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Faculty of science

***Bacterial Contamination of Health care worker's
Mobile Phones in Aljalaa Hospital***

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Contents

Dedication	II
Acknowledgment	III
List of contents	IV
List of tables	VIII
List of figures	X
Abstract	XIII
List of abbreviations	XV

Dedication

To my great mother

*To my dear husband who supported me true
my life*

To my sister and brothers

To my daughters

Acknowledgement

First of all, I give my thanks to my Allah, to help me through my life and to complete this research. I would like to thank my supervisor prof. Salha F. Ben-Gweirif, a professor of bacteriology, for her great support before and during my research and it was a great pleasure for me. I am also grateful to my faculty of science especially department of botany and microbiology stuff in Aljalaa analysis laboratory, Benghazi and a great thanks to my family who helped me a lot through my study, Finally I am gratefully for very one who gave my advice and information to complete this research.

CHAPTER ONE

1. introduction.....	19
1.1 Aim of the study	24

CHAPTER TWO

Review of literature

2.Review of literature	26
2.1 Bacteria found on the mobile phone.....	36
2.1.1 Staphylococcus spp	36
2.1.2 Streptococcus spp	37
2.1.3 Bacillus spp	38
2.1.4 Pseudomonas spp	38
2.1.5 Acinetobacter spp	39
2.1.6 Escherichia coli	40
2.1.7 Klebsiella spp	40
2.1.8 Proteus spp	41
2.1.9 Enterobacter spp	41

CHAPTER THREE

MATERIAL AND METHODS

3. Material and methods	43
3.1. Collection of samples	43
3.2. Transportation & Inoculation of the sample.....	43
3.4 Sub –culture.....	45
3.5 Gram stain technique and microscopic examination	47
3.6 Biochemical test	48
3.6.1 Deoxyribonuclaease (DNase) test	48
3.6.2 Oxidase test.....	50
3.6.3 Catalase test.....	52
3.7 BD Phoenix system.....	54
3.8 Antibiotic sensitivity test.....	55

CHAPTER FOUR

RESULTS

4.1 Identification of bacterial isolates.....	57
4.1.1 Staphylococcus spp.....	57
4.1.2 Streptococcus spp.....	62
4.1.3 Bacillus spp.....	64
4.1.4 Klebsiella spp	64
4.1.5 Pseudomonas spp.....	66
4.1.6 Proteus spp.....	67
4.1.7 Acinetobacter paumannii	70
4.1.8 Escherichia coli	71
4.1.9 Enterobacter spp	72
4.1.10 Micrococcus spp	74
4.2 Distribution of Results of culture from mobile phones and sex of (HCWs) :	75
4.3 Distribution of multiple organisms on mobile phone of HCWs...75	
4.4 Distribution of types of microorganisms isolated from mobile phones of healthcare workers in hospital.....	78

4.5 Distribution of <i>S.aureus</i> that were found on mobile phones of female and male in all department.....	83
4.6 Distribution of <i>MRSA</i> that were found on mobile phones of female and male in all department.....	84
4.7 Distribution of <i>S.capitis</i> that were found on mobile phones of female and male in all department.....	89
4.8 Distribution of <i>S.heamolyticus</i> that were found on mobile phones of female and male in all department.....	90
4.9 Distribution of <i>Streptococcus spp</i> that were found on mobile phones of female and male in all department.....	95
4.10 Distribution of <i>Bacillus spp</i> that were found on mobile phones of female and male in all department.....	95
4.11 Distribution of <i>Escherichia coli</i> that were found on mobile phones of female and male in all department.....	101
4.12 Distribution of <i>Enterobacter spp</i> that were found on mobile phones of female and male in all department.....	101
4.13 Distribution of <i>Klebsiella pneumonia</i> that were found on mobile phones of female and male in all department.....	106
4.14 Distribution of <i>Acinetobacter paumannii</i> that were found on mobile phones of female and male in all department.....	106

4.15 Distribution of <i>Proteus mirsibilis</i> that were found on mobile phones of female and male in all department.....	112
4.16 Distribution of <i>Pseudomonas spp</i> that were found on mobile phones of female and male in all department.....	112
4.17 Distribution of types of microorganisms isolated from mobile phones of HCWs in all department in hospital.....	117
4.18 Distribution of high level bacterial contamination from mobile phones between different departments in hospital.....	120
4.19 Distribution of Bacterial Growth from mobile phones of different health care workers	124
4.20 Distribution of sensitivity antibiotic of Gram positive organisms.....	128
4.21 Distribution of sensitivity antibiotic of gram negative organisms.....	131

CHAPTER FIVE

5. Discussion.....	135
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LIST OF TABLES

Table (1): Distribution of Results of culture from mobile phones and sex of (HCWs)	76
Table (2): Distribution of multiple organisms on mobile phone of HCWs.....	77
Table (3): Distribution of types of microorganisms isolated from mobile phones of healthcare workers in hospital	80
Table (4): Distribution of <i>S.aureus</i> that were found on mobile phones of female and male in all departments	85
Table (5): Distribution of MRSA that were found on mobile phones of female and male in all department	87
Table (6):Distribution of <i>S.capitis</i> that were found on mobile phones of female and male in all department.....	91
Table (7):Distribution of <i>S.heamolyticus</i> that were found on mobile phones of female and male in all department.....	93
Table (8) :Distribution of <i>Streptococcus spp</i> that were found on mobile phones of female and male in all department.....	97
Table (9) :Distribution of <i>Bacillus spp</i> that were found on mobile phones of female and male in all department.....	99
Table (10) : Distribution of <i>Escherichia coli</i> that were found on mobile phones of female and male in all department.....	102

Table (11) :Distribution of *Enterobacter spp* that were found on mobile phones of female and male in all department.....104

Table (12) :Distribution of *Klebsiella pneumonia* that were found on mobile phones of female and male in all department..... 107

Table (13) :Distribution of *Acinetobacter paumannii* that were found on mobile phones of female and male in all department..... 109

Table (14) :Distribution of *Proteus mirsbilis* that were found on mobile phones of female and male in all department.....113

Table (15) :Distribution of *Pseudomonas spp* that were found on mobile phones of female and male in all department.....115

Table (16): Distribution of types of microorganisms isolated from mobile phones of HCWs in all department in hospital119

Table(17): Distribution of high level bacterial contamination from mobile phones between different departments in hospital.....123

Table (18) :Distribution of Bacterial Growth from mobile phones of different health care workers126

Table (19) : Sensitivity antibiotic of Gram positive organisms129

Table (20): Sensitivity antibiotic of Gram negative organisms.....132

LIST OF FIGURES

Figure(1): Thioglycollate transport media before incubation	44
Figure (2):Thioglycollate transport media after incubation	46
Figure (3) : DNase test.....	49
Figure (4): Oxidase positive test.....	51
Figure (5) : catalase positive test.....	52
Figure (6) : BD Phoenix system.....	54
Figure (7) : <i>S.aureus</i> on blood agar.....	58
Figure (8): <i>Methicillin resistant Staphylococcus aureus</i> (MRSA).....	59
Figure (9) : <i>S.heamoliticus</i> on blood agar.....	59
Figure (10): <i>S.ebidermidis</i> on blood agar	60
Figure (11): <i>S.capitis</i> on blood agar	60
Figure (12) : <i>S.saprophyticus</i> on blood agar	61
Figure (13) : <i>S.oralis</i> on TSA.....	62
Figure (14) : <i>S.oralis</i> on blood agar	63
Figure (15): <i>S.viridians</i> on blood agar.....	63
Figure (16): <i>B. subtilis</i> on blood agar and on macConkey agar	65
Figure (17) : <i>B.cereus</i> on blood agar.....	65

Figure (18): <i>klebsiellapneumonia</i> on MacConkey agar.....	66
Figure (19) : <i>Pseudomonas aeruginosa</i> on MacConkey agar.....	67
Figure (20) : <i>Proteus mirabilis</i> on blood	68
Figure (21): <i>P.mirabilis</i> on blood and macConkey agar	69
Figure (22) : <i>Acinetobacter paumannii</i> on MacConkey agar.....	70
Figure (23): <i>Escherichia coli</i> on MacConkey agar.....	71
Figure(24) : <i>E. agglomerans</i> on blood agar.....	72
Figure (25): <i>Pantoea agglomerans</i> on MacConky agar.....	73
Figure (26) : <i>Micrococcus lylae</i> on blood agar.....	74
Figure (27): Results of culture from mobile phones and sex.....	76
Figure (28): Distribution of sample according to number of organism isolated and sex.....	77
Figure (29)- A: Types of microorganisms isolated from mobile phones of healthcare workers in hospital (gram positive).....	81
Figure (29)-B: Types of microorganisms isolated from mobile phones of healthcare workers in hospital (gram negative).....	82

Figure (30) : Distribution of *S.aureus* that were found on mobile phones of female and male in all departments

.....86
Figure (31) : Distribution of MRSA that were found on mobile phones of female and male in all department.....88

Figure (32) :Distribution of *S.capitis* that were found on mobile phones of female and male in all department92
Figure (33):Distribution of

S.heamolyticus that were found on mobile phones of female and male in all department94
Figure(34) :Distribution of

Streptococcus Sp, that were found on mobile phones of female and male in all department98
Figure (35) :Distribution of

Bacillus Sp, that were found on mobile phones of female and male in all department 100
Figure (36) : Distribution of

Escherichia coli that were found on mobile phones of female and male in all department103
Figure (37) :Distribution of

Enterobacter Spp. that were found on mobile phones of female and male in all department105
Figure (38) :Distribution of

Klebsiella pneumonia that were found on mobile phones of female and

male in all department.....	109
Figure (39) :Distribution of <i>Acinetobacter paumannii</i> that were found on mobile phones of female and male in all department.....	111
Figure (40) :Distribution of <i>Proteus mirbilis</i> that were found on mobile phones of female and male in all department	114
Figure (41):Distribution of <i>Pseudomonas spp</i> that were found on mobile phones of female and male in all department	116
Figure (42):Distribution of Bacterial Growth from mobile phones of different health care workers.....	127
Figure(43): Distribution of sample according to sensitivity of gram positive organisms for antibiotic	130
Figure (44) : Distribution of sample according to sensitivity of gram negative organisms for antibiotic	133

Abstract

Mobile phones may transmit more than just information in today's busy hospitals. They may also be involved in the transmission of infections in the healthcare systems. This study reveals that mobile phones are commonly used by Health Care Workers, even during patient contact and may serve as a potential vehicle for the spread of nosocomial pathogens. A total 155 sample of this study, 150 of isolates appeared to show bacterial growth, the isolated bacteria *S. epidermidis* (21.7%), followed by *Bacillus spp* (10.3%), *S. aureus* (8.2%), *S. haemolyticus* (6.9%), *Methicillin resistant Staphylococcus aureus (MRSA)* (6.5%), *S. capitis* (6.2%), *Staphylococcus spp* (3.8%), *Streptococcus spp* (2.8%), *Bacillus subtilis* (2.4%). Low frequency was among observed *S. hominis*, *S. saprophyticus* (2.1%), followed by *Micrococcus spp* and *Micrococcus caseolyticus* (1%). However the lowest frequency among *Enterococcus casseliflavus*, *Dermacoccus nishinomiyaensis* and *Leuconostoc mesentero* (0.3%). High percentage of Gram negative bacteria was *Pseudomonas spp* (5.5%), *Escherichia coli* (4.8%), *Acinetobacter*

paumannii (4.5%) ,*Klebsiella pneumonia* (3.8%) *Proteus mirabilis*,*Enterobacter spp*(2.1%) and *Pantoea agglomerans* (1%) .However *Alealigenes faecalis*exhibit the lowest frequency reach to (0.3%) . The sensitivity patterns of bacteria isolated from mobile , the bacteria were sensitive to Gentamicin, Amoxicillin-Clavulanate , Tetracycline, Cefoxitin and Augmentin showing the highest percentage while the lowest percentage was ciprofloxacin , Vancomycin, penicillin , Ampicillin .

List of abbreviations

HCWs	Health Care Workers
OT	Operation theatres
ICU	Intensive care units
HP	Healthcare personnel
MCDs	Mobile communication devices
MDR	Multidrug resistant
MPs	Mobile phones
PVs	Patients visitors
USA	United States American
CONS	Coagulase-negative Staphylococci

CHAPTER ONE

1- Introduction

Cell phones are increasingly becoming important of communication means in communities , Being conveniently small in size, these days, mobile phones utilization has increased in healthcare system and its acceptance by healthcare personnel , they are used by doctors and other Health Care Workers (HCWs) in a hospital for immediate communication during emergencies, in rounds, and even in operation theatres (OT) and intensive care units (ICU) Bardy *et al.*,(2006)- Rafferty and Pancoast.,(1984) . They may serve as mobile reservoirs of infection allowing the transportation of the contaminating bacteria to many different clinical environments,also sharing of cell phones between(HCWs) and (non HCWs) may directly facilitate the spread of potentially pathogenic bacteria to the community Bardy *et al.*,(2007) .

Cellphones which are seldom cleaned and often touched during or afterthe examination of patients without hand washing , can harbor various potential pathogens and become an exogenous source of nosocomial infections among hospitalized patients Many epidemiological cell phone studies have confirmed that many

contaminated surfaces played a major role in the spread of infectious diseases Jayalakshmi *et al.*, (2008) .

Mobile phones are used in close contact with the body and as for most non-medical electronic equipment, there are no cleaning guidelines available that meet hospital standards, the hygiene risk involved in using mobile phones in the operation room (OR) has not yet been determined Jeske *et al.* ,(2007).

Mobile phones are the much preferred and most used routes of communication. However one aspect that has not been covered is the bacterial contamination of mobile phones. They are particularly susceptible to this as they are in close contact with mouth, nose, ears, hand and various clinical environments. Further keeping the mobile phones in pockets, handbags and snug pouches increases the possibility of bacterial proliferation due to warmth and ideal temperature conditions. Mobile phones are continuously used all day long but never cleaned. Further there are no guidelines for proper disinfection and decontamination of mobile phones thus mobile phones act as reservoirs of

infection which may proliferate from patient to patient in a hospital setting Goeland Goel,(2009).

Nosocomial infections increase day by day and such infections cause a significant rate of mortality and morbidity. The a etiological agents of hospital healthcare personnel (HP) thermometers , infections may spread through the hands of in stethoscopes, and even toys the pediatric intensive care units of hospitals Fleming and Randle , (2006).Today, mobile phones have become one of the indispensable accessories of professional and social life. The use of cell phones often occurs in hospital halls, laboratories, and/or intensive care units when dealing with severe illnesses .Bardy *et al.*,(2006) .

Because of the achievements and benefits of the mobile phone, it is easy to overlook its hazard to health; this is against the background that many users may have no regard for personal hygiene, and the number of people who may use the same phone. This constant handling of the phone by different users exposes it to an array of microorganisms and makes it a good carrier for microbes, especially those associated with the skin resulting in the spread of different microorganisms from user to user.

The environment being the source of nosocomial agents occasionally, Inanimate objects in the hospital environment are known to be contaminated with microorganisms . Mobile phones have become an extension of office practice for physicians, may serve as perfect substrate for microorganisms, especially in high temperature and humid conditions. Extensive use of mobile phones by(HCWs) acts as a vehicle for transmission of nosocomial agents . Schulster and Chinn, (2009)The wide spread use of mobile phones among medical personnel in hospitals is a matter of controversy. The question of concern is how to use the mobile phone sensibly, getting their benefits and minimizing their risks. In an emergency, surgeons , if mobile phones are used carelessly in surgical words or ICU, they may act as a source of infection to patients while handling them, such as during dressing of surgical wounds Tambekar *et al.*,(2008). Besides there are no guidelines for disinfection of mobile phones that meet hospital standards. Moreover, the mobile phones are used routinely all day long and the same phones are used both inside and outside the hospital playing a possible role in spreading infections to the outside community Karabay *et al.*, (2007) .

