (Jaya Madhuri, et al., 2015; Hadir EL-Kady., 2017).

In many studies, it is mentioned that the use of hand disinfection regularly and poor personal hand washing follow by health specialized and other personalities will help to prevent the mobile phones colonization by microbes. An experimental study which conducted in the United States of America (USA) discovered around 80% of the common microbes make up our "fingerprints" and on our mobile phones (Chang, C. H., et al, 2017; Meadow, J. F., et al, 2014). Commonly the antimicrobial drugs are recycled to infection by susceptible of bacterial pathogens. The antimicrobial drug resistance is also related with nosocomial infection and this will be a result in serious community health problematic cases. Many pathogens have been developed as resistant to numerous type of drugs, following infections behind resistant bacteria are nowadays are too public, following the drug resistance donates significantly to the increasing prices of the health care unit, also this will be resulting from lengthy hospital visits in another side it leads to need to use other cheaper drugs (Bodena, D., et al, 2019; Teng, S. O., et al, 2009). There are many studies showed that the most commonly isolated pathogens from mobile phones were gram positive bacteria counting as coagulase negative *Staphylococci, Staphylococcus aureus, Micrococcus spp*. spore forming *Bacillus spp.* There are some other gram-negative bacteria predominantly such as Escherichia *coli*, *Proteus spp., Pseudomonas aeruginosa, Klebsiella spp., Acinetobacter spp*. In addition to being a habitat for bacterial pathogens. Although surface of commonly used smartphones could be polluted by pathogens, factors influencing the transmission of contagious infection such as the survival period of microorganisms colonized on non-living exteriors and substances, deprived environmental disinfection of normally used devices and/or poor hand hygiene among individuals play important role in various human disease transmission. The determination of microorganisms is accompanying with the environmental factor conditions such as temperature, humidity, presence of organic substances, the capability to produce biofilms, studies have been showed that survival

of clinically pertinent microbial pathogens on non-living exteriors surface depends on the surface and characteristics of microorganisms. For example, the most frequently isolated *S.aureus* including methicillin resistant *Staphylococcus aureus* (MRSA) and methicillin sensitive *Staphylococcus aureus* (MSSA) can survive in the environment at least 7 days to up to 1 year. The period has been assumed as around 9 to 12 days and 72 hours for bacteria colonized on correspondingly plastic in addition to stainless-steel surfaces. *Esherichia coli, Acinetobacter spp., Pseudomonas aeruginosa, Proteus spp., Klebsiella spp.* can stay infective in the environment 1.5 hours to 16 months, 3 days to 1 year, 6 hours to 16 months, 1-2 days and 2 hours to extra than 30 months respectively. The ability of yeasts and clinically relevant viruses to persist on dry surfaces also effect the danger for transmission of fungal and viral infectious diseases. Reports have shown that human coronaviruses (MERS-CoV) can live on inanimate surfaces and remain infective for up to 9 days at room temperature and shorter at higher temperatures. On the other hand, this period has been given as 4 weeks for influenza viruses although both viruses are transmitted by polluted air born droplets. Infection with respiratory pathogens such as respiratory syncytial virus, and rhinoviruses which have a habit of to happen mainly in winter time of year and spread easily can survive respectively up to 6 hours and 7 days due to inefficient use of disinfectants. Molds are also related with contamination of environments, devices and objects as they can survive for numerous months in house soil (Kramer, A., & Assadian, O., 2014; Russotto, V., et al, 2017).

2.4. Microbial contamination and antibiotic resistance

The discovery of antibiotics turned to more than 70 years, initiated a period of drug innovation and application in human. There are many outbreaks of bacterial infection that are progressively being reported when it is associated with antibiotic resistance, the Centers for Disease Control and Prevention (CDC) tracked a multistate outbreak of *Salmonella enterica, the* enteric serovar Heidelberg infections which related to contaminated ground turkey and disgusted more than 130 people. While

these bacteria were resistant to numerous types of antibiotics, the distressed might be preserved with another agent. Also, in Germany, an epidemic of bacteria *Escherichia coli* contaminations caused through vegetables pretentious up to 5,000 people in addition to 50 deaths. Forthcoming large outbreaks is the emergence and universal spread of antibiotic resistance genes. Like the New Delhi metalloβ-lactamase resistance gene (blaNDM-1), which discusses resistance to penicillin, cephalosporins and a range of their derivatives which has been spread quickly in 2010 (Bush, K., et al, 2011). From the start of the antibiotic period selective used by antibiotic usage was a soon reflected by resistance improvement in *Staphylococci* and *Micrococcus* (Gram positive type of bacteria), this was the initiated of immediately with outline of penicillin G in 1941, followed by resistance to additional classes of materials presented one after the other throughout the golden age of antibiotics. The bacterial resistance belongs to Gram-positive in additional to Gram-negative are motionless cumulative. There are numerous drug resistance in *pneumococcal* infections determination of principal toward extra treatment disappointments fail which so distant consume seen by way of penicillins and pathogens through in height value of resistance, and this condition result in greater mortality with long term of staying hospital then advanced prices related with methicillin resistant *Staphylococcus aureus* (MRSA) infections, now in contrast through methicillin susceptible *Staphylococcus aureus* (MSSA) infections likewise, vancomycin resistant enterococci (Witte, W., et al, 2008; Lode, H. M., 2009). Moreover, the pathogens microorganism is producing infections which regularly may resistant to some presently anti-bacterial that result in very problematic to heal. Difficult and the most pathogens that may cause resistance to human are *Streptococcus pneumoniae* which resistant to group of B-lactams and macrolides drug, viridians *streptococci* are mostly resistant to aminoglycosides and group of B-lactams, Moreover the resistance which caused by *Enterococci* to teicoplanin, vancomycin, with strongly resistant to aminoglycosides and penicillins. The most important one is *Staphylococcus aureus* which cause worldwide resistant generally to methicillin drug, macrolides, aminoglycosides, lincosamides and B-lactams group.

Another significant pathogen is *Streptococcus pyogenes* that is resistant to macrolides, and the macrolide resistant *streptococci* of groups B, C, and G, also the coagulase (–) *staphylococci* that are resistant to macrolides, aminoglycosides, B-lactam group, glycopeptides and lincosamides (Baquero, F., 1997). The Gram-negative microorganisms characteristically are more resistant to antimicrobials than comparing to Gram-positive bacteria, and this has long been clarified by the presence in the former of the outer membrane penetrability barrier of the cell wall which limits access of the antimicrobial agents to their targets in the bacterial cell. The gram-negative bacteria are responsible for a considerable percentage of all bloodstream infections, which lead in patterns of reduced susceptibility to antibiotics were found among gram-negative bacteria. Despite the high prevalence of antibiotic resistance among gram-negative bacteria causing bacteremia, the clinical consequences of resistance remain unclear (Poole, K., 2001). Important members of the gram-negative bacteria are containing (Acinetobacter spp, *Pseudomonas spp, Stenotrophomonas spp,* and *Burkholderia spp*). Also, these microorganisms are belonging to those function pathogens that principally source of opportunistic infection especially in healthcare associated contaminations who remain disapprovingly ill and/or condition with low immune system. The treatment with multidrug resistance nowadays is communal besides to increasing amongst gram negative non-fermenters bacteria, the quantity of straining has currently remained recognized that exhibit resistance to fundamentally altogether generally used antibiotics, as well as anti-pseudomonal penicillins in additional carbapenems, aminoglycosides, sulfamethoxazole, cephalosporins, tetracyclines, trimethoprim- and fluoroquinolones. The polymyxins are outstanding antibiotic medication with justly reliable activity in contradiction of multidrug-resistant for *Acinetobacter spp, Stenotrophomonas maltophilia, Pseudomonas aeruginosa (P.aeroginosa).*

There are variety mechanisms of *P. aeruginosa* towards the resistance including efflux pumps, target-site variations, enzyme creation, porin insufficiencies.