Mobile phones may serve as vehicles of transmission of diseases such as diarrhea, pneumonia, boils, and abscesses Soto *et al.*, (2006) . Telephone operators were asked to monitor time elapsed as they attempted to contact medical staff by various methods. Of 266 medical staff and students at the time of the study, almost all (98%) used mobile phones: 67% used their mobile phones for hospital-related matters; 47% reported using their phone while attending patients. Only 3% reported washing their hands after use and 53% reported never cleaning their phone. Mobile phones were cultured for micro-organisms; 45% were culture-positive and 15% grew Gram-negative pathogens. The survey of staff working in close proximity to sensitive equipment revealed only one report of minor interference with life-saving equipment. Telephone operators were able to contact medical staff within 2 min most easily by mobile phone. Mobile phones were used widely by staff and were considered by most participants as a more efficient means of communication. However, microbial contamination is a risk associated with the infrequent cleaning of phones. Hospitals should develop policies to address the hygiene of mobile phones Ramesh *et al.*, (2008)..

1.2 Aim of the study

- 1.To Isolation and Identification of bacteria from mobile phones .
- 2.To study the sensitivity tests of isolated bacteria to antibiotic .

CHAPTER TWO

2. Review of Literature

The global system for mobile telecommunication was established in 1982 in Europe and quickly spread all around world. Mobile phones have become one of the most essential accessories in our social and professional life. Mobile phones increase the speed of communication and contact within healthcare institutions, making healthcare delivery more efficient Ramesh *et al.*, (2008); Soto *et al.*, (2006) .

Rafferty and Pancoast ,(1984) In a previous investigation, found a 7% rate of bacterial contamination with potentially pathogenic bacteria contaminatal telephones, intercoms and dictaphones used in patient care areas .Butz *et al.*, (1993) reported that pathogens passed from contaminated hand and skin of the users to another user, through that there is exchange of flora between the users. Cell phone of doctors and other health care workers carry nosocomial pathogens which cause every form of skin infections to meningitides . O'Hara *et al.*, (2000) showed that *Proteus mirabilis* is one of the most common Gram-negative pathogens encountered in clinical specimens. It can cause a variety of community or hospital-acquired infections, including those of the urinary tract, respiratory tract, wounds and burns, bacteremia , neonatalMeningoencephalitis, empyema and osteomyelitis. Hendley *et al.*,

(1997) reported that pathogens live and or multiply in the reservoir on which their survival depends, pathogens live on fomites. Many epidemiological studies have confirmed that many contaminated surfaces played a major role in the spread of infectious diseases . Rusin *et al.*, (2002) had documented both Gram-positive and Gram-negative bacteria in the hand-to-mouth transfer during casual activities. Mobile phones may serve as vehicles of transmission of diseases such as diarrhoea, pneumonia, boils, and abscesses .

Also presence of *pseudomonas aeruginosa* has been reported in the United States by the Centre for Disease Control and Prevention to be the most isolated nosocomial pathogen accounting for 10.1% of all hospital-acquired infections, and has been implicated in gastrointestinal infection, primarily in immunocompromised individuals (Todar , 2004). Borer *et al* ., (2005) showed that *Acinetobacter* spp., with a potential for drug resistance were isolated from 7 (4.8%) cell phones of 3 clinicians and microbiologists, they found that 30% of nosocomial infection in the ICU, are associated with *Acinetobacter* spp ., Similar study at the Soroka university medical centre, identified multidrug resistant *Acinetobacter*

baumannii in cellphones of the health care workers and patients admitted to the ICU .

Brady *et al.*, (2006)had shown that the combination of constant handling and heat generated by the phones creates a prime breeding ground for microorganisms that are normally found in our skin. This may be because these types of bacteria increase in optimum temperature and phones are perfect for breeding these germs as they are kept warm and easy to handle in pockets, handbags and brief-cases .Khivsara *et al.*, (2006)reported that potential of mobile phones of healthcare workers to serve as a reservoir of bacteria known to cause nosocomial infection .Goldblatt *et al.*, (2007) reported that colonization of potentially pathogenic organisms on various objects, such as stethoscopes, bronchoscopes, pagers, ballpoint pens, patient hospital charts, computer keyboards and mobile phones has been reported as a potential vehicle for transmission of nosocomial pathogens from HCWs .

Karabay *et al.*, (2007)reported that mobile phones of HCWs provide a reservoir of potentially pathogenic bacteria within healthcare environment.Jeske *et al.*, (2007)investigated that mobile or fixed phones by anesthetists working in the OR not only demonstrated a high

contamination rate with non-human pathogen bacteria but also caused a 10% rate of contamination with human pathogen bacteria.

Ramesh *et al.*, (2008)found in Queen Elizabeth Hospital in Barbados, West Indies, more than 40 % of mobile phones of 266 medical staff and students were positive with pathogenic bacteria . Famurewa and David (2009) found that *S. aureus* was recovered in all the cell phone sampled while *Proteus vulgaris* showed the least consistency .Commercial phones had the largest variety of bacteria. This may be as a result of multiple usage and long time of exposure to the environment, the surface of the patients' phones carries more pathogenic bacteria than the ear piece. Nurses' phones carry the least array of bacteria and all isolated bacteria from the cell phones of the hospital personnel (doctors and nurses) and hospitalized patients , were resistant to more than three antibiotics, this revealed that cell phone may have notable role in the transmission of multidrug resistant nosocomial pathogens.

Brady *et al.*,(2009) investigated that (MCDs) contamination is presumably primarily the hands of the user, but hands themselves are subject to transient and permanent carriage of a range of pathogens. Thus the identity of micro-organisms contaminating a given MCDs on a given

occasion is also transient and variable. The risk of contamination with pathogens, their ability to survive on the surface, the duration of survival and the risk of patient exposure to the pathogen.

Ulger *et al.*,(2009) found that *S. aureus* strains isolated from mobile phones of 52.0% and Gram negative strains were isolated from mobile phones of 31.3%. At the study period the nosocomial isolates at ICU were: 33.3% Staphylococci, 21.4% non-fermentative Gram negatives, 21.4% Coliforms, 7.1% enterococci . The rate of routine cleaning of (HCW's) mobile phones was 10.5%, which means 89.5% of the participants never cleaned their mobile phones. Although the assistant doctors' phones have higher colony count there was no significant difference in the rates of specific types of bacterial growth and colony counts, isolated on all groups' mobile phones and distributions of the isolated microorganisms from mobile phones were similar to 37.7% hands isolates. Some mobile phones were contaminated with nosocomial important pathogens.

Srikanthaet *al .*, (2009) found that a total of 89 bacterial isolates were isolated from mobile phones of HCWs, of which 58(65%) were pathogenic , Commonly isolated pathogens from mobile phones were *S.*

aureus, MRSA, MSSA, *Escherichia coli*, *Pseudomonas aeruginosa*, *Acinetobacter spp.*, *Klebsiella pneumoniae* and Coagulase-negative *Staphylococci* (CONS). A higher percentage (42 %) of mobile phones of doctors was contaminated.

Chawla *et al.*, (2009) reported that, the cell phones play an important role as vectors to nosocomial infection and the most commonly found bacterial isolate was *Coagulase Negative Staphylococcus* (CONS) as a part of normal skin flora. Potentially pathogenic bacteria found were Methicillin sensitive *Staphylococcus aureus* (MSSA), coliforms, methicillin resistant *Staphylococcus aureus* (MRSA), *Corynebacterium spp.*, *Enterococcus faecalis*, *Clostridium perfringens*, *Klebsiella spp.*, *Enterobacter spp.*, *Pseudomonas spp.*, *Aeromonas spp.*, and *Acinetobacter spp.*

Abdalall, (2010) found a colonization rate reaching as high as 96.5% of mobile phone colonization with bacteria in a previous study in Saudi Arabia. Trivedi *et al.*, (2011) reported that, the several kind of isolated microorganisms from dominant hands correlated with the isolated ones from mobile phones in 78% of participants. They found that 50% isolated *Staphylococcus aureus* were methicillin resistant *Staphylococcus aureus* (MRSA). methicillin resistant. *Staphylococcus aureus* is a multidrug

resistant and responsible for several difficult-to-treat infections in humans. Methicillin resistant *Staphylococcus aureus* is especially troublesome in hospitals where patients with open wounds, invasive devices and weakened immune systems are at greater risk of infection than the general public.

Tekerekoluet *al.*, (2011) reported that 39.6% of the patient group phones and 20.6% of HCW phones tested positive for pathogens. Additionally, seven patient phones contained multidrug resistant (MDR) pathogens such as MRSA and multiply resistant Gram-negative organisms, extended spectrum β -lactamase producing *Escherichia coli*, *Klebsiella* spp., high-level aminoglycoside-resistant *Enterococcus* spp, and carbapenem-resistant *Acinetobacter baumannii*. Findings suggest that mobile phones of patients, patients' companions, and visitors represent higher risk for nosocomial pathogen colonization than those of HCWs. While no HCW phones tested positive for MDR pathogens.

Washington *et al.* ,(2011) reported that Hospital-acquired infections affect more than 25 percent of admitted patients in developing countries. In U.S.

hospitals, they cause 1.7 million infections per year and are associated with approximately 100,000 deaths. It is estimated that one third of these infections could be prevented by adhering to standard infection control guidelines . Jaya *et al.*,(2011) showed that bacteria causing nosocomial infections are present on mobile phones and the rate of contamination was 84%, bacterial isolations were *S.aureus*, *P. aeruginosa*, *K. pneumoniae*, *E. coli* and *Enterococcus faecalis*. The role of those agents in spreading nosocomial infections is well established and that group of volunteers were in direct contact with patient clinical sample at the time of collection and or processing in the laboratory and usually this group of volunteers keep their mobile on workbench. These might be the reasons for getting more number of isolates.

Bhat *et al.*, (2011) found that 99% of the phones demonstrated evidence of bacterial contamination. 64.8% of medical samples showed growth of pathogenic micro-organisms and 37.9% showed growth of Multi drug resistant bacteria. 59.37% of dental samples showed growth of pathogenic micro-organisms and 43.75% showed growth of Multi drug resistant bacteria. Pathogens isolated included Methicillin-resistant *Staphylococcus aureus*, Methicillin-sensitive *Staphylococcus aureus*, *Escherichia coli*,

Klebsiella pneumoniae, *Acinetobacter*, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*. Tankhiwale *et al.* (2012) found that Maximum samples showed growth of *Klebsiella* spp., (19%) followed by growth of *Staphylococcus aureus* (18%), *coagulase negative Staphylococci* (16%), *E. Coli & Micrococci* (16%) and *candida spp.*, were grown in (2%). All these micro-organisms were tested for antibiotic sensitivity and resistance to commonly used antibiotics in hospital. It was observed that the microorganisms isolated from patients samples and microorganisms isolated from mobile phones were showing sensitivity and resistance, to antimicrobials in a very identical way and were comparable. This indicated clearly that the mobile phones got contaminated from patient source in hospital Environment .

Badret *al.*,(2013) found that 94.5% of phones showed evidence of bacterial contamination and the isolated microorganisms were similar to hand isolates. They found that 49% of phones grew one bacterial species, 34% grew two different species and 11.5% grew three or more different species and no bacterial growth was found in 5.5% of phones. *S. aureus* strains isolated from mobile phones and from hands were 52.0% and 37.7% *meticillin* resistant respectively, while Gram-negative strains

isolated from mobile phones and from the hands were 31.3% and 39.5% ceftazidime resistant respectively and Microbiological analysis revealed that, same microorganisms were recovered from both mobile phones and HCWs' hands that were carrying the phone with the same antibiograms and same biochemical profiles .

2.1 Bacteria found on the mobile phone

2.1.1 *Staphylococcus spp.*

Staphylococcus is a genus of bacteria that is characterized by being round (coccus or spheroid shaped), Gram-stain positive, and found as either single cells, in pairs, or more frequently, in clusters that resemble a bunch of grapes , non-motile , non-sporeforming acute diseases facultatively anaerobic. The staphylococci are considered important human and animal pathogens responsible for causing nosocomial infections . Human infections are caused by coagulase- positive *S.aureus* strains. *S. epidermidis* strains and other Staphylococcus spp., that are coagulase-negative produce slime that interferes with immune defenses , *S.aureus* that likely cause o the severity of certain diseases. Such diseases include (food poisoning , septic shock, toxic shock syndrome , scalded

skin syndrome , pneumonia and impetigom) . *S. epidermidis* strains, which usually do not cause infections, can cause infections in people whose immune system is suppressed .costaet al .,(2000).

2.1.2 *Streptococcus spp.*

Gram-positive, facultative anaerobes, often pathogenic bacteria having an ovoid or spherical appearance and occurring in pairs or chains, pathogenic species that cause erysipelas, scarlet fever, and septic sore throat in humans. On blood agar species can be classified as α -hemolytic type, producing a zone of greenish discoloration much smaller than the clear zone produced by the β -hemolytic type about the colony on blood agar; and the β -hemolytic type, producing a clear zone of hemolysis immediately around the colony on blood agar, γ -hemolytic colonies showed no hemolysis. Most of the pathogenic species are β hemolytic. The medical important bacteria is *S.pyogenes* this species cause tonsillitis and respiratory, urinary, skin infections , acute sore throat and ear infections . *S. pneumoniae* (formerly *Diplococcus pneumoniae*) causes a majority of the cases of bacterial pneumonia , *Enterococci* can cause urinary tract and meningitis , wound infection , *S. viridians* can

cause abdominal and brain abscesses , dental caries . Streptococcus spp., their presence in hand and mobile phone HCWs .cheesbrough , (1984) .

2.1.3 *Bacillus spp* .

Gram-positive, rod-shaped bacteria are widely distributed in the environment , bacillus species can be obligate aerobes or facultative anaerobes. Bacillus includes both free-living and pathogenic species. Under stressful environmental conditions, two Bacillus species are considered medically significant , *B. anthracis*, which causes anthrax and *B. cereus* which causes a foodborne illness . Although this species is commonly found in soil. *B. subtilis* is only known to cause disease in severely immunocompromised patients cheesbrough , (1984) .

2.1.4 *Pseudomonas spp* .

The Pseudomonadaceae family (*P. aeruginosa*, *P. stutzeri*, *P. fluorescens*) are Gram-negative motile, aerobic bacteria , Pseudomonas are natural residents of soil and water. Pseudomonas spp., often invades the host tissue and cause infection and bacteremia in immunocompromised hosts (e.g., HIV , cystic fibrosis, bronchiectasis, and severe chronic obstructive

pulmonary disease, malignancy, or diabetes mellitus) the species is infectors of wounds and burns . cheesbrough , (1984).

2.1.5 *Acinetobacter spp.*

Acinetobacter is a Gram-negative bacterium, non-motile and oxidase-negative, that is readily found throughout the environment including drinking and surface waters, soil, sewage and various types of foods. *Acinetobacter* is also commonly found as a harmless coloniser on the skin of healthy people and usually poses very few risks. *Acinetobacter* infections acquired in the community are very rare and most strains found outside hospitals are sensitive to antibiotics, while *Acinetobacter* poses few risks to healthy individuals, a few species, particularly *Acinetobacter baumannii*, can cause serious infections, mainly in very ill hospital patients. The most common *Acinetobacter* infections include pneumonia, bacteraemia (blood stream infection), meningitis , wound infections, and urinary tract infections. 'Hospital-adapted' strains of *Acinetobacter* are sometimes resistant to antibiotics and are increasingly difficult to treat. Ryan and Ray (2004) .

2.1.6 *Escherichia coli.*

Escherichia is a genus of Gram-negative, non-spore forming, rod-shaped bacteria from the family Enterobacteriaceae , the main medical importance is *Escherichia coli* is responsible for the vast majority of Escherichia-related pathogenesis, other members of the genus have also been implicated in human disease are harmless commensals, particular strains of some species are human pathogens, are known as the most common cause of urinary tract infections, significant sources of gastrointestinal disease, ranging from simple diarrhea to dysentery-like conditions, it utilizes a mixed acid fermentation pathway to produce lactate, acetate and carbon dioxide ethanol and gas cheesbrough,(1984) .

2.1.7 *Klebsiella* spp.

Gram-negative, non-motile, encapsulated, lactose fermenting, facultative anaerobic, rod shaped bacterium. Although found in the normal flora of the mouth, skin, and intestines. *K. pneumoniae* can cause the disease *Klebsiella pneumoniae*. They cause destructive changes to human lungs inflammation and hemorrhage with cell death (necrosis) that sometimes produces a thick, bloody, mucoid sputum (currant jelly

sputum). urinary tract, lower biliary tract, and surgical wound sites Podschun and Ullman (1998) .

2.1.8 *Proteus spp.*

Gram negative non-capsulate , rods , pleomorphic capsulate they found in the intestinal tracts of humans and animal in areas contaminated with face , it presence on mobile phones , *Proteus mirabilis* can cause pyogenic infection in other parts of the body like wound infection cheesbrough ,(1984) .

2.1.9 *Enterobacter spp.*

Gram negative rods , this organisms are found mostly in soil and dry surface , they are not generally considered human pathogens unless they are directly introduced into the bloodstream , some species include *Enterobacter agglomerans* can cause avariety of necroses cheesbrough ,(1984) .

CHAPTER THREE

3. Material and Methods

This cross-sectional study was conducted in 2012 from October to December in Aljalaa hospital in Benghazi.

3.1. Collection of samples .

A total of 155 samples were taken from mobile phones of health care workers in hospital, using sterile cotton swabs moistened with normal saline water was rolled over all the exposed outer surfaces of the mobile phones .Care was taken to make sure that all the buttons of the keypad , mouth piece, earpiece were properly swabbed since these areas are the most frequently in contact with the fingers.

3.2. Transportation & Inoculation of the sample.

These swaps were transported in sterile tubes containing Thioglycollate transport medium and transferred immediately to the microbiology laboratory and incubated at 37°C for 24- 48 hours. figure

(1)



Figure(1): Thioglycollate transport media before incubation

3.4 Sub –culture.

Samples were inoculated into Thioglycollate medium broth to ensure that any microbial present in the cotton swab diffused into the broth and organisms were sub-cultured on Blood agar for Gram positive bacteria and MacConky agar for Gram negative bacteria. The plates were incubated at 37°C for 24- 48 hours aerobically. Plates were observed for bacterial growth and identification of isolated bacteria was confirmed by biochemical tests and BD Phoenix system (fig 2).



Figure (2):Thioglycollate transport media after incubation

3.5 Gram stain technique and microscopic examination .

The Gram stain is the first step in the identification pathogens and Gram staining is a bacteriological laboratory technique used to differentiate bacterial species into two large groups (Gram-positive and Gram-negative) based on the physical properties of their cell walls also its combined with the morphology . Firstly were used a clean slide and one drop of water on a slide. Organism is rolled the over the slide surface heat – fixed and add the primary stain (Crystal violet) to the sample/slide for 1 minute. The slide was rinsed with a gentle stream of water for a maximum of 5 seconds to remove unbound crystal violet, add Gram's iodine for 1 minute this is a mordant, or an agent that fixes the crystal violet to the bacterial cell wall. Rinse sample slide with acetone or alcohol for 3 seconds and the slide was rinsed with a gentle stream of water. The alcohol will decolorize the sample if it is Gram negative, safranin was add to the slide for 1 minute. The slide was washed with a gentle stream of water for a maximum of 5 seconds. The slide was observed under microscope for primary identification .

3.6 Biochemical test :

3.6.1 Deoxyribonuclease (DNase) test .

The test used to differentiate between *Staphylococcus aureus* which produces the enzyme DNase and *Staphylococcus* species non produces the enzyme, the test is performed by using sterile loop and taking few colonies of the organism and placed in the DNase agar plate, the plate was incubated at 37°C for 24h. The surface of the plate covered with 1mol/l hydrochloric acid within few minutes of adding the acid, clearing around the colonies was observed figure (A,B3).

3.6.2 Oxidase test .

The oxidase test is a test used in microbiology to determine if a bacterium. The slide was produces cytochrome oxidase enzyme such as *Pseudomonas* species. Disks were impregnated with a reagent such as (tetra methyl-p-phenylenediamine hydrochloride), the reagent is a dark-blue to purple color when reduced oxidized, colorless when reduced oxidase-positive bacteria possess. The test was done by picking up a portion of the tested colony and smearing it on a strip of filter paper

impregnated with the oxidase reagent. The immediate development of a deep purple color indicated a positive test (Fig. 4).

3.6.3 Catalase test.

The catalase test is used to detect the presence of catalase enzymes by decomposition of hydrogen peroxide (H_2O_2) to release oxygen and water, this test to differentiate Staphylococci from non-catalase producing bacteria such Streptococci. The test performed by taking few colonies of bacteria on the slide, using a sterile wooden stick and immerses it in the Hydrogen peroxide solution, bubbles of oxygen will be seen in the slide when catalase is produced by the organism (positive test) no release of bubble (negative test) (fig. 5).

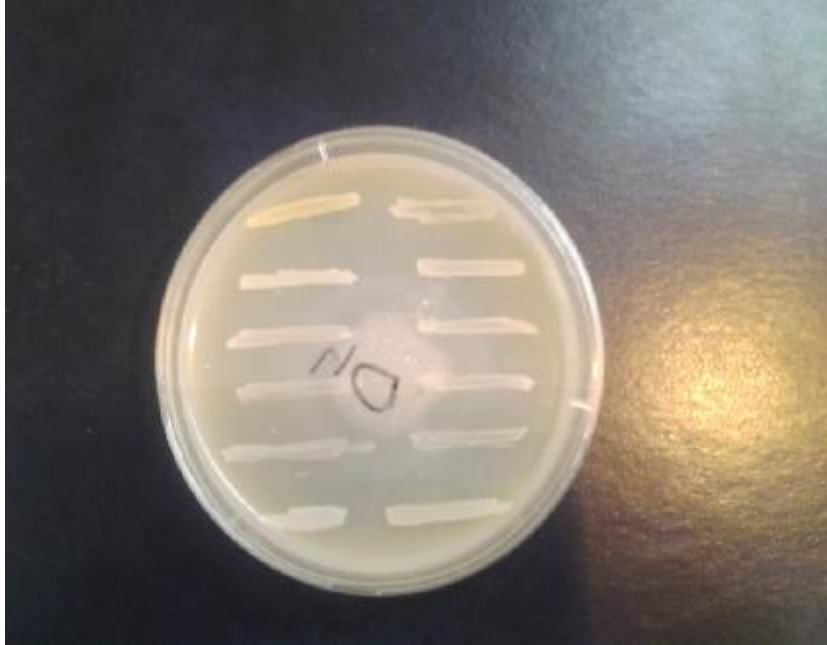


Figure (A3) : before DNase test

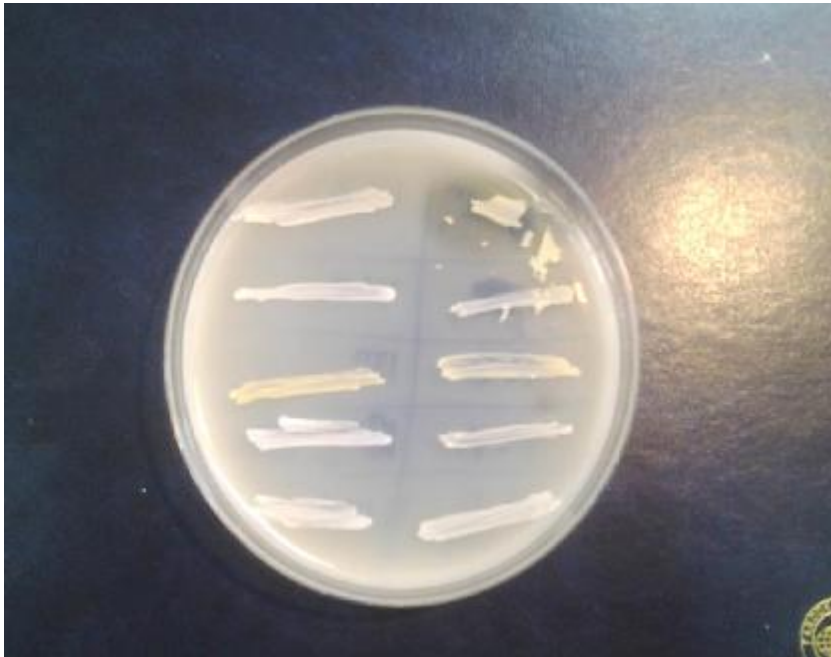


Figure (B3) : After DNase test



Figure (4): Oxidase positive test



Figure (5) : Catalase positive test

3.7 BD Phoenix system .

The performance of the BD Phoenix Automated Microbiology System (BD Diagnostic Systems, Sparks, MD) was assessed for identification (ID) and antimicrobial susceptibility testing (AST) of the majority of clinically encountered bacterial isolates in Aljalla Hospital laboratory Benghazi (fig6).



Figure (6): BD Phoenix system

3.8 Antibiotic sensitivity tests.

The antibiotic sensitivity pattern of selected isolate was studied by disc diffusion method and all isolated strains were tested against various antibiotics Ampicillin, Penicillin, Gentamicin and Vancomycin , Ciprofloxacin, erythromycin,tetracycline, Amoxicillin-clavulanic. Bacterial growth were striked on Muller Hinton agar plates, antibiotic discs were placed on the media, than incubated at 37°C for 24h .

CHAPTER FOUR

4. Results

The total of sample of this study was one hundred and fifty five from mobile phones of health care workers from different department in hospital. 150 of isolates appeared to showed bacterial growth. The number of samples from surgery department was 22 and 12 samples from laboratory, 23 from intensive care unit, 21 from operating theaters, 16 collected from burns department, 20 from emergency section , 24 from orthopedics department, 4 samples collected from dental section, 8 from stitch room and 5 collected from physical therapy department.

4.1 Identification of bacterial isolates

4.1.1 *Staphylococcus spp* .

In this study staphylococcus was the most common bacterial isolates in the hospital, the isolated bacteria was Gram positive. On blood agar produced white, cream or yellow colonies. The biochemical tests showed catalase positive, *S.aureus* golden-yellow colonies often with hemolysis when grown on blood agar plates (Fig 7). Methicillin resistant *Staphylococcus aureus* (MRSA) was identified by phonex (Fig 8) . Several species of staphylococci were also identified such as

S. heamolyticus (Fig9), *S. ebidermidis* (Fig10),
S. capitis(Fig11), *S. saprophyticus*(Fig12) . All identification was confirmed
by phoenix .



Figure (7) : *S. aureus* on blood agar



Figure (8): *Methicillin resistant Staphylococcus aureus* (MRSA)



Figure (9) :*S.heamolyticus* on blood agar



Figure(10): *S.ebidermidis* on blood agar

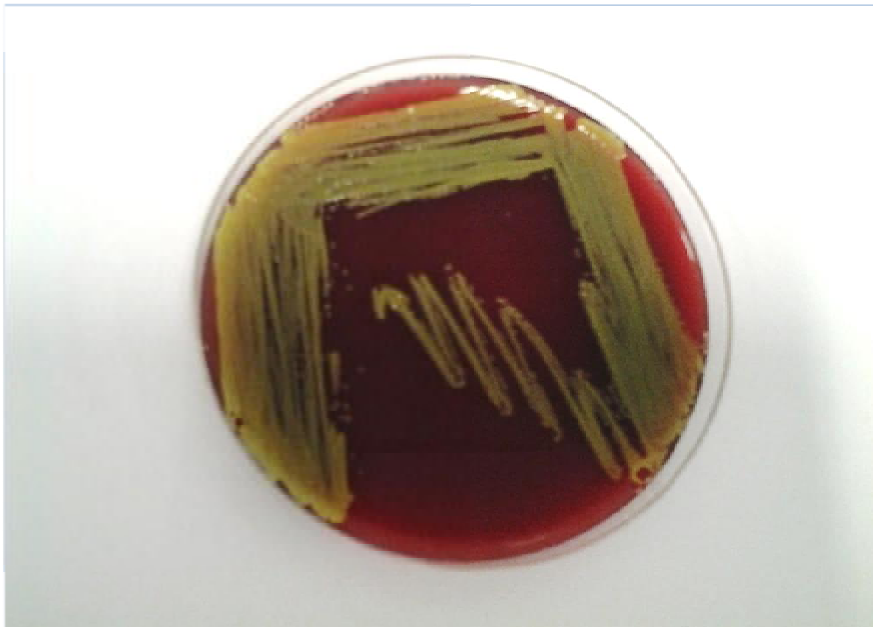


Figure (11): *S.capitis* on blood agar



Figure (12) : *S.saprophyticus* on blood agar

4.1.2 *Streptococcus spp* .

In this study the samples showed by Gram stain were Gram –positive cocci ovoid , smooth colonies typically form chain of cells,the isolates bacteria were *S.oralis* ,*Enterococcus faecalis*, the *S.viridans* Alpha-heamolytic producing a zone of greenish discoloration on blood agar . All isolates were confirmed by BD phonex system(Fig13,14,15,16).