Also, there are many genes responsible for resistance regularly cohabit in organism at the same time. Moreover, the many medication resistances in non-fermentative and gram-negative lead to difficult in treatment which lead to both problematic and costly. For the detection of the resistance of bacteria, a current test should be performed in order to detect different types of bacteria among different types of antibiotics. Moreover, different susceptibility testing methods are necessary when it is suspecting that patients may be infected with these types of microorganisms, for example the developing strains voicing metallo-β-lactamases (McGowan Jr, J. E., 2006).

2.5. Microbial contamination and disinfection

The inanimate objects in the environment are known to be contaminated with microorganisms, also mobile phones have become a postponement of the office practice for physicians and others, it may serve as the perfect substrate for microorganisms, particularly in high temperature and humid conditions. Also, the organisms that cause nosocomial infections are commonly transmitted by hand contacting. Hand hygiene is one of the most important procedures in preventing nosocomial infections. The officials at the CDC mention the hand personal hygiene before and after interaction with patient, also an assessed 1/3 of wholly hospital acquired contaminations are affected by absence of adherence of recognized infection control applies. Moreover, it is very common in health carry surroundings to consume parentages perform first hand and arm scrub upon incoming to the unit. The hand hygiene procedures have been established inspire either by washing hands and/or via antimicrobial lotion or disinfectant beforehand touching patient and after contacting. In spite of this importance on better-quality hand cleanliness, a little emphasis has been prearranged to parent's cell phone usage at the bedside.

Nowadays there are many experimental studies performing regarding to the bacterial pollution of cell phones with microorganisms although the principally attention on health care workers and/or adult in patient locations. Also, there are a

little consideration has remained to paid the possible of the transmission rate of bacteria from the cell phone toward the patients and other peoples (Brady, R. R., et al, 2011; Beckstrom, A. C., et al, 2013).

The disinfectants are expected to play an even more important role in microbial control in patients and the hospitals in the future. Even though, numerous alcohols have been exposed to be used as antimicrobials, ethyl alcohol, isopropyl alcohol and n-propanol, remain the most commonly used. Alcohol has wide broad spectrum type of the anti-microbial action in contradiction of vary of bacteria, viruses, and fungi but alcohol cannot destroy spore forms (are not sporicidal), conversely, it is recognized to prevent sporulation, moreover, the influence is alterable for the reason the lack ability to sporicidal action, also the alcohols are not suitable options for sterilization but are extensively used in both solid surface disinfection and skin antisepsis, also the poorer concentrations might be used for the preservers the action of biocides agents.

There are numerous types of alcohol products that contain the little stages biocides than other agents like specific chlorhexidine that preserve on living things skin surface next to be vaporization of alcohol and/or excipients. Emollients that may result in reduction of the vaporization time of the alcohol which are able to significantly increase creation efficacy. Medically, the type of the isopropyl alcohol is deliberated somewhat more efficacious in contradiction of bacteria and ethyl alcohol have more powerful effecting against viruses, this dependent on the amount of the concentrations of both, (i) Active agent. (ii) The test microorganism such as isopropyl alcohol has better lipophilic possessions when comparing with ethyl alcohol and it have fewer activation against hydrophilic viruses. Usually, the ability of the antimicrobial action of alcohols are lesser concentrations under 50%, but optimum the (60 - 90%) variety. There is little knowledge about recent specific method of act toward the alcohols, the idea turned to founded the improved efficacy in occurrence of water, because third commonly supposed the reason of the layer destruction in

addition to quick lysis of content proteins following interfering by means of metabolism and cell denaturation. This may result in maintained by specific information of analysis of *E. coli* dehydrogenases then the improved the lag bacterial phase development trendy to Enterobacter aerogenes, hazarded in line for reserve of metabolic rate necessarily meant for speedy living cell separation (Alwarid, R. J., et al, 2018). Ethanol needs to have a contact time of at least 10 seconds to kill *Staphylococcus aureus* and *Streptococcus pyogenes.* At a 10 second drying time, ethanol also kills *Pseudomonas aeruginosa, Serratia marcescens, E. coli, Salmonella typhosa, Staphylococcus aureus, Streptococcus pyogenes.* The Isopropyl alcohol mainly in solutions are arranged between the 60% to 90% alcohol in additional to 10 – 40% decontaminated water, it is main and quickly antimicrobial against the (bacteria, fungi, and viruses). Moreover, if the concentration of the alcohol applications drop underneath 50 percentage will be usefulness for disinfection drops sharply, but the higher alcohol concentrations don't prevent additional desirable properties of (bactericidal, virucidal, or fungicidal).

Alcohol contain some amount of distilled water; the attendance of water is a crucial influence in an inhibiting the development of pathogenic microorganisms with isopropyl alcohol and destroyed it. The water entertainments as a catalyst and plays an important role in analysis of the proteins of the cell membranes. Moreover the 70% IPA solutions enter the cell wall of living things more completely which infuses the complete cell, make coagulates to all proteins, and then the microorganism dies. Also, the extra water lead to the slows processes of the evaporation, for that reason collective external interaction time and enhancing the efficiency. The IPA concentrations more than 91 percentage will coagulate proteins promptly. Therefore, a defensive coating is created which care for other proteins from further coagulation. Moreover, the substance more than 91% IPA do murder bacteria, however, sometimes need extended interaction of times for disinfection, which enable spores to falsehood in a dormant state without actuality destroyed. In this analysis, moreover the 50% of isopropyl alcohol reagent will murders the *Staphylococcus Aureus bacteria within* 10

seconds, but the 90% solution with interaction of time over 2 hours is useless. Also, there are many of the disinfectants recognized to kill spores which are categorized as a chemical sterilants compound. In this situation, we know that higher alcohol component harvest less results for bactericidal and antimicrobial results, also there are a product in pharmacy termed a Ethanol Wipes, the 70% Ethanol Wipes for surface and Objects, presaturated ethanol wipes (ethyl alcohol) are a common surface decontamination products for pharmaceuticals, healthcare, and medical device manufacturing. Clean surfaces gloves, notebooks, phones or any compatible material. Use alcohol with care: may degrade some types of plastics, display surfaces, and enamels (Boothe, H. W., 1998; https://blog.gotopac.com/2017/05/15/why-is-70-isopropyl-alcohol-ipa-a-better-disinfectant-than-99-isopropanol-and-what-is-ipa-used-for/; https://www.compliancenaturally.com/blog-page/2018/4/15/why-70-ethanol-is-the-most-effective-disinfectant-for-any-food-or-pharma-facility)