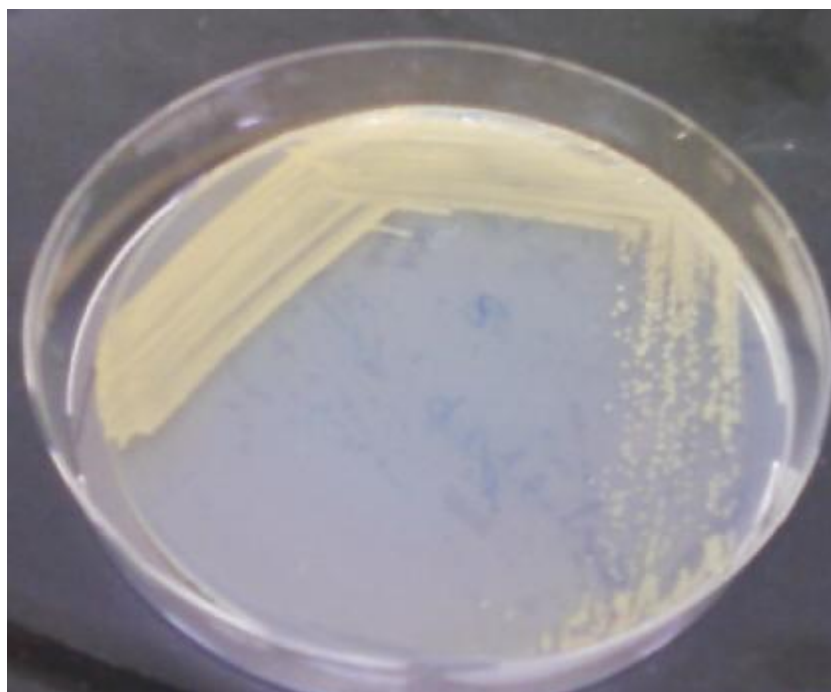


Figure (13) :*S.oralis* on TSA



Figure (14) : *S.oralis* on blood agar

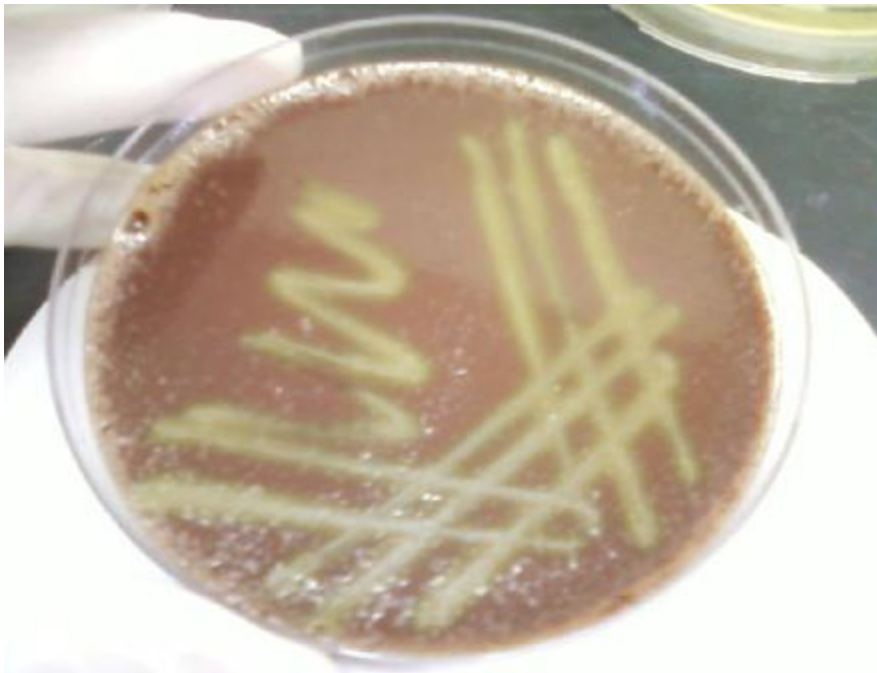


Figure (15): *S.viridians* on blood agar

4.1.3 *Bacillus spp* .

A different species of bacillus had been isolates , bacteria appeared by Gram stain as Gram-positive rods, culture media showed flat large dry, grey to white colonies .On blood agar appeared beta-haemolytic and colonies had been showed white dry growth on macConkey agar. All isolates were confirmed by BD phoenix system (Fig 16,17).

4.1.4 *Klebsiella spp*.

Gram stain showed the isolates was Gram-negative rods. However in culture media showed a large mucous pale pink colonies, the isolated colony have the ability to ferment the lactose on macConkey agar plates. The samples were confirmed by BD phoenix system (Fig18).

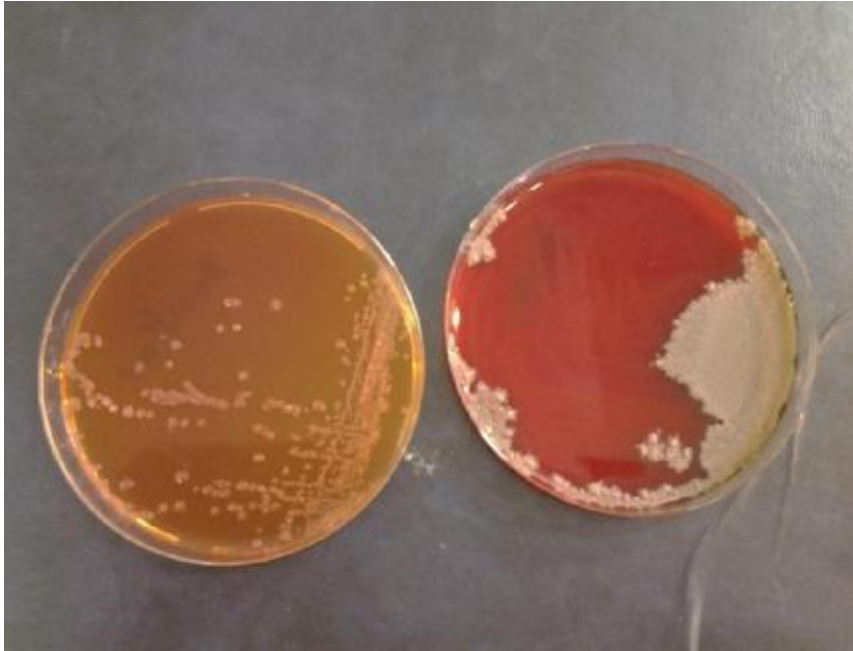


Figure (16): *B. subtilis* on blood agar and on macConkey agar



Figure (17) : *B.cereus* on blood agar



Figure (18):*Klebsiella pneumoniae* on macConkey agar

4.1.5 *Pseudomonas* spp.

By Gram stain bacteria appeared as Gram-negative rods . In this study sixteen samples were contaminated as pseudomonas species. By culture media colonies on blood agar were surrounded by wide zone of beta-hemolysis and small yellow-green colonies. The biochemical tests showed oxidase positive. All isolates were confirmed by BD phoenix system (Fig19).



Figure (19) :*Pseudomonas aeruginosa* on macConkey agar

4.1.6 *Proteus mirabilis*.

The results showed that, six samples were contaminated with *proteus mirabilis*. By using Gram stain isolates appeared to be Gram-negative rods and on blood agar media swarming growth was observed and light brown to yellow colonies was observed in macConkey agar. The identification was confirmed by BD phoenix system (Fig 20,21) .



Figure (20) : *Proteus mirabilis* on blood

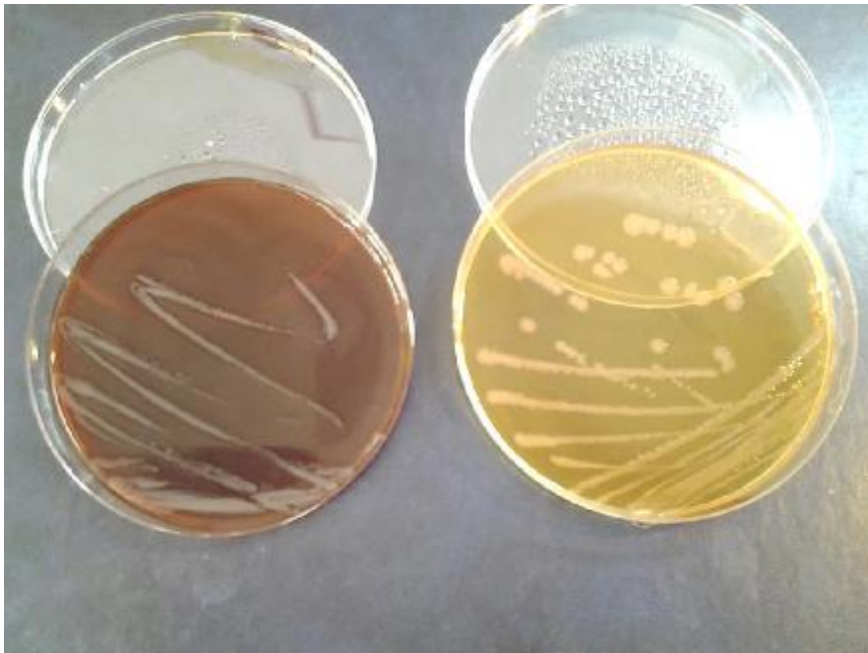


Figure (21): *Proteus mirabilis* on blood and macConkey agar

4.1.7 *Acinetobacter paumannii*.

Gram stain showed the isolated bacteria was as Gram-negative on macConkey agar small cream colonies was observed. The identification of this bacteria was confirmed by BD phonex system (Fig22) .



Figure (22) : *Acinetobacter paumannii* on macConkey agar

4.1.8 *Escherichia coli*.

The bacteria was Gram-negative rod shaped bacteria, with small pink lactose positive colonies on macConkey agar media, fourteen samples were contamination with *E.coli* and all identification was confirmed by BD phoenix system (Fig 23).



Figure (23): *Escherichia coli* on MacConkey agar

4.1.9 *Enterobacter Spp.*

Six species of this bacteria were isolates , Gram stain of *enterobacter* appeared as Gram-negative rods. Culture media showed that small smooth colonies on macConkey agar and presence of 3 species *Pantoea agglomerans* is a Gram-negative bacterium that belongs to the family Enterobacteriaceae. All species was confirmed by BD phoenix system (Fig 24,25).



Figure(24) : *E. agglomerans* on blood agar



Figure (25):*Pantoea agglomerans* on macConky agar

4.1.10 *Micrococcus spp.*

Only three samples was contamination with micrococcus, the isolated were Gram-positive cocci ,on blood agar showed small white colonies. The isolated bacteria was confirmed by BD phoenix system (Fig 26).



Figure (26) : *Micrococcus lylaeon* blood agar

4.2: Distribution of Results of culture from mobile phones and sex of (HCWs) .

In this study the number of bacterial isolates was 155 samples. Bacterial growth was observed in 150 sample and 5 samples did not show any bacterial growth . Table (1) showed the distribution of results of culture from mobile phones and sex of (HCWs). The contamination among the female was 94.9%. However the bacterial contamination was higher in male than female reach to 98.7% (fig 27).

4.3: Distribution of multiple organisms on mobile phone of HCWs .

Table (2) showed the frequency of multiple kind of bacteria in both mobile phone of female and male . This study showed that both , the one type and two type was higher among female 41.3% and 40% respectively than in male which reach to 29.3% for one type and 36% for two type . The contamination with three or more type was observed among male than female 34.7% and 18.7% (fig 28).

Table (1): Distribution of results of culture from mobile phones and sex of (HCWs) .

Results of culture	Sex			
	Female		Male	
	No.	%	No.	%
No growth	4	5.1	1	1.3
Growth	75	94.9	75	98.7
Total	79	100	76	100

$X^2 = 0.749$. $df=1$ p value =0.387(Not significant).

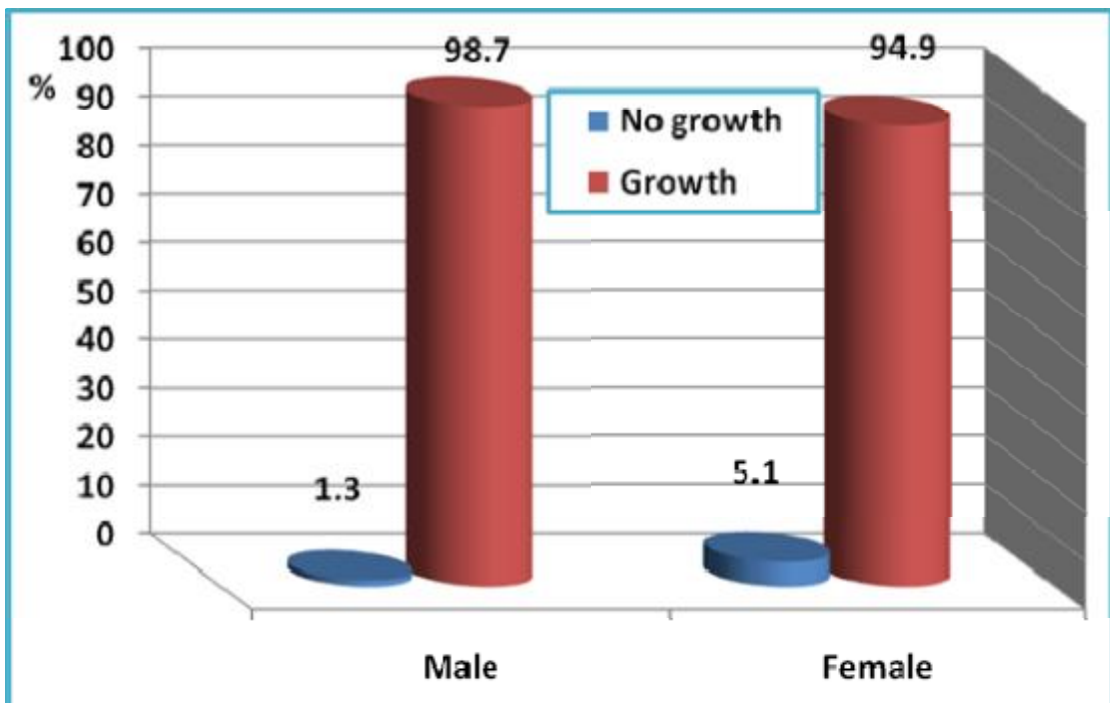


Figure (27): Results of culture from mobile phones and sex.

Table (2): Distribution of sample according to number of organism isolated and sex of HCWs .

Number of different organisms isolated	Sex			
	Female		Male	
	No.	%	No.	%
One type	31	41.3	22	29.3
Two type	30	40	27	36
Three or more type	14	18.7	26	34.7
Total	75	100	75	100

$\chi^2 = 5.286$. $df=2$ p value =0.071(Not significant).

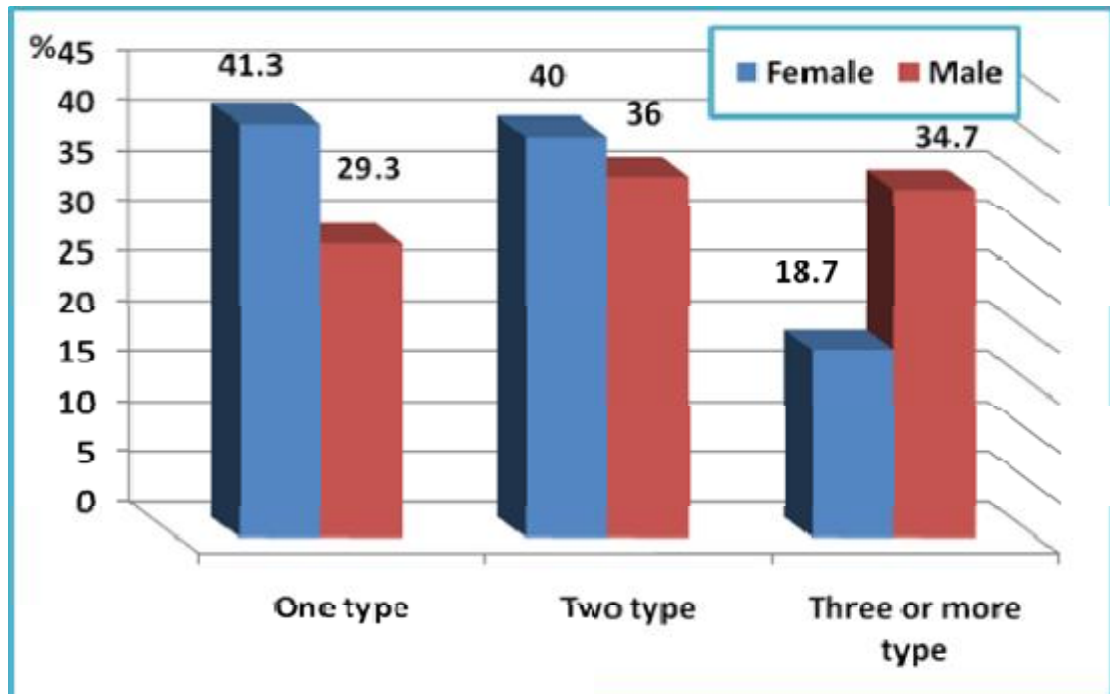


Figure (28): Distribution of sample according to number of organism isolated and sex.

4.4: Distribution of types of microorganisms isolated from mobile phones of healthcare workers in hospital .

Table (3) showed the contamination of the mobile phone for health care workers. The bacterial contamination was higher with Gram positive bacteria reach to 75.9% , while Gram negative bacteria was 24.1%. This study showed that most of the bacterial isolates among Gram positive bacteria were *S. epidermidis* (21.7%) , followed by *Bacillus spp* (10.3%), *S. aureus* (8.2%) , *S. heamolyticus* (6.9%), *Methicillin resistant Staphylococcus aureus (MRSA)* (6.5%), *S. capitis* (6.2%), *Staphylococcus spp* (3.8%) , *Streptococcus spp* (2.8%) , *Bacillus subtilis* (2.4%). Low frequency was among observed *S. hominis*, *S. saprophyticus* (2.1%), followed by *Micrococcus spp* and *Macrococcus caseolyticus* (1%). However the lowest frequency among *Enterococcus casseliflavus*, *Dermacoccus nishinomiyaensis* and *Lenconostoc mesentero* (0.3%) . Among Gram negative bacteria the High frequency was observed with *Pseudomonas spp* (5.5%), *Escherichia coli* (4.8%), *Acinetobacter paumannii* (4.5%), *Klebsiella pneumonia* (3.8%), *Enterobacter spp* and *Proteus mirabilis* (2.1%) , *Pantoea agglomerans* (1%) .

However *Alealigenes faecalis* exhibit the lowest frequency reach to (0.3%) (Fig 29 A-B)

Table (3): Distribution of types of microorganisms isolated from mobile phones of healthcare workers in hospital.

Bacterial agents identified	No of bacteria	Percent%
Gram positive		
<i>Staphylococcus epidermidis</i>	63	21.7 %
<i>Staphylococcus aureus</i>	24	8.2 %
<i>Methicillin resistant Staphylococcus aureus (MRSA)</i>	19	6.5 %
<i>Staphylococcus capitis</i>	18	6.2%
<i>Staphylococcus heamoliticus</i>	20	6.9%
<i>Staphylococcus saprophyticus</i>	6	2.1%
<i>Staphylococcus hominis</i>	6	2.1%
<i>Staphylococcus spp</i>	11	3.8%
<i>Streptococcus spp</i>	8	2.8%
<i>Bacillus spp</i>	30	10.3%
<i>Bacillus subtilis</i>	7	2.4%
<i>Enterococcus casseliflavus</i>	1	0.3%
<i>Micrococcus spp</i>	3	1 %
<i>Macroccoccus caseolyticus</i>	3	1 %
<i>Dermacoccus nishinomiyaensis</i>	1	0.3%
<i>Lenconostoc mesentero</i>	1	0.3%
Total gram positive	221	75.9%
Gram Negative		
<i>Escherichia coli</i>	14	4.8%
<i>Enterobacter spp</i>	6	2.1%
<i>Klebsiella pneumonia</i>	11	3.8%
<i>Acinetobacter paumannii</i>	13	4.5%
<i>Proteus mirabilis</i>	6	2.1%
<i>Pseudomonas spp</i>	16	5.5%
<i>Pantoea agglomerans</i>	3	1 %
<i>Alealigenes faecalis</i>	1	0.3%
Total gram negative	71	24.1%

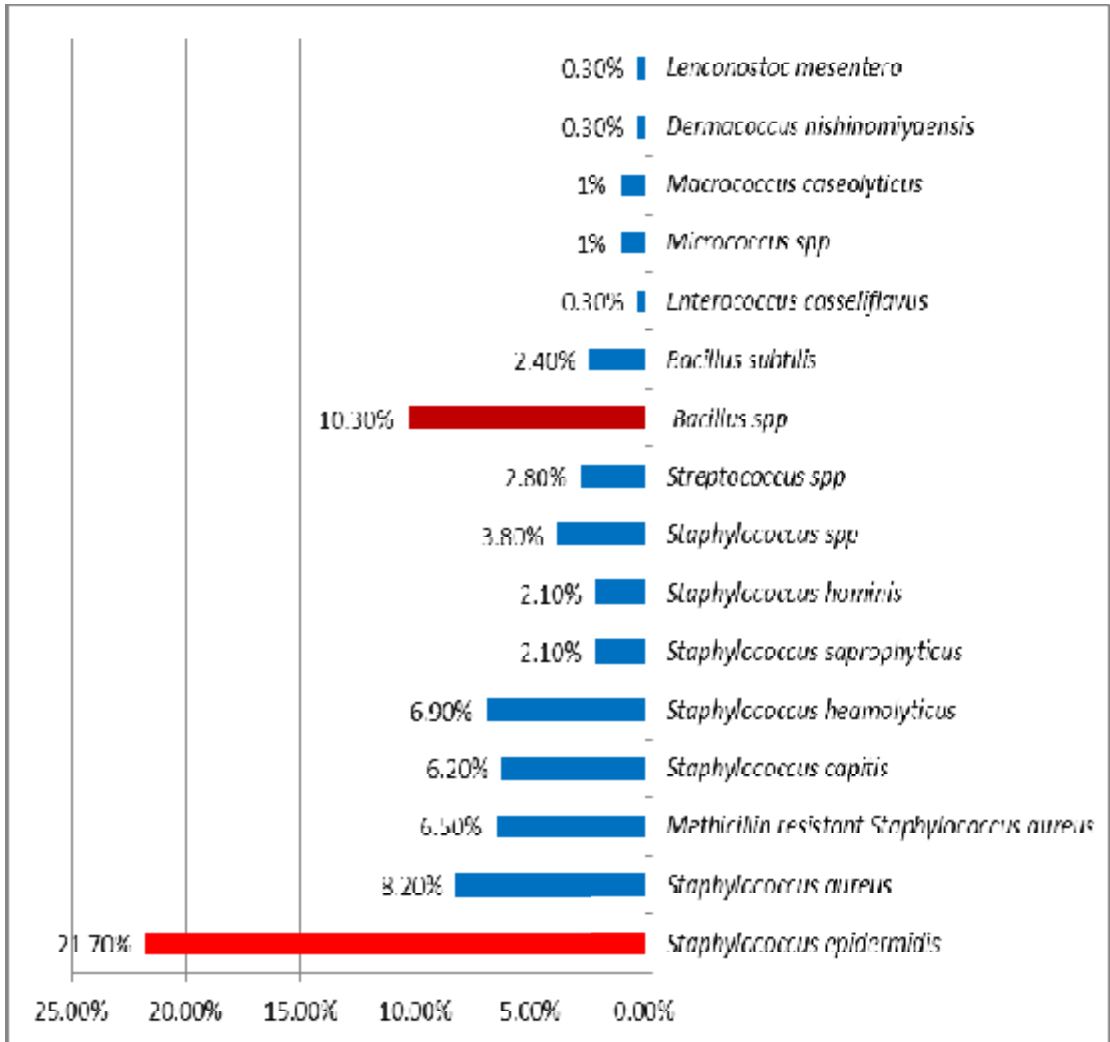


Figure (29)- A: Types of microorganisms isolated from mobile phones of healthcare workers in hospital (gram positive).

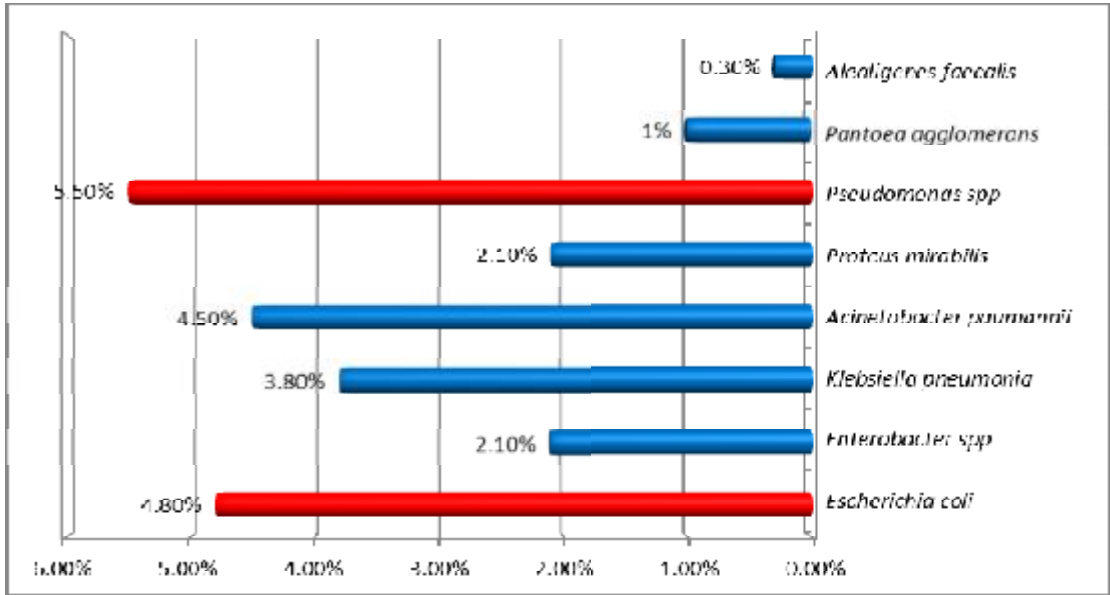


Figure (29)-B: Types of microorganisms isolated from mobile phones of healthcare workers in hospital (gram negative).

4.5: Distribution of *S.aureus* that were found on mobile phones of female and male in all department .

Table (4) showed the frequency of *S.aureus* in the all departments. The presence of this bacteria was observed in the male more than in female. However this study showed high level of contamination was found among males in Surgery part, ICU and Stitch room reach to (18.7%), followed by operating theatres and burn unit (12.5%). The lower percentage was observed in comment unit, orthopedic and Physical therapy department (6.3%). In contrast *S.aureus* not observed in laboratory and dental clinic. Among females the high level of *S.aureus* reach to (37.5%) in comment unit, followed by burn unit and orthopedic (25%), the lowest frequency was found in OT (12.5%) (Fig 30) .

4.6:Distribution of MRSA that were found on mobile phones of female and male in all department .

Table (5) showed the high frequency of MRSA in all departments. This study showed contamination of MRSA was observed among the males in ICU (26.7%), followed by OT (20%), comment unit, orthopedic and Physical therapy department (13.3%). However the lower percentage was observed in surgery part and burns unit(6.7%).In Contrast to females MRSAfound only in Burns unit (50%), followed by OT and comment unit(25%). The remains department was free from MRSA in dental clinicand laboratory (Fig 31) .

Table (4) : Distribution of *S.aureus* that were found on mobile phones of female and male in all departments .

Department	<i>S.aureus</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	0	0	3	18.7	3	12.5
Laboratory	0	0	0	0	0	0
Intensive care unit	0	0	3	18.7	3	12.5
Operating theatres	1	12.5	2	12.5	3	12.5
Burns unit	2	25	2	12.5	4	16.7
Stitch room	0	0	3	18.7	3	12.5
comment unit	3	37.5	1	6.3	4	16.7
orthopedic	2	25	1	6.3	3	12.5
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	6.3	1	4.1
Total	8	100	16	100	24	100

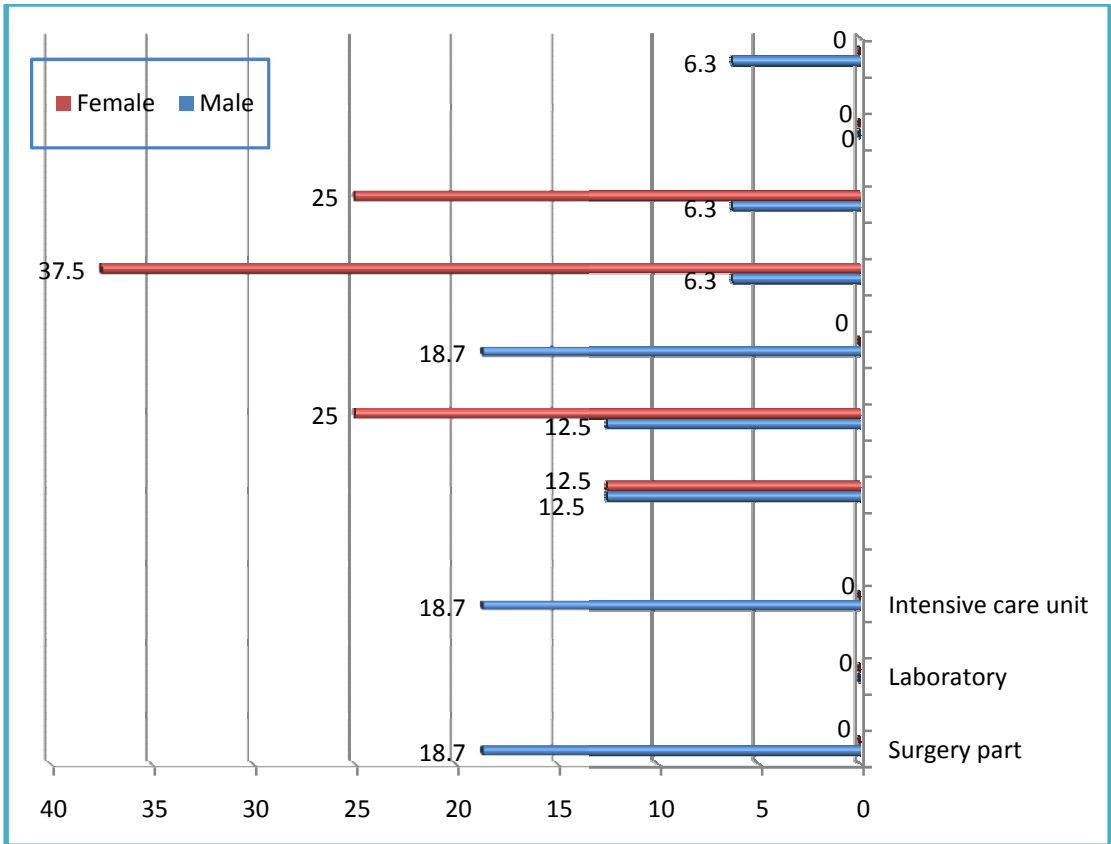


Figure (30) : Distribution of *S.aureus* that were found on mobile phones of female and male in all departments .

Table (5) : Distribution of MRSA that were found on mobile phones of female and male in all department .