SECTION 2: MATERIALS AND METHOD

2.1. Materials

2.1.1. Devices and Tools

• Pipette	• China
• Yellow Tip	• Germany
• Blue Tip	• UK
• Timer	• UK
• Incubator	• China
• Autoclave	• China
• Microscope	• Germany
• Sterile Cup	• Germany
• Microscopic Slide	• Germany
• Cover Slip	• Malaysia
• Petri Dish	• Turkish
• Blood Agar	• USA
• EMB Agar	• USA
• SDA Agar	• Germany
• Ethanol Ethyl	• Germany
• Povidone Iodine	• Germany
• Sodium Hydrochloride	• Turkey
• Swap	• USA
• McF Device	• Germany
• VITEK 2 MoiB France	• France

2.1.2. Powder agar Firm Name

LAB028 SDA Agar Base (LAB M)
LAB028 EMB Agar Base (LAB M)
LAB028 blood Agar Base (LAB M)
Tel: +44(0)161 797 5729
www.labm.com
United Kingdom

2.2. Study Group and study design

This study was conducted in Nicosia province of Northern Cyprus. Mobile phones of 233 dental students were included in the study. A total of 466 swab samples were collected before and after disinfection of mobile phones of dental students in order to detect different types of microorganism such as bacteria and fungi. Different types of culture media were used in order to grow microorganism including (i) enriched medium: 5% sheep blood agar, (ii) for gram negative bacteria: eosin methylene blue (EMB), (iii) for fungi: sabaraud's dextrose agar (SDA). Moreover, gram stain was performed in order to differentiate different type of bacteria, lactophenol cotton blue stain was used to identify different types of fungi. Biochemical tests were performed for further identification of bacteria.

2.3. Samples Collection

All samples were collected by aseptically microbiological technique. A total of 466 swab samples were collected from various surfaces (screen, sides, back, phone accessories) of mobile phones belonging to 233 Term II dental students of Near East University, Faculty of Dentistry. This age group was preferred because it includes people who use mobile phones frequently in daily and social lives. Sterile cotton swabs were used to collect samples as before and after the use of the

disinfectant. For taking proper samples, the students disinfected their hands using alcohol-based hand antiseptics and wore powder free disposable gloves per each sample collection in order to prevent potential cross contamination.

The sterile swabs were moistured with sterile saline before use and rotated firmly over the whole surfaces of the mobile phones. Totally, 466 samples were collected from dental student's mobile phones as before (233 swab samples) and after (233 swab samples) disinfection. Wet wipes consisting of 70% alcohol were used for disinfection of the mobile phones. The swab samples were inoculated on 5% sheep blood agars and EMB agars immediately and transported directly to the microbiology laboratory for incubation at 37°C for 24-48 hr. in order to promote the growth of bacteria.

2.4. Bacterial Quantification

Bacterial colonies were counted by specific microbiological tool termed as counter reader colony (Quebec). The calculation unit also arranged by following bacteriological unit used for colony forming units (CFU) to each sample.

2.5. Identification of Isolates

The identification of microbial isolates in both blood and EMB agar was performed according to bacterial morphology by using gram stain as a first step. Later on, the colonies were microscopically examined in order to determine the morphology of bacteria. Biochemical tests (Forbes *et al.,* 2007) were performed as further tests. Bacteria generally divided into gram positive and gram negative therefore, documentation type of bacterial Gram-positive cocci which abbreviated as (GPC) based on different characteristics like bacterial size, organized in arrangement with white color and sometime golden yellow color with appearance circle to smooth colony, with noted plate if there were β-hemolytic or non-hemolytic on blood agar. Catalase and coagulase tests were performed for these colonies. Positive results for

slide and tube coagulase tests were assessed as *Staphylococcus aureus*. The catalase (+), coagulase (-) GPC were accepted to be coagulase (-) *Staphylococci* spp. (CNS). Non-hemolytic, catalase (+), and coagulase (–), oxidase (+) GPC were considered to be *Micrococcus* spp.

For some gram-negative bacilli that could not be identified by conventional methods, VITEK 2 MoiB morf sdrac TSA/DI tcapoC-rieux company otomatic identification system was used. They were tested for detection of bacteria in addition to antibiotic sensitivity test, VITEK 2 device is automatic system which reduces hand time for enhance workflow and rapid reporting after performing primary bacterial isolation on plate. Test was performed by taken colony and mixed with distil water following mixing by vortex then put mixed solution in to specific caskets after putting in machine. The results were obtained after 6 hr. of inoculation.

The automated system was used for further identification of bacteria that were considered to be resistant, such as *CoNS, Pseudomonas spp.*, *Acinetobacter spp.*, and for determining their antibiotic resistance patterns. Vitek 2 automated reader incubator (VITEK2, France) was performed by using AST-GN (for gram negative bacteria), AST-PN (gram positive bacteria), AST-P641 (for *Staphylococci spp.*), AST-N325 (for *Acinetobacter spp., Pseudomonas spp.)* cards. According to the gram characteristics of bacteria, different antibiotic patterns were carried out for susceptibility testing. For gram-positive bacteria, the pattern consisted of; cefixitin (ctx), ciprofloxacin (cip), daptomycin (dap), fosfomycin (fos), fusidic acid (fus), gentamicin (gen), levofloxacin (lvx), linezolid (lzd), nitrofurantoin (nit), tetracycline (tc), tigecycline (tgc), trimethoprim/sulfamethoxazole (sxt), vanomycin (vanc). For gram-negative bacteria, the antibiotic disks tested were; amikacin (amk), cip, colistin (cst), gen, imipenem (imp), lvx, meropenem (mem), netilmicin (net), tgc tobramycin (tob), sxt; amk, aztreonam (azt), cefepime (cpe), ceftazidime (caz), cip, cst, gen, imp, lvx, mem, net, piperacillin (pip), piperacillin/tazobactam (tzp), tob.

Antibiotic sensitivity test results were confirmed by Kirby-Bauer disk diffusion method according to the EUCAST criteria for gram negative bacteria that were thought to be pathogenic bacteria.

2.6. Negative Control

A non-inoculated %5 sheep blood agar and an EMB agar were placed on the laboratory benches before collecting samples from mobile phones as negative controls of the study.

2.7. Questionnaire forms

For all dental students (Turkish and English groups), a questionnaire form was directed in order to have information about demographic features (gender, age, nationality) of dental students. The questionnaire form is given in Appendix 1.

2.8. Statistical Analysis

The Statistical Package Social Sciences (SPSS) application was used in order to manipulate each result parameters with other data in this study. The SPSS is a widely used program for statistical analysis in social science. It is also used by many of other fields include health researchers. It can handle complex data manipulations and analyses them very easy and within minutes.

Because of the data pertaining non-parametric and there is some parameter relate to quality (category) data the Chi-square test was used to solve the relation variable on before and after sterilization inoculation of samples. But there was some other parameter contain quantitative (continues) data therefore, other test such as frequency and compare mean was the best option for comparison each group of

bacteria and fungi, SPSS program was used in order to manipulate the significant rate by evaluation each of (P value, mean, standard deviation).

2.9. Ethical Approval

The Ethical approval of this thesis was taken from Near East University Ethical Approval Committee of Near East University with the permission number no NEU/2019/73-915 and the informed consent forms were collected from all individuals included in the study (Appendix 2).