Department	MRSA					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	0	0	1	6.7	1	5.2
Laboratory	0	0	0	0	0	0
Intensive care unit	0	0	4	26.7	4	21.1
Operating theatres	1	25	3	20	4	21.1
Burns unit	2	50	1	6.7	3	15.8
Stitch room	0	0	0	0	0	0
comment unit	1	25	2	13.3	3	15.8
Orthopedic	0	0	2	13.3	2	10.5
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	2	13.3	2	10.5
Total	4	100	15	100	19	100

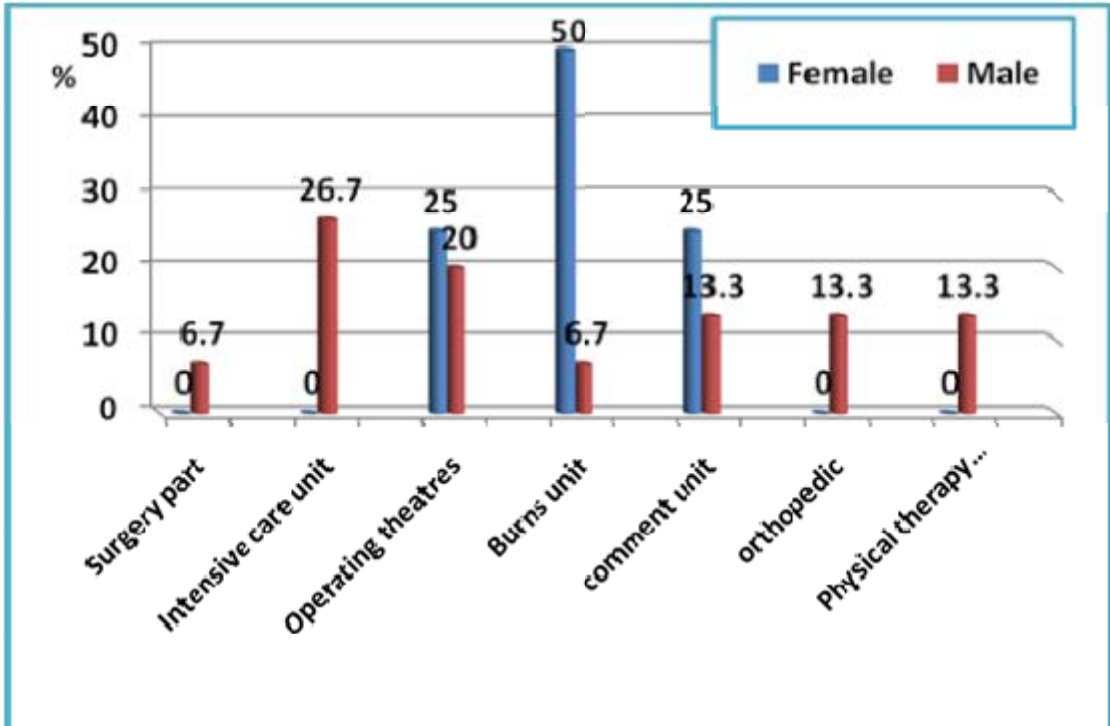


Figure (31) : Distribution of MRSA that were found on mobile phones of female and male in all department.

4.7:Distribution of *S.capitis* that were found on mobile phones of female and male in all department .

Table (6) showed the distribution of *S.capitis* in all departments. The bacterial contamination was equal in percentage of both male and female. Among females the highest percentage in surgery part ,OT, burns unit and comment unit (22.2%), followed by ICU (11.2%). However the highest percentage of *S.capitis* among males in burns unit and orthopedic reach to (22%), followed by Physical therapy department, comment unit , laboratory , Stitch room and ICU(11.2%). The remains department was free from *S.capitis* in dental clinic(Fig 32).

4.8:Distribution of *S.heamolyticus* that were found on mobile phones of female and male in all department .

This study showed the high level of contamination of *S.heamolyticus* was observed the females in surgery part (40%), followed by in orthopedic and comment unit (20%) . The lowest frequency was observed in stitch room and ICU (10%), while the rate for males was highest in surgery part and orthopedic (20%), followed by ICU , OT, burns unit, stitch room ,comment unit and Physical therapy department (10%). In contrast

S.heamolyticus not observed in laboratory and dental clinic table (7) (Fig 33) .

Table (6) :Distribution of *S.capitis* that were found on mobile phones of female and male in all department .

Department	<i>S. capitis</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery depart.	2	22.2	0	0	2	11.1
Laboratory	0	0	1	11.2	1	5.6
Intensive care unit	1	11.2	1	11.2	2	11.1
Operating theatres	2	22.2	0	0	2	11.1
Burns unit	2	22.2	2	22	4	22.2
Stitch room	0	0	1	11.2	1	5.6
comment unit	2	22.2	1	11.2	3	16.6
orthopedic	0	0	2	22	2	11.1
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	11.2	1	5.6
Total	9	100	9	100	18	100

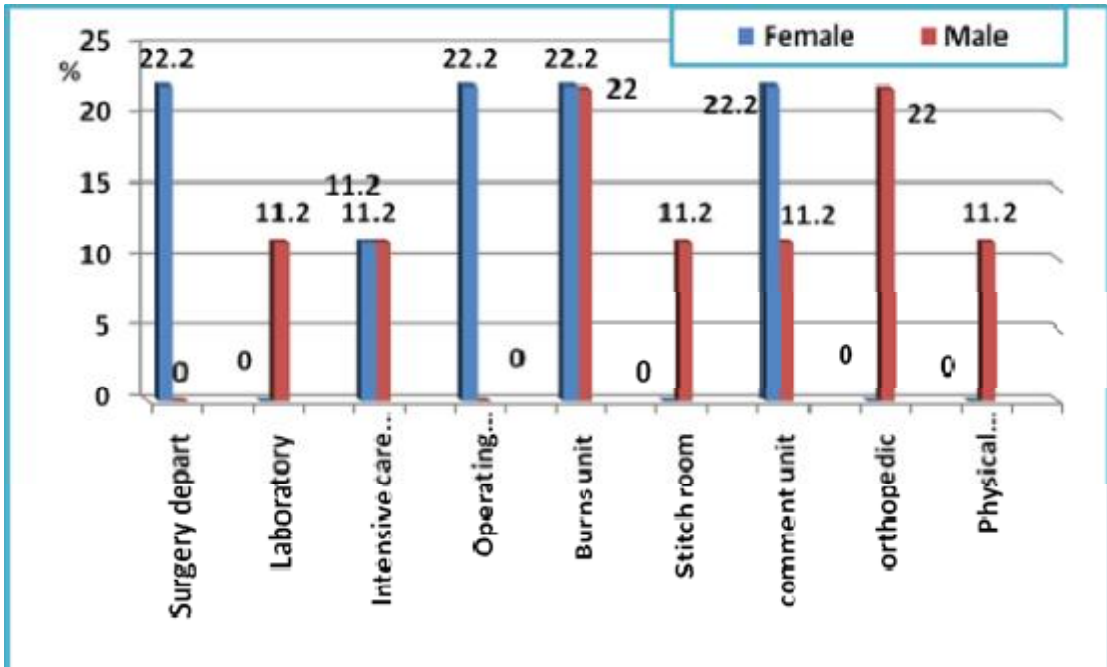


Figure (32) :Distribution of *S.capitistat* that were found on mobile phones of female and male in all department .

Table (7) :Distribution of *S.heamolyticus*that were found on mobile phones of female and male in all department .

Department	<i>S.heamolyticus</i>					
	Sex					
	Female		Male		Total	
Surgery part	4	40	2	20	6	30
Laboratory	0	0	0	0	0	0
Intensive care unit	1	10	1	10	2	10
Operating theatres	0	0	1	10	1	5
Burns unit	0	0	1	10	1	5
Stitch room	1	10	1	10	2	10
comment unit	2	20	1	10	3	15
orthopedic	2	20	2	20	4	20
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	10	1	5
Total	10	100	10	100	20	100

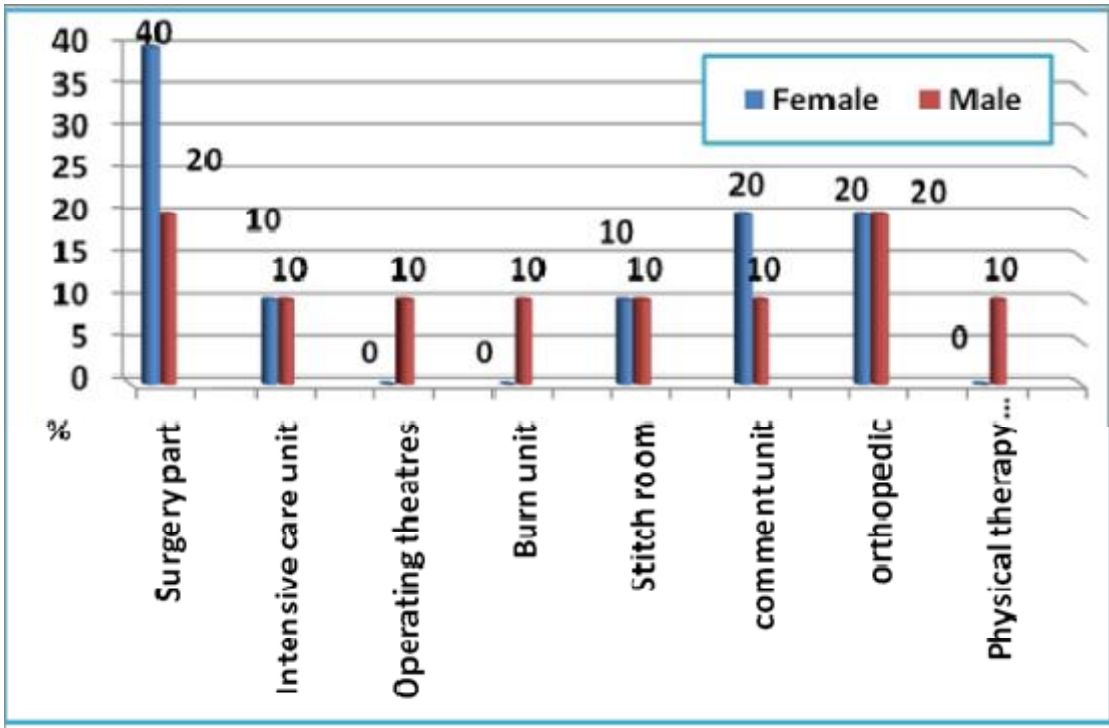


Figure (33):Distribution of *S.hemolyticus*that were found on mobile phones of female and male in all department .

4.9:Distribution of *Streptococcus Sp.*that were found on mobile phones of female and male in all department.

Table (8) showed the distribution of *Streptococcus spp* in all departments. This study showed high level of contamination was observed among the males in ICU (40%), followed by OT, comment unit and burns unit (20%). However among females the high frequency of *Streptococcus Sp*, in Stitch room (66.7%), followed by in surgery part (33.3%). In contrast *Streptococcus spp* not observed in laboratory, dental clinic, orthopedic and physical therapy department (Fig 34).

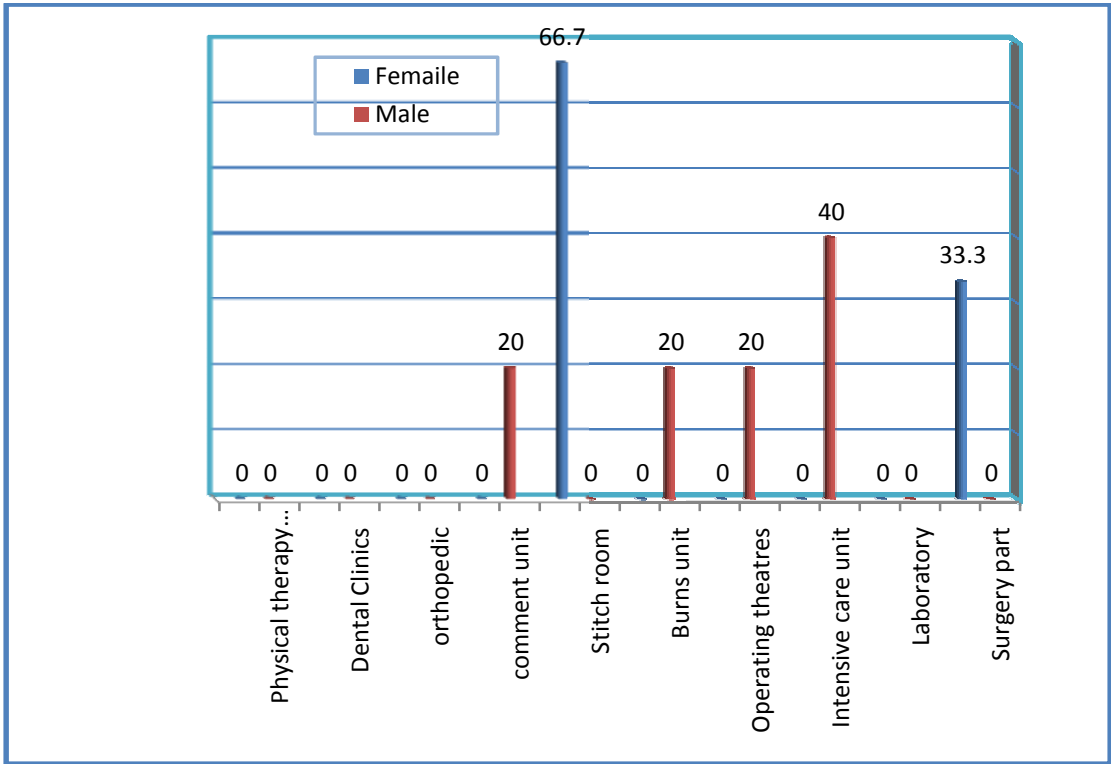
4.10:Distribution of *Bacillus spp* that were found on mobile phones of female and male in all department.

Table (9) showed the frequency of *Bacillus spp* in the all departments. The presence this bacteria was observed among males in surgery part (18.7 %), followed by ICU, OT, stitch room , orthopedic and physical therapy department (12.5%). The lower percentage was observed in burns unit, comment unit and dental clinical (6.3%) . The high contamination of *Bacillus spp* was observed among females in ICU

and comment unit (21.4 %), followed by surgery part, OT, orthopedic ,
burns unit (14.3%). The laboratory was free from *Bacillus* spp (Fig 35).

Table (8):Distribution of *Streptococcus Sp.* that were found on mobile phones of female and male in all department

Department	<i>Streptococcus Sp.</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	1	33.3	0	0	1	12.5
Laboratory	0	0	0	0	0	0
Intensive care unit	0	0	2	40	2	25
Operating theatres	0	0	1	20	1	12.5
Burns unit	0	0	1	20	1	12.5
Stitch room	2	66.7	0	0	2	25
comment unit	0	0	1	20	1	12.5
orthopedic	0	0	0	0	0	0
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	0	0	0	0
Total	3	100	5	100	8	100



Figure(34) :Distribution of *Streptococcus Sp*,that were found on mobile phones of female and male in all department .

Table (9) :Distribution of *Bacillus Sp*,that were found on mobile phones of female and male in all department

Department	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	2	14.3	3	18.7	5	16.7
Laboratory	0	0	0	0	0	0
Intensive care unit	3	21.4	2	12.5	5	16.7
Operating theatres	2	14.3	2	12.5	4	13.3
Burns unit	2	14.3	1	6.3	3	10
Stitch room	0	0	2	12.5	2	6.7
comment unit	3	21.4	1	6.3	4	13.3
orthopedic	2	14.3	2	12.5	4	13.3
Dental Clinics	0	0	1	6.3	1	3.3
Physical therapy department	0	0	2	12.5	2	6.7
Total	14	100	16	100	30	100

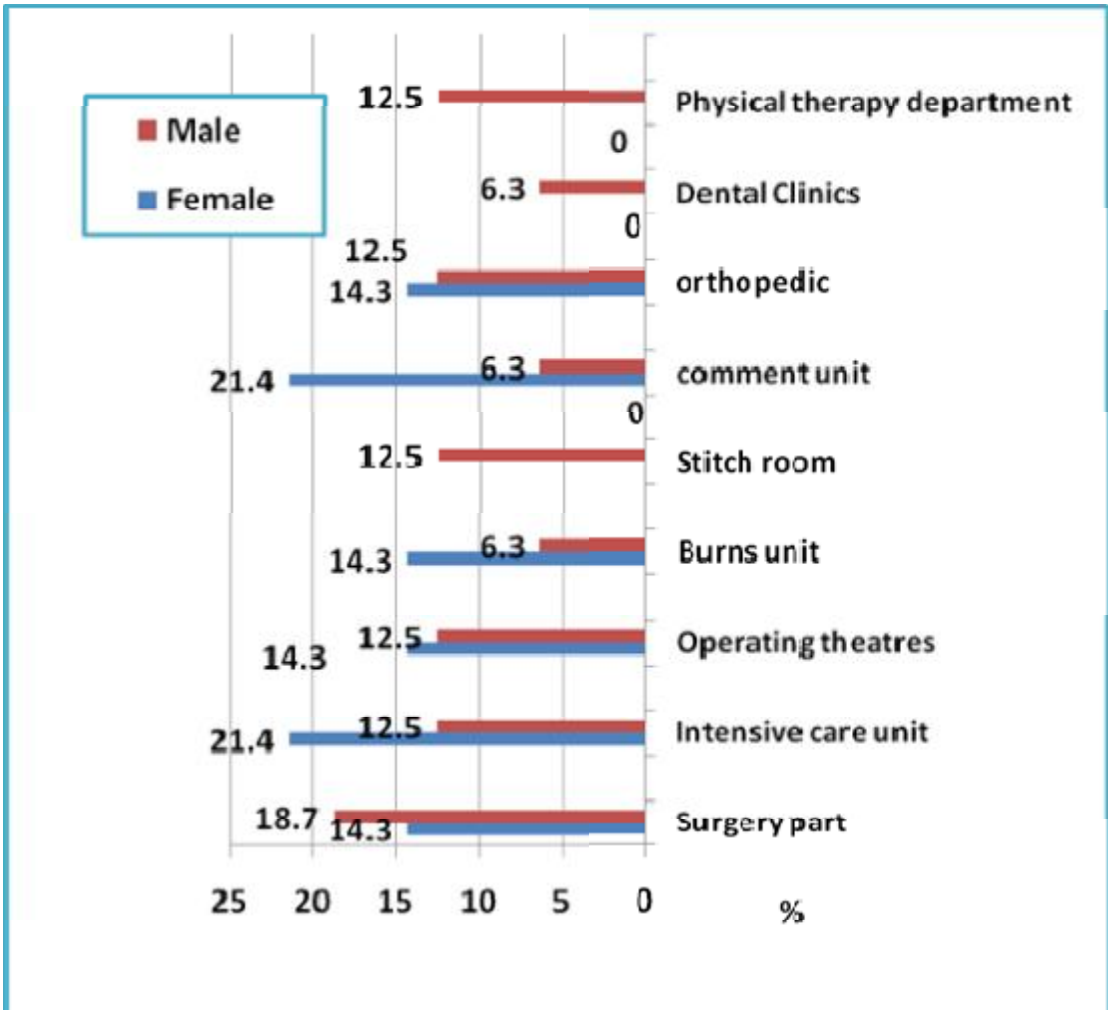


Figure (35) :Distribution of *Bacillus Sp*,that were found on mobile phones of female and male in all department .

4.11: Distribution of *Escherichia coli* that were found on mobile phones of female and male in all department.

Table (10) showed distribution of *Escherichia coli* were found on mobile phones of females and males in all department. The high level of contamination was observed among male in OT reach to (33.3%) ,followed by comment unit (22.2%) , surgery part , ICU, orthopedic and in Physical therapy department (11.1%). However the contamination was observed among females reach to (20 %) in surgery part, ICU, OT, burns unit and stitch room (Fig 36) .

4.12:Distribution of *Enterobacter spp* that were found on mobile phones of female and male in all department.

This study showed the frequency of *Enterobacter spp* in the all departments. Table (11) showed the presence of this bacteria was observed among males in OT reach to (50 %), followed by burns unit and surgery part (25%) . The high contamination of *Enterobacter spp* among females in laboratory and orthopedic (50%). In contrast *Enterobacter spp* not observed in ICU, stitch room, dental clinic and physical therapy department (Fig 37).

Table (10) : Distribution of *Escherichia coli* that were found on mobile phones of female and male in all department

Department	<i>Escherichia coli</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	1	20	1	11.1	2	14.3
Laboratory	0	0	0	0	0	0
Intensive care unit	1	20	1	11.1	2	14.3
Operating theatres	1	20	3	33.3	4	28.7
Burns unit	1	20	0	0	1	7.1
Stitch room	1	20	0	0	1	7.1
comment unit	0	0	2	22.2	2	14.3
orthopedic	0	0	1	11.1	1	7.1
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	11.1	1	7.1
Total	5	100	9	100	14	100

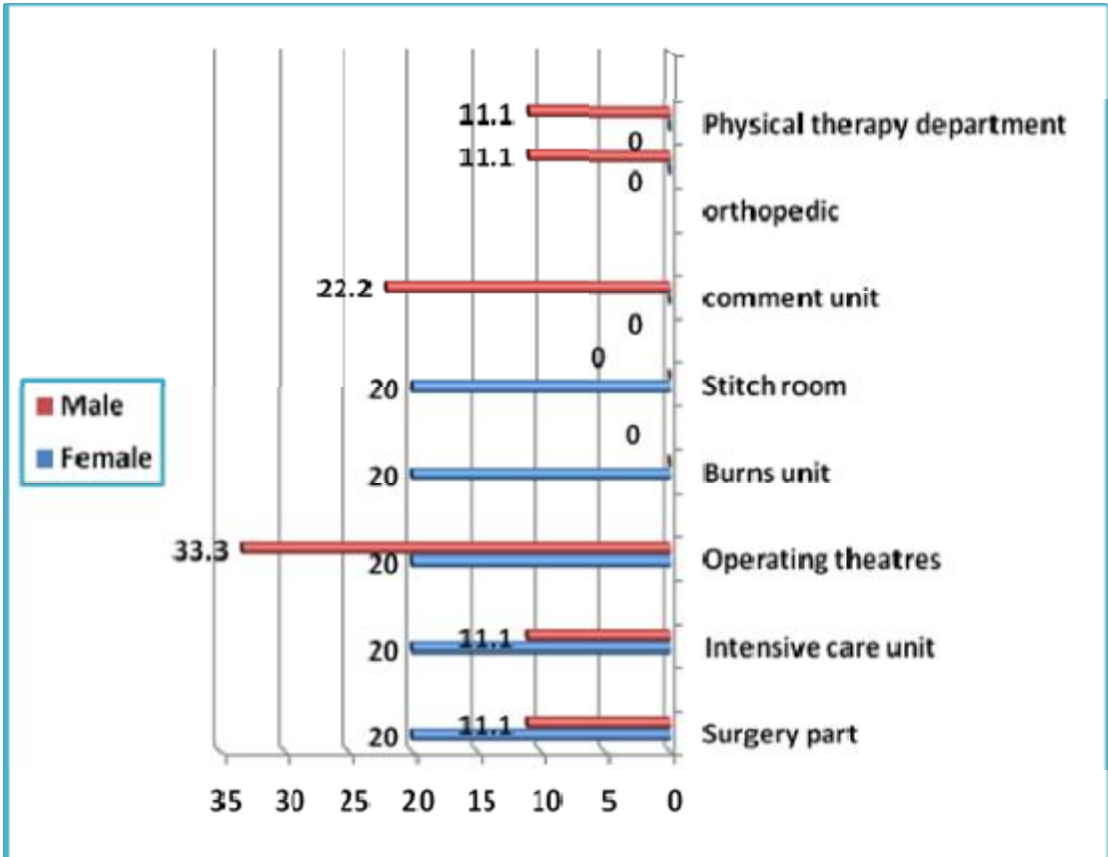


Figure (36) : Distribution of *Escherichia coli* that were found on mobile phones of female and male in all department .

Table (11) :Distribution of *Enterobacter spp* that were found on mobile phones of female and male in all department

Department	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	0	0	1	25	1	16.7
Laboratory	1	50	0	0	1	16.7
Intensive care unit	0	0	0	0	0	0
Operating theatres	0	0	2	50	2	33.2
Burns unit	0	0	1	25	1	16.7
Stitch room	0	0	0	0	0	0
comment unit	0	0	0	0	0	0
orthopedic	1	50	0	0	1	16.7
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	0	0	0	0
Total	2	100	4	100	6	100

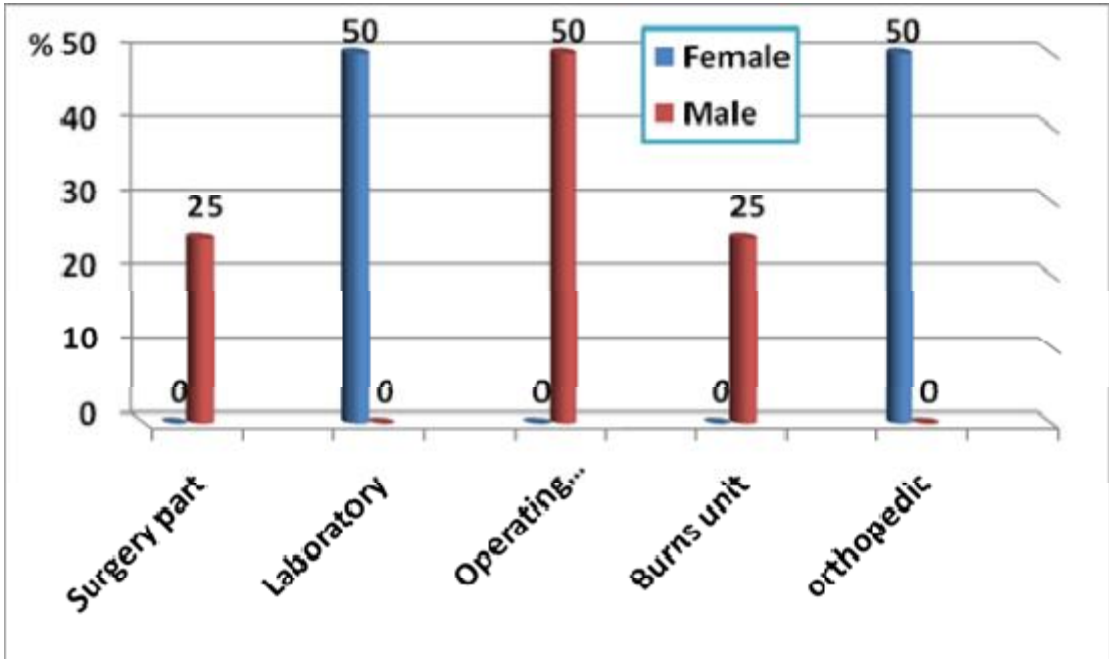


Figure (37) :Distribution of *Enterobacter* spp that were found on mobile phones of female and male in all department .

4.13:Distribution of *Klebsiella pneumonia* that were found on mobile phones of female and male in all department.

Table (12) showed that the most isolates of *Klebsiella pneumonia* was observed among males reach to (28.6%) in surgery part and OT, followed by burns unit, orthopedic and Physical therapy department (14.3%). Among female frequency was observed was in burns unit, comment unit, orthopedic and dental clinics (25%). The remains department was free from *Klebsiella pneumonia* in stitch room, Intensive care unit and laboratory (Fig 38) .

4.14:Distribution of *Acinetobacter paumannii* that were found on mobile phones of female and male in all department.

Table (13) showed that the frequency of *Acinetobacter paumannii* in all department .The contamination of this bacteria was observed among male in orthopedic reach to (28.5%), followed by surgery part, laboratory , comment unit , stitch room and Physical therapy department (14.3%) . However highest percentage among females was observed in laboratory reach to (33.2%), followed by surgery part, burnsunit ,orthopedic , comment unit (16.7%) . The remains department was free from

Acinetobacter paumannii in Intensive care unit , Operating theatres and dental clinics (Fig 39) .

Table 12: Distribution of *Klebsiella pneumonia* that were found on mobile phones of female and male in all department.

Department	<i>Klebsiella pneumonia</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	0	0	2	28.6	2	18.2
Laboratory	0	0	0	0	0	0
Intensive care unit	0	0	0	0	0	0
Operating theatres	0	0	2	28.6	2	18.2
Burns unit	1	25	1	14.3	2	18.2
Stitch room	0	0	0	0	0	0
comment unit	1	25	0	0	1	9.1
orthopedic	1	25	1	14.3	2	18.2
Dental Clinics	1	25	0	0	1	9.1
Physical therapy department	0	0	1	14.3	1	9.1
Total	4	100	7	100	11	100

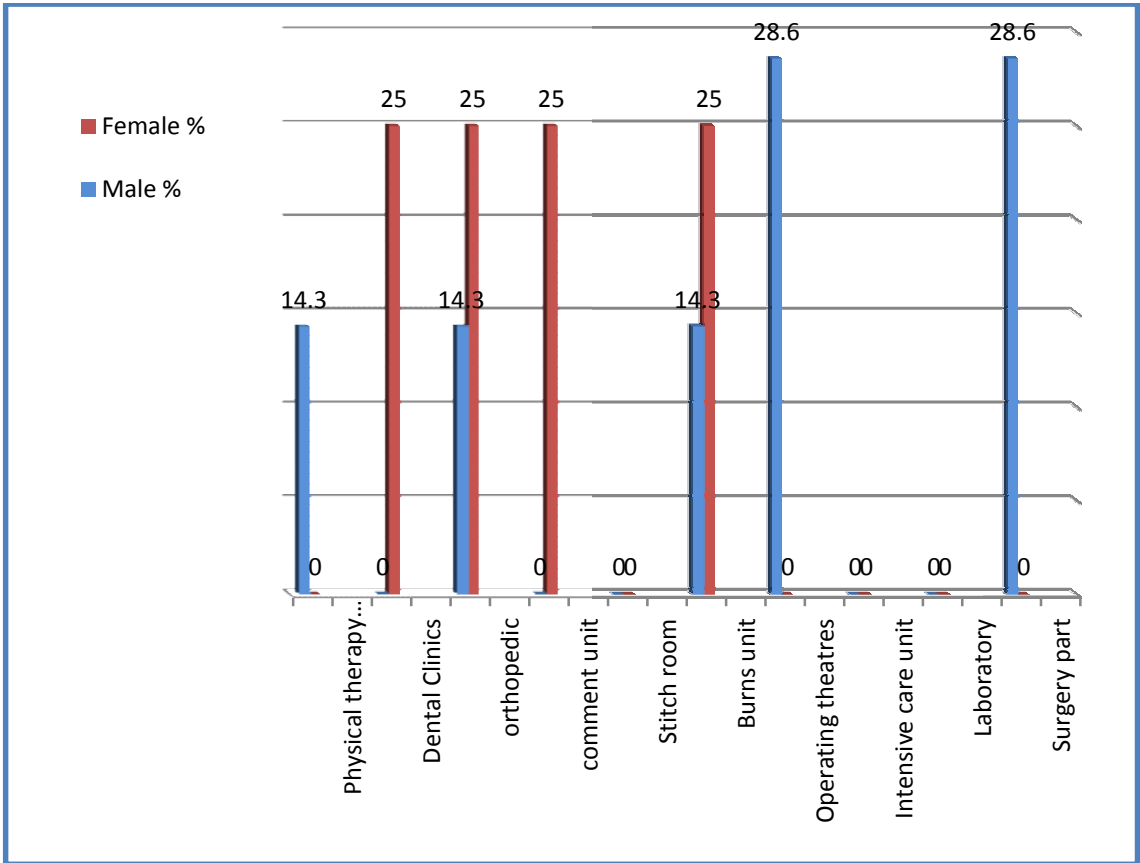


Figure (38) :Distribution of *Klebsiella pneumoniae* that were found on mobile phones of female and male in all department.