SECTION THREE: RESULTS

3.1. Study Group Characteristics

In the study, Near East University, Faculty of Dentistry Term II dental students, who live in Northern Cyprus, were enrolled. The study was divided in to two sections. Samples collection before disinfection and after disinfection of the mobile phones. The age range of the participants was between 18-22 years. Among all, 117 participants were females and 116 were in gender belong to male. Moreover, all participants use smart mobile phones in their daily lives. The general characteristics of the students is given in Table 3.1.

According to the questionnaire forms, 35% of the students responded that they use their mobile phones 4 hours (hr.) and the rest of them responded that they use their mobile phones more than 10 hr. during a day. All participants responded that they clean their mobile phones but they clean their mobile phones after they use for more than 11 hr. Among all students, 55% of them use wet wipes for disinfection and others use dry tissue for disinfection. Additionally, all of the dental students thought that their mobile phones may carry microorganisms and they pay attention to their hand hygiene. However, they often wash their hands once daily. The summary of the answers to the questions in the questionnaire forms is given in Table 3.2.

Table 3.1. General characteristics of the participants

Characteristics	Number of participants (%)
Age	18-22 (100)
Gender (Female/Male)	117 (50) / 116 (50)

Table 3.2. The analysis of questioner forms

No	Questions	Number of participants (%)
1	number of students who use mobile phones	100 (100%)
2	number of students who use mobile phones for at least 3-4 hours in a day	76 (32%)
3	number of students who disinfect their mobile phones	100 (100%)
4	number of students how often disinfect their mobile phones more than 10 hours	92 (39%)
5	number of students who use wet wipes rather than alcohol based wet wipes to disinfect their mobile phones	128 (55%)
6	number of students who think that their mobile phones may carry microorganisms	100 (100%)
7	number of students who care about your hand hygiene	100 (100%)
8	number of students who use proper hand wash	79 (33%)

According to the findings, there was no growth detected in negative controls however, 81% (n:189) of mobile phones were found to be contaminated and the bacterial count was determined to be 1200953 cfu/ml. Polymicrobial contamination was detected with the mobile phones. The number of colony counts for cultures before disinfection of mobile phones was quite higher compared to the number of bacterial counts for cultures after disinfection process which was counted to be 170 cfu/ml. Gram-negative growth was detected in 17 cultures in samples taken before disinfection with the 43 cfu/ml colony counts. However, gram negative bacteria

growth was not detected in samples taken after disinfection. Fungal growth was detected in 53 and 8 cultures in samples taken before disinfection and after disinfection respectively. Additionally, *Micrococcus spp*. was isolated in 7 samples taken from before disinfection with 4492 cfu/ml bacterial counts. After disinfection of the mobile phones, *Micrococcus spp.* was determined in 5 cultures with bacterial counting 17 cfu/ml.

Among samples taken from before disinfection, beta-hemolysis (82217 cfu/ml) colonies were determined in 131 cultures. This number dropped to 11 cultures (43 cfu/ml) after disinfection of the mobile phones. There was alfa- hemolytic colonies in 9 cultures and the total number of bacterial count was 1033 cfu/ml. After disinfection, no bacterial growth was observed. There were also some cultures (n:34) that contained non-hemolytic colonies with 33168 cfu/ml bacterial count. The number of colony counted after disinfection was 110 cfu/ml and observed in 21 cultures.

Moreover, biochemical detection tests including catalase, coagulase, oxidase tests were performed for further identification. Catalase tests were performed to 174 cultures and all tests were determined to be positive for catalases test. Coagulase test was performed for catalase positive colonies. All of the colonies were coagulase test negative which indicated the strains were not *Staphylococcus aureus*. Oxidase test was performed for the catalase test positive strains and 7 of them which were found to be positive assessed as *Micrococcus species.* Growth of microorganisms on different media with their bacterial colony counts are given in Table 3.3.

Table 3.3. Growth on media and the colony counts of bacteria

No	Sample	Before Disinfection		After Disinfection	
		Plate n	No.colony cfu/mL	Plate n	No.colony cfu/mL
1	growth on blood agar	189	120953	50	170
2	growth on EMB agar	17	43		-
3	polymicrobial growth on blood agar (bacteria and mold)	45	-	6	-
4	growth on blood agar (mold)	8	-	2	-
5	beta hemolysis on blood gar	131	82217	11	43
6	Non-hemolysis on blood agar	34	33168	26	110
7	alpha hemolysis on blood agar	9	1033	-	
8	*Micrococcus spp.*	7	4492	5	17
9	colonies for catalase tests positive	174	-	37	-
10	colonies for coagulase tests negative	174	-	37	-
11	colonies for oxidase tests positive	7	-	5	-

3.2. The bacterial profiles before disinfection and after disinfection of the mobile phones

The cultures obtained from the samples taken before and after disinfections were polymicrobial. Gram-positive bacteria were isolated in 181 cultures with the number of colony count 120910 cfu/ml for before disinfection and this number was found to be 170 CFU/ml in 42 cultures with the samples taken after disinfection. Of the gram positive-bacteria, the only isolates were coagulase negative *Staphylococci* (ConNS) and *Micrococcus spp*. with the percentage 96% and 4% respectively. *Micrococcus spp*. was isolated in 7 cultures before disinfection with 4492 cfu/ml colony counts. The growth dropped to 5 cultures after disinfection of mobile phones

with 70% alcohol-based wipes and the number of bacteria count determined to be 17 cfu/ml.

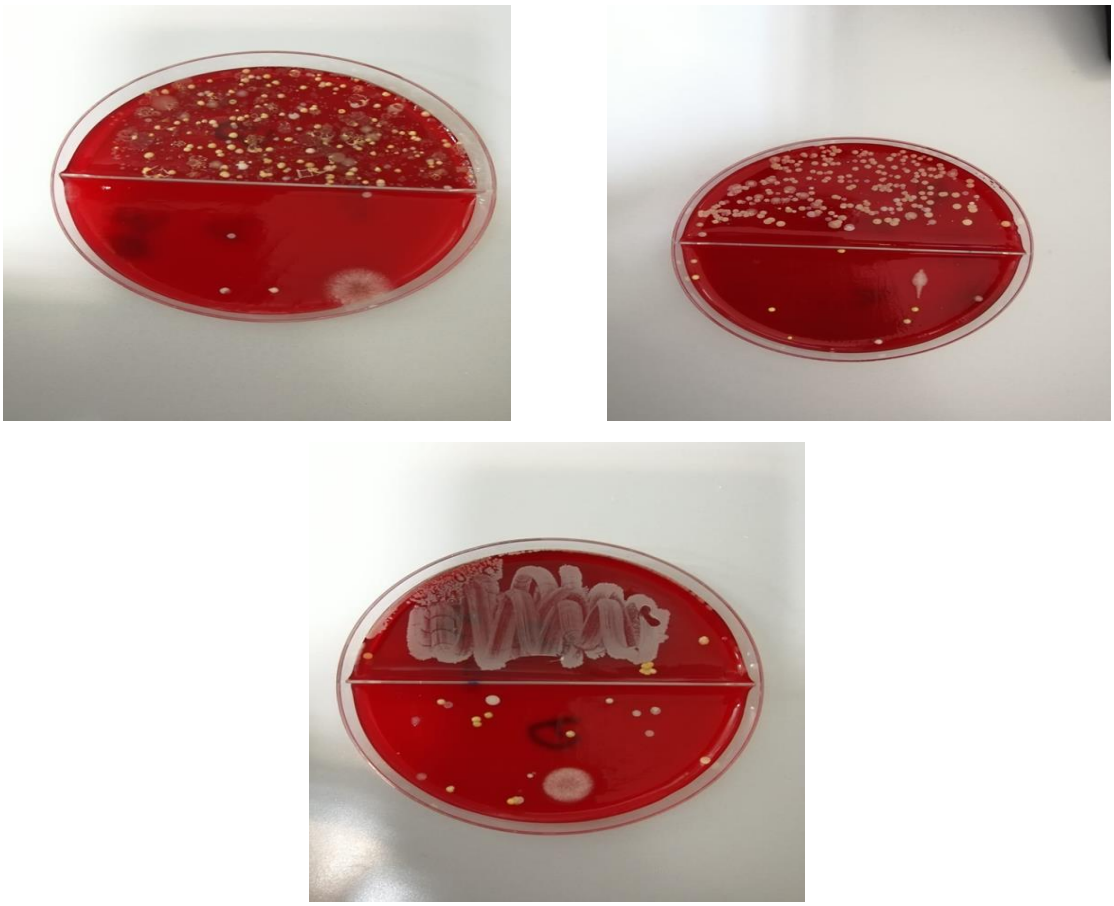


Figure 3.1: Polymicrobial growth of bacteria on blood agar

Among all, there were 17 cultures contaminated with gram-negative bacteria. The total colony counting in 17 cultures was found to be 43 cfu/ml before disinfection. The bacterial growth on EMB agar is shown in Figure 3.2 Amongst gram-negative bacterial isolates, *Pantoea spp*. (53%) and *Pseudomonas aeruginosa* (*P. aeroginosa*) (18%) were the main isolates. After disinfection, there was no gram-negative growth determined.

Figure 3.2: Growth of gram-negative bacteria on EMB agar before disinfection

Overall growth, 53 cultures, 8 of which were pure, were contaminated with fungi in samples taken before and after disinfection respectively. Among a total of 53 mold isolates, *Aspergillus niger (A.niger)* (n: 32, 60%) and *Microsporum audouinii* (n: 13, 25%) were the major isolates. The total number of microorganisms isolated on mobile phones before and after disinfection is given on Table 3.4. and 3.5.

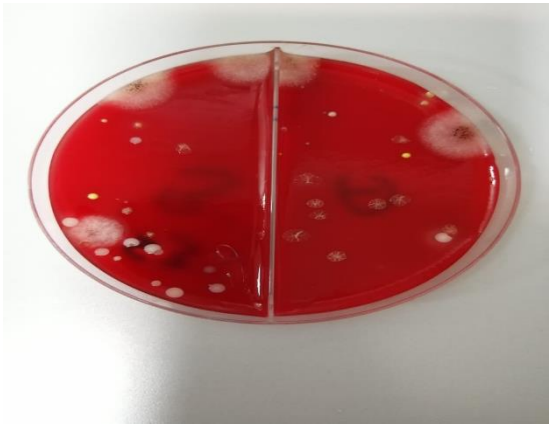


Figure 3.3: Growth of mold colonies on blood agar

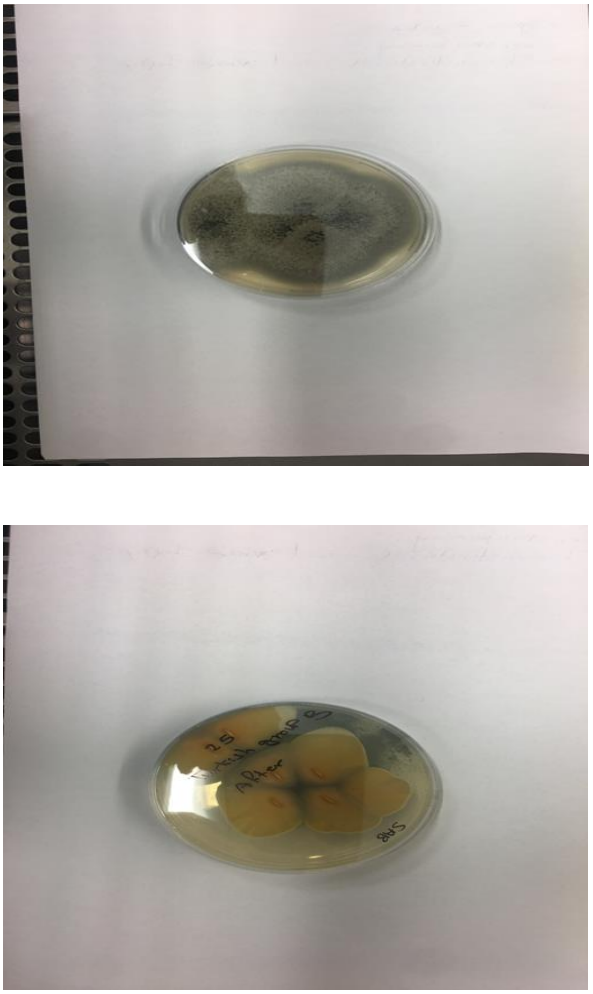


Figure 3.4: Growth of mold colonies on SAB agar after sub culturing from blood agar

Table 3.4. Total number of microorganisms isolated from samples taken before and after disinfection of mobile phones

No.	Types of microorganism	Before Disinfection		After Disinfection	
		Plate n (%)	No.colony cfu/mL	Plate n (%)	No. colony cfu/mL
1	Gram positive bacteria	181 (77.6 %)	120910	42 (18.0%)	170
2	Fungus (Mold)	53 (22.7 %)	-	8 (3.4%)	-
3	Gram negative bacteria	17 (7.2 %)	43	No growth	-

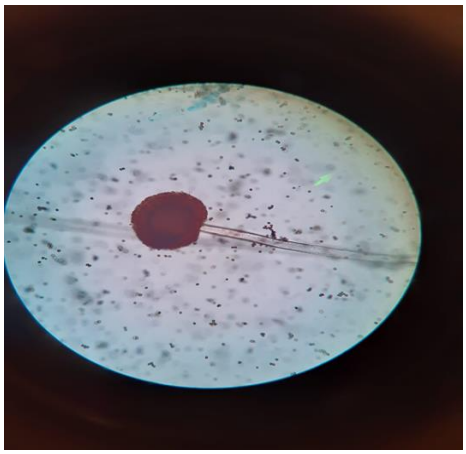
After disinfection process with 70% alcohol based wet wipes, the overall growth was determined as 21% (n:50) and the overall bacterial isolates counting reduced to 201 cfu/ml. There was no growth detected in 183 (79%) of the mobile phones. The prevalence of microbial contamination of mobile phones were reduced significantly (80%) by using disinfection process. Most of the isolated pathogens were gram-positive bacteria (n: 42, 18%) and 16% were fungal pathogens. Among gram positive bacteria, CoNS (n:37, 74%) and *Micrococcus spp*. (5, 10%) were the most isolated microorganisms. The Fungal result show the *Aspergillus niger* (*n:* 6, 75%), and *Microsporum audouinii* (*n:* 2, 25%). The microbial contamination of mobile phones was reduced by 42% and 100% in the cases of molds and gram-negative bacteria respectively. Total number of bacterial and fungal isolates on mobile phones before and after disinfection process and the percentage of reduction contamination is given in Table 3.5.

Table 3.5. Total number of bacterial and fungal isolates on mobile phones before and after disinfection process and percentage of reduction contamination.

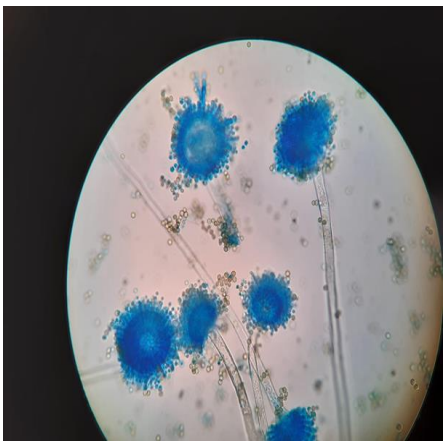
Organisms	**Before disinfection**		**After is infection**		
	Plate n(%)	**Count of bacteria (cfu/ml)**	**Plate n(%)**	**Count of bacteria (cfu/ml)**	**Reduction of contamination**
Gram positive bacteria	181 (78%)	120910	42 (18%)	170	77%
CoNS	174 (96%)	116418	37 (74%)	153	
Micrococcus spp.	7 (4 %)	4492	5 (10%)	17	
Fungus (mold)	53 (28%)	-	8 (16%)	-	42%
Aspergillus niger	32 (60%)	-	6 (75%)	-	
Aspergillus flavus	3 (5%)	-	-	-	
Trichosporon asahii	2 (4%)	-	-	-	
Penicillium spp.	2 (4%)	-	-	-	
Microsporum audouinii	13 (25%)	-	2 (25%)	-	
Alternarias spp.	1 (2%)	-	-	-	
Gram negative bacteria	17(9%)	43	-	-	100%
Pantoea spp.	9 (53%)	-	-	-	
Pseudomonas aeroginosa	3 (18%)	-	-	-	
Aeromonas salmonicida	2 (11%)	-	-	-	
Acinetobacter baumannii	1 (6%)	-	-	-	
Aeromonas spp.	1 (6%)	-	-	-	
Pseudomonas stutrezi	1 (6%)		-	-	
TOTAL	189	120,953	50	170	80%

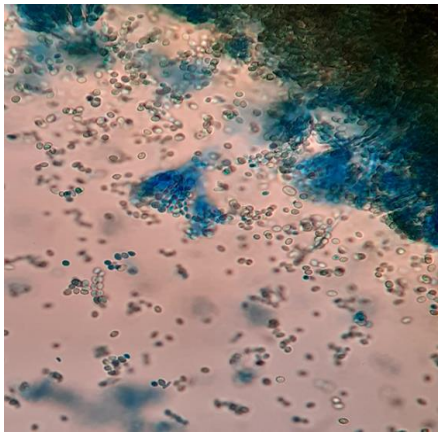
Abbreviations: CoNS**:** coagulase negative staphylococci; cfu/ml: colony forming unit/milliliter

(a)



(b)





(c)

Figure 3.5: Microscopic examination of mold colonies by using lactophenol cotton blue stain. (a, b) *Aspergillus spp.* (c) *Penicillium spp.*

3.3. Antibiogram patterns for isolated bacteria

The antibiotic susceptibility patterns were performed for *Pseudomonas stutrezi* (*P. stutrezi*), *Aeromonas spp.*, *Acinetobacter baummanni* (*A. baummanni*). The antibiotic patterns for gram-negative bacteria including *A. baumanni*, *Pseudomonas* spp. consisted of; ctx, cip, dap, fos, fus, gen, lvx, lzd, nit, tc, tgc, sxt, vanc; amk, cip, cst, gen, imp, lvx, mem, net, tgc, tob, sxt; amk, azt, cpe, caz, cip, cst, gen, imp, lvx, mem, net, pip, tzp, tob. The antibiotic susceptibility patterns showed

that all bacteria were susceptible to all antibiotics. The antibiotic susceptibility pattern for gram negative bacteria is given in Table 3.6.

Table 3.6. Antibiotic susceptibility testing of gram-negative bacteria

Type of Bacteria	***Antibiotic testing***	
	Sensitive	**Resistant**
Gram-negative bacteria		
Pantoja spp.	Sensitive	Sensitive
Pseudomonas spp.	Sensitive	Sensitive
Aeromonas salmonicida	Sensitive	Sensitive
Pseudmonas stutrezi	Sensitive	Sensitive
Aeromonas spp.	Sensitive	Sensitive
Acinetobacter spp.	Sensitive	Sensitive

The total number of growth of bacteria in samples taken from before and after disinfection was 81% (n:189) and 21% (n:50) respectively. There was a statistically significant difference between the number of the bacteria observed before and after disinfection (P = 0.000) (Table 3.7).

Table 3.7. Statistical variance of the bacterial count in samples taken before and after disinfection

	No. plate	**%**	**Mean ± Std. Deviation**	**P. Value**
Before Disinfection	189	81	0,80 ± 0.399	0.000
After Disinfection	50	21	0.27 ± 0.447	

SECTION FOUR: DISCUSSION

Nowadays, the one of the most important things in life used by human and it is connecting between persons are the system of telephone announcement, and in Europe it was proven in 1982. Moreover, the mobile knowledge in 20 century formulates to be greater than before the rapidity of infrastructures, the mobile phones take also turn out to be one of the best and vital fittings in human communal lifetime.

The mobile phones also provide rapid effective announcement and interaction with health care establishment, manufacture health worker carriage additional effective (Soto, R. G., et L, 2006). According to Ramesh experimental study, mobile phones provide better and more successful communication between health staff workers and visitors of the patients (Ramesh, J., et al, 2008). In recent years, contamination of mobile phones with bacterial and other microbes has been essential toward the field of disease infection controller. In hospitals, clinics households, mobile phones may production transmission of serious type of pathogenic organisms (Jayalakshmi, J., et al, 2008).

The idea which founded toward the estimation of authority's mobile phones are extra pretentious contamination when comparing with laboratories and soles of shoes (Brady, R. R., et al, 2009; Brady, R. R., et al, 2009). The mobile phones are rarely disinfected and they are often used or touched by health care professionals during examination of patients without disinfecting their mobile phones and washing their hands. This may lead to carry potential pathogenic microorganisms. This may also lead the spread of infectious diseases among patients (Jayalakshmi, J., et al, 2008). Approximately there are 2 million people infected each year and 90,000 deaths associated with nosocomial infections. The hand hygiene of health care workers plays a major and significant role in spread of variety of microorganisms (Mohammadi-Sichani, M., & Karbasizadeh, V., 2011; Burke, J. P., 2003). Jeske and his friends

(Jeske, H. C., et al, 2007) mentioned that the isolated microorganisms from hands of healthcare staffs which were very similar to microorganisms isolated from mobile phones. Brady mentioned that isolated organisms from mobile phones were similar to that of microorganisms found in anterior nasal area (Brady, R. R., et al, 2009).

In this study, 466 samples were collected before and after disinfection of mobile phones and 81% of mobile phones were found to be contaminated by microorganisms. The isolation of bacterial and fungal agents from mobile phones similar to other study conducted by Bures S. et al, confirmed that mobile phones can act as vector for microorganisms (Bures S, et al, 2000). There are many studies conducted and they found different microbial contamination with mobile phones for example; there was a study which conducted in hospital of Queen Elizabeth in India and it was shown that more than 40% of mobile phones used by medical students and the staff were contaminated by microorganisms (Ramesh J, et al., 2008). In a study conducted in New York and Israel, Ulger (Ulger F, et al, 2009) reported that 94.5% of 200 health care workers' mobile phones were contaminated with various microorganisms, including nosocomial pathogens.

The present study agrees with their findings and the mobile phones remained contaminated by means of different types of bacteria and fungi. Moreover, the daily handling and contacting to many daily objects may lead to several contaminations of different types of bacteria and fungi to other commonly used surfaces and objects. Out of 466 samples collected before and after disinfection, the rate of the bacterial contamination before disinfection was higher than the rate of bacterial contamination after disinfection process which showed that disinfection of mobile phones decreases the number of bacteria on the surfaces of the mobile phones. The polymicrobial growth was observed in many cultures before disinfection therefore, different procedures were applied to identify different types of bacteria and fungi. After these steps, we found that the number of gram-positive bacteria was determined in 181 cultures and the number of colony count was 116418 CFU/ml before disinfection.

This growth dropped to 27 cultures with the colony count (153 CFU/ml) after disinfection of the mobile phones. The gram-negative growth was determined only in before disinfection in 17 cultures with the colony number (43 CFU/ml). In 53 cultures and 8 cultures, fungal growth was observed before and after disinfection respectively. We also assessed 7 cultures as *Micrococcus spp.* in samples taken from before disinfection. The colony number was counted to be 4492 CFU/ml). In addition, 5 cultures in samples taken after disinfection with 17 CFU/ml colony counting was determined, as a comparing to a study conducted by Fard et al. (Fard, R. H., et al, 2018).

The study also showed that there were many types of pathogenic bacteria in the surfaces of mobile phones of dental students. Coagulase negative Staphylococcus (CNS) was the most predominant bacteria isolated on mobile phones in this study. Similarly, Karabay et al. had the similar results (Karabay O, et al., 2007), it has been seen that the CNS have the maximum representative come across bacteria which is estimated. The outcome of this microorganism was similar in another study conducted by Brady et al. (Brady R, et al, 2006), the mixture of constant handling mobile and warmness made by the phones are major upbringing the microorganisms that are normally found in our human skin.

In our study, the overall prevalence of bacterial contamination amongst the mobile phones was 81 %. Only 189 mobile phones showed contamination with multiple bacterial species while the majority of growth were related to gram positive bacteria are *Staphylococcus sp.* There are also the different types of bacteria related to gram-negative bacteria including *Acinetobacter spp., Pseudomonas spp., Aeromonas app., Aeromo spp., Pantoea spp.*, Additionally, *Micrococcus spp.* were detected in some cultures before disinfection. According to the antibiotic susceptibility performed to gram negative bacteria, all bacteria were sensitive against all antibiotics tested with VITEK 2 otomatic identification system and Kirby-Bauer disk diffusion method. In a similar study, many types of microorganisms were isolated including *Escherichia coli*

(E.coli), P. aeruginosa, K. pneumoniae, S. aureus, and E. faecalis. These types of bacteria are characterized by nosocomial type of infections (Brady R, et al, 2006) that can be transferred with improper hand hygiene during casual activities.

The present findings imply that the mobile phones may serve as vector of transmission of diseases such as pneumonia and abscesses. In our study, we found that all bacteria were sensitive to all antibiotics tested. This result is similar to (Akinyemi KO, et al, 2007) study in side of antibiotic susceptibility and in this study mentioned that there is a big risk to get infection from person to person with mobile phones that may carry many pathogenic microbial agents during sharing their mobile phones. Antibiotic susceptible test results show that high rate of the (75%) samples were susceptible to various antibiotics such as fluoroquinolone and ceftriaxone.

On the ther hand, out of 466 samples cultured from mobiles, the fungal growth was observed in 53 plates after performing stain with Lactophenol Cotton Blue (LPCB). The majority of mobile phones were contaminated with *Aspergillus niger, Aspergillus flavus, Trichosporon asahii, Penicillium spp., Microspore audouinii, Alternaria spp.* Some other studies showed that different type of fungi such as *Candida spp., Aspergillus spp., Mucor spp., Trichophyton spp., Aspergillus spp*., and yeasts can also be transmitted via mobile phones.

Today, mobile phones are considered as an important tool for both professional and social lives of users. However, in environments where hospitals, conference rooms, business centers, toilets, and others are likely to have a high percentage of bacteria, restrictions on the use of mobile phones are difficult and therefore not a practical solution. Mobile phone users are hence advised to use antibacterial wipes for disinfection of their mobile phones. In addition, strict adherence to mobile phone users to infection control and measures such as hand washing and good hygienic practice is advocated to prevent phones from being a transmission factor of both bacterial diseases, both hospitals, clinics and community.

SECTION FIVE: CONCLUSION AND RECOMMENDATION

5.1. Conclusion

There was a high contamination rate of mobile phones of dental students with many pathogens which of most of them may be resistant to antibiotics. This shows that mobile phones which are frequently used by both households and healthcare workers, can play an effective role in in the transmission of hospital acquired infections, and they may cause spread of nosocomial infections. The study confirms that the mobile phones host different types of microorganism due to the wider use of the touch screen. However, the prevalence of microbial contamination of mobile phones were reduced significantly (80%) by using disinfectant. For this reason, care is required to prevent contamination of the pathogenic microorganism. Therefore, continuous disinfection of mobile phones with proper disinfectants (70% alcohol based) and hand hygiene with proper hand washing should be used as means of limiting some possible of disease spread. The study also showed the efficiency of disinfection. However, the high rate of general microbial contamination and the lack of consciousness of the population about disinfection procedures emphasize the necessity of educations on universal disinfection protocols and maintaining hand hygiene practices.

5.2. Recommendation

This study recommended to:

1. Emphasis should be given on strict guidelines regarding mobile phone use and disinfection in population care settings.
2. Hand washing should be practiced both for healthcare professionals and households.
3. We recommend to disinfect mobile phones and non-living surface

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APPENDIX

Appendix A

SURVEY FORM

The questions were prepared for a research which was carried out in the Department of Medical Microbiology and Clinical Microbiology, Faculty of Medicine, Near East University. The aim of this study is to detect bacterial contamination in the hands of population and the mobile phones they use. This scientific research has no administrative or political aspect.

We thank you in advance for your valuable help and contributions with the answers to your questions.

Sincerely,

Professor Dr. Prof. Tamer Sanlidag Assist. Prof. Dr. Ayse Sarioglu Tara Sediq

QUESTIONS

l. Age & Nationality? () 18-20 years of age () 21-25 years of age () 26-30 years of age ……

2.How many people do you live in? .....

3. Do you use a mobile phone? ( ) Yes No

4. How often do you use your mobile phone during the day? () Less than 1 hour () 1-2 hours () 3-4 hours () 5-6 hours () 7-8 hours () 9-10 hours () 11 hours and up

5. Do you clean your mobile phone? ( ) Yes No

6. If you are cleaning your mobile phone, how often do you clean it? () Less than 1 hour () 1-2 hours () 3-4 hours () 5-6 hours () 7-8 hours () 9-10 hours () 11 hours and up

7. How do you clean your mobile phone? () Pure water () Wet wipes () Surface disinfectant () Other (specify ……)

8. Who else in your family uses your mobile phone? () No other uses () My father () My mother () My brother () My wife () My child () Other (please specify ....)

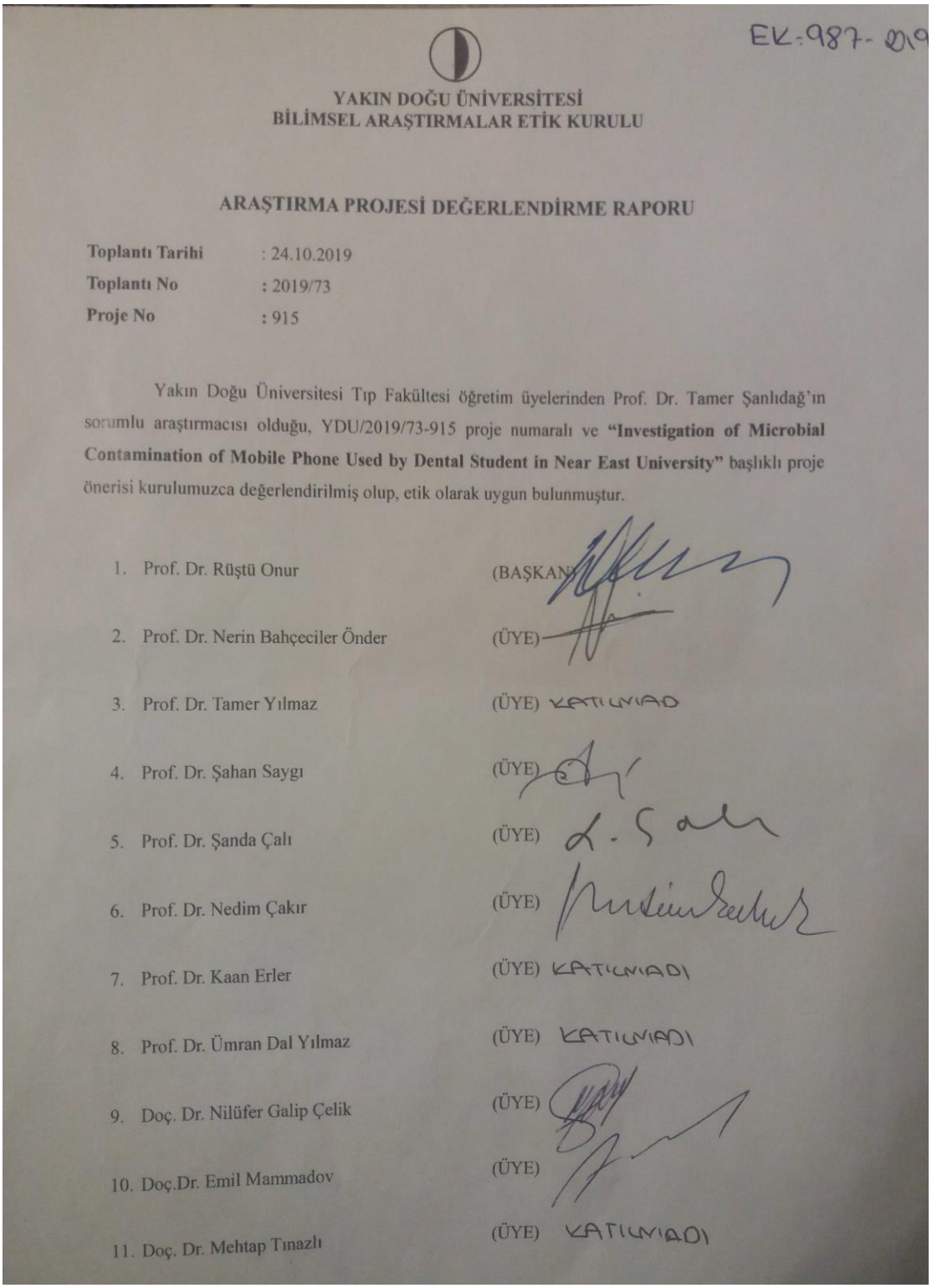
9. Do you think your mobile phone can carry microorganisms? ( ) Yes No

10. Do you care about your hand hygiene? ( ) Yes No

11. How often do you wash your hands? () Less than 1 hour () 1-2 hours () 3-4 hours () 5-6 hours () 7-8 hours () 9-10 hours () 11 hours and up

12. How do you wash your hands? () Social hand washing () Hygienic hand washing () Other (Specify …….

Appendix B



EK-987-019

YAKIN DOĞU ÜNİVERSİTESİ
BİLİMSEL ARAŞTIRMALAR ETİK KURULU

ARAŞTIRMA PROJESİ DEĞERLENDİRME RAPORU

Toplantı Tarihi : 24.10.2019
Toplantı No : 2019/73
Proje No : 915

Yakın Doğu Üniversitesi Tıp Fakültesi öğretim üyelerinden Prof. Dr. Tamer Şanlıdağ'ın sorumlu araştırmacısı olduğu, YDU/2019/73-915 proje numaralı ve **"Investigation of Microbial Contamination of Mobile Phone Used by Dental Student in Near East University"** başlıklı proje önerisi kurulumuzca değerlendirilmiş olup, etik olarak uygun bulunmuştur.

1. Prof. Dr. Rüştü Onur (BAŞKAN)
2. Prof. Dr. Nerin Bahçeciler Önder (ÜYE)
3. Prof. Dr. Tamer Yılmaz (ÜYE) KATILMAD
4. Prof. Dr. Şahan Saygı (ÜYE)
5. Prof. Dr. Şanda Çalı (ÜYE)
6. Prof. Dr. Nedim Çakır (ÜYE)
7. Prof. Dr. Kaan Erler (ÜYE) KATILMADI
8. Prof. Dr. Ümran Dal Yılmaz (ÜYE) KATILMADI
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10. Doç.Dr. Emil Mammadov (ÜYE)
11. Doç. Dr. Mehtap Tınazlı (ÜYE) KATILMADI

CURRICULUM VITAE

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Objective

To enhance my knowledge and capabilities by working in a dynamic organization that prides itself in giving substantial responsibility to new talent.

QUALIFICATION

I have been Graduated from university of Salahadin_College of Scince_Biology Department_Iraq_Erbil from 2008_2009

Experience

- I have ten (10) years experience in my country and I have been worked at many hospitals in Erbil like (Rizgary Teachnic_ West emergincy hospital and Consultant center of the lungs and respiratory in Erbil)

- I have labrotery licence from 2016 for opening my privait lab aslo I awarded this from Kurdistan Ministry of Health_General Directorate of Health.

- I recived appreciation letter from Kurdistan Ministry of Health_General Directorate of Health,Due to excelent work at microbilogy lab.

- I have worked for two years at virlogy lab in the Rizgary hospital_Erbil.

- I have six years experienace at microbilogical lab (Bactriology and parasitology) in the Rizgry Teachnic hospital_Erbil.

Relevant Training Course work

- I have participated in a trainig cousre for Consultant center of the lungs and respiratory in Erbil and completed sucsessfully in Erbil and aslo I recivid the certificate of acceptance from 2014.

- I have participted in MasterStudent Microbilogy Labrotery Practical Course and completed succsessfully also I recived the certificate of acceptance from Near East University Hospital from 2019.