Table 13: Distribution of *Acinetobacter paumannii* that were found on mobile phones of female and male in all department.

Department	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	1	16.7	1	14.3	2	15.4
Laboratory	2	33.2	1	14.3	3	23.1
Intensive care unit	0	0	0	0	0	0
Operating theatres	0	0	0	0	0	0
Burns unit	1	16.7	0	0	1	7.7
Stitch room	0	0	1	14.3	1	7.7
comment unit	1	16.7	1	14.3	2	15.4
orthopedic	1	16.7	2	28.5	3	23.1
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	14.3	1	7.7
Total	6	100	7	100	13	100

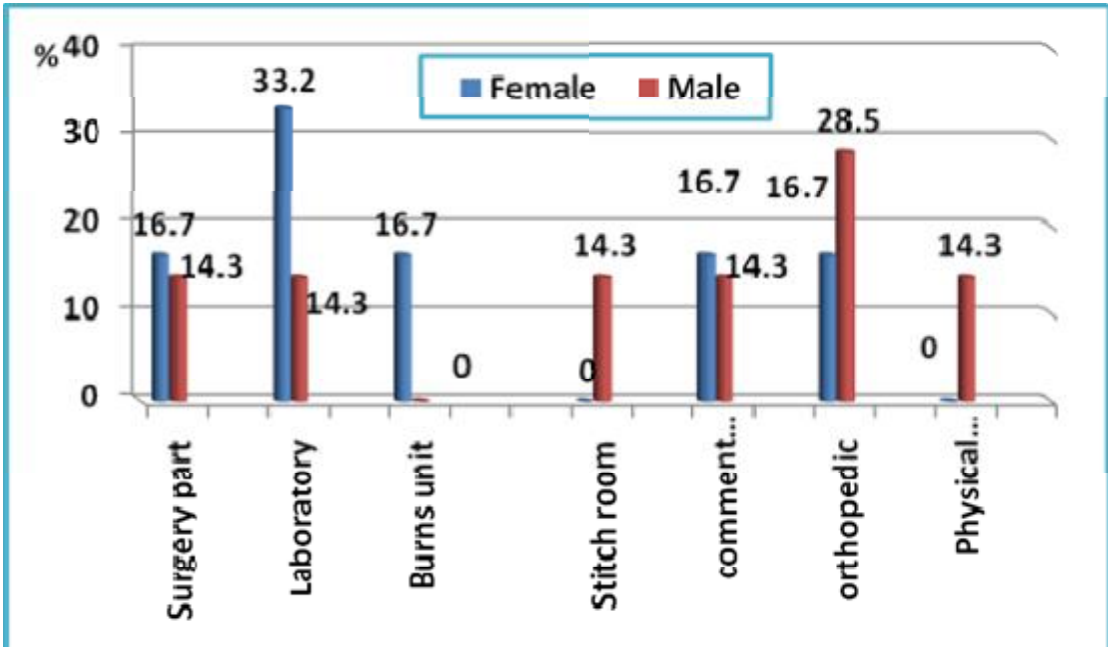


Figure (39) :Distribution of *Acinetobacter paumannii* that were found on mobile phones of female and male in all department.

4.15: Distribution of *Proteus mirabilis* that were found on mobile phones of female and male in all department

Table (14) showed the frequency of *Proteus mirabilis* in all department. The contamination of *Proteus mirabilis* was observed among females in orthopedic (40%), followed by surgery part, burns unit and ICU (20%). Among males all departments was free from this bacteria except Physical therapy department (100%) (Fig 40) .

4.16: Distribution of *Pseudomonas aeruginosa* that were found on mobile phones of female and male in all department

Table (15) showed the distribution of *Pseudomonas* in all departments .The high level of this bacteria in burns unit were bacterial contamination was equal in percentage of both male and female reach to (37.5%) , followed by surgery part and comment unit (25%). Lower frequency was observed among OT (12.5%) . The percentage was observed among males in ICU, comment unit, OT, Stitch room and orthopedic reach to (12.5%) (Fig 41) .

Table 14: Distribution of *Proteus mirabilis* that were found on mobile phones of female and male in all department

Department	<i>Proteus mirabilis</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	1	20	0	0	1	16.7
Laboratory	0	0	0	0	0	0
Intensive care unit	1	20	0	0	1	16.7
Operating theatres	0	0	0	0	0	0
Burns unit	1	20	0	0	1	16.7
Stitch room	0	0	0	0	0	0
comment unit	0	0	0	0	0	0
orthopedic	2	40	0	0	2	33.2
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	1	100	1	16.7
Total	5	100	1	100	6	100

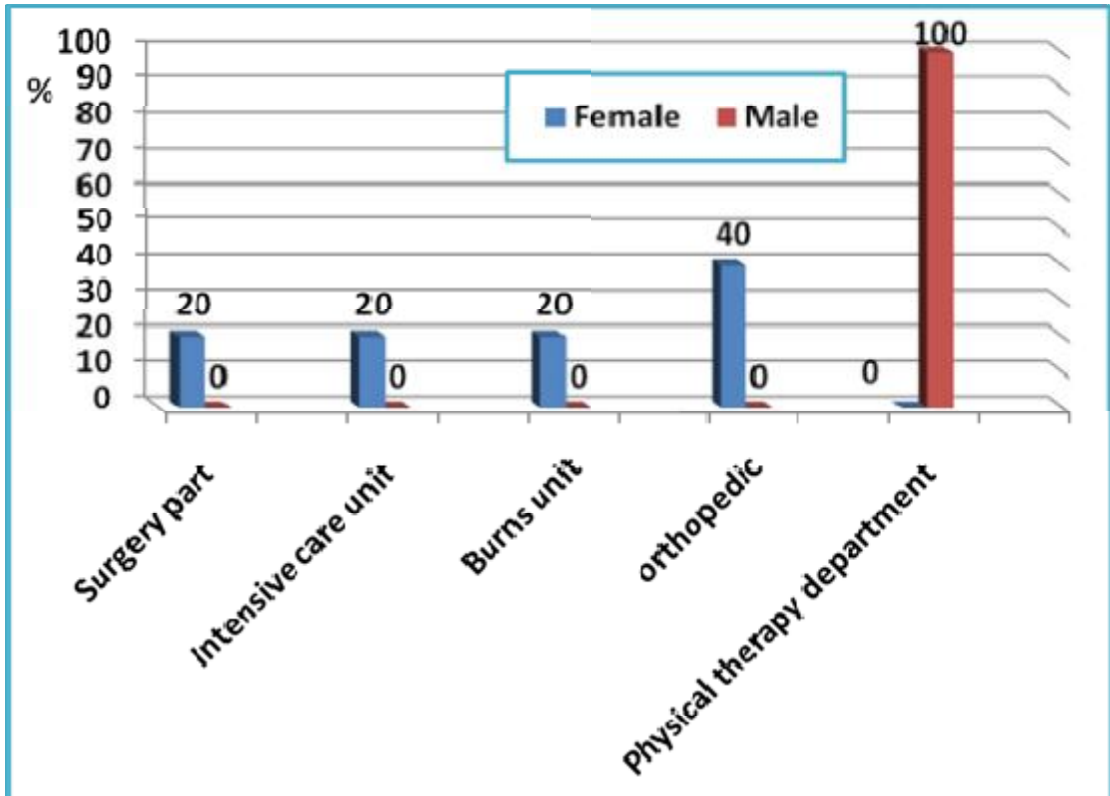


Figure (40) :Distribution of *Proteus mirabilis* that were found on mobile phones of female and male in all department .

Table 15: Distribution of *Pseudomonas aeruginosa* that were found on mobile phones of female and male in all department .

Department	<i>Pseudomonas aeruginosa</i>					
	Sex					
	Female		Male		Total	
	No.	%	No.	%	No.	%
Surgery part	2	25	0	0	2	12.5
Laboratory	0	0	0	0	0	0
Intensive care unit	0	0	1	12.5	1	6.3
Operating theatres	1	12.5	1	12.5	2	12.5
Burns unit	3	37.5	3	37.5	6	37.4
Stitch room	0	0	1	12.5	1	6.3
comment unit	2	25	1	12.5	3	18.7
Orthopedic	0	0	1	12.5	1	6.3
Dental Clinics	0	0	0	0	0	0
Physical therapy department	0	0	0	0	0	0
Total	8	100	8	100	16	

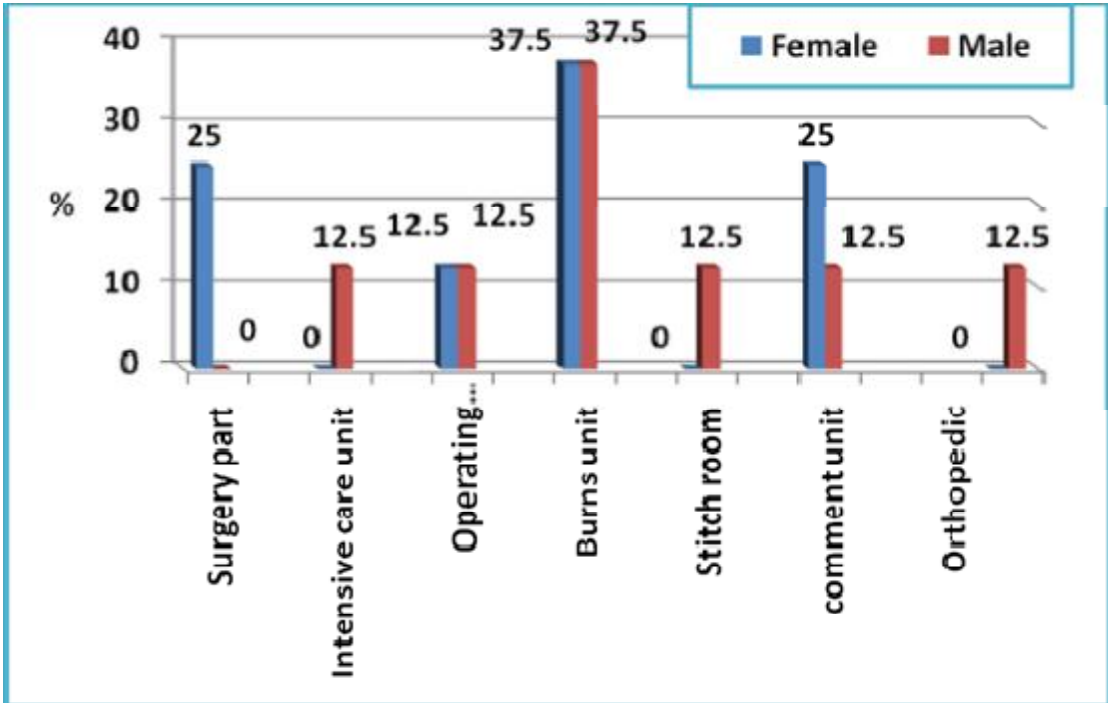


Figure (41):Distribution of *Pseudomonas spp* that were found on mobile phones of female and male in all department .

4.17: Distribution of types of microorganisms isolated from mobile phones of HCWs in all department in hospital.

Table (16) showed the isolated bacteria from mobile phone in all department . High frequency of *S.aureus* was observed in burns unit and comment unit (16.6%), followed by ICU, OT, surgery, orthopedic and Stitch room (12.5%), followed by (4.3%) in Physical therapy . *MRSA* was observed in both ICU and OT (21.1%), followed by burns unit and comment unit (15.7%), in orthopedic , physical therapy(10.5%) . Lower frequency was observed among surgery (5.4%) .

S. capitis was found in all department except in dental clinic. The frequency of this bacteria reach to (22.2%) in burns unit, followed by comment unit (16.6%) , in ICU, OT, surgery and orthopedic (11.1%) , in physical therapy, Stitch room and lap (5.6%).*S. heamoliticus* was observed in surgery(30%) , followed by orthopedic (20%), in comment unit (15%) . Similar percentage was observed in Stitch room , ICU (10%) . The lowest frequency was in , burns unit ,OT and physical therapy (5%) . This study showed that *Streptococcus spp* was observed in ICU and Stitch room (25%), followed by in burns unit, OT, surgery and comment

unit (12.5%) . High percentage of *Bacillus spp* was observed in surgery and ICU (16.7%). In OT, comment unit and orthopedic reach to (13.3%) ,followed by burns unit (10%) , in Stitch room and physical therapy (6.7%) . Lower frequency was observed among Dental Clinics was (3.3%) . *Escherichia coli* reach to (28.6%) in OT ,followed by ICU , surgery and comment unit (14.2%) , in orthopedic , Stitch room, physical therapy and burns unit (7.2%). The most isolated bacteria in OT department was *Enterobacter spp* reach to (33.2%) , followed by burns unit , surgery , lap and orthopedic (16.7%) . *Klebsiella pneumonia* was observed in burns unit , surgery, OT and orthopedic (18.1%), followed by physical therapy, Dental Clinics and comment unit (9.2%) . *Acinetobacter paumannii* was found in lap and orthopedic (23.1%), followed by surgery and comment unit (15.3%) . However (7.7%) was found in burns unit ,Stitch room and physical therapy . The higher bacterial percentage was found in burns unit with *Pseudomonas spp* (37.6%) , followed by comment unit (18.8%) , OT and surgery (12.5%) . However in ICU , orthopedic and Stitch room the frequency was (6.2%) . *Proteus mirabilis* was observed in orthopedic (33.2%) , followed by burns unit , ICU , surgery and physical therapy department (16.7%).

Table (16) : Types of microorganisms isolated from mobile phones of HCWs in all department in hospital

Bacterial agents	Burns unit	ICU	OT	Surgery	Lab	Dental Clinics	comment unit	orthopedic	Physical therapy	Stitch room
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
<i>S.aureus</i>	4 16.6	3 12.5	3 12.5	3 12.5	0 0	0 0	4 16.6	3 12.5	1 4.3	3 12.5
<i>MRSA</i>	3 15.7	4 21.1	4 21.1	1 5.4	0 0	0 0	3 15.7	2 10.5	2 10.5	0 0
<i>S. capitis</i>	4 22.2	2 11.1	2 11.1	2 11.1	1 5.6	0 0	3 16.6	2 11.1	1 5.6	1 5.6
<i>S. heamolyticus</i>	1 5	2 10	1 5	6 30	0 0	0 0	3 15	4 20	1 5	2 10
<i>Streptococcus spp</i>	1 12.5	2 25	1 12.5	1 12.5	0 0	0 0	1 12.5	0 0	0 0	2 25
<i>Bacillus spp</i>	3 10	5 16.7	4 13.3	5 16.7	0 0	1 3.3	4 13.3	4 13.3	2 6.7	2 6.7
<i>Escherichia coli</i>	1 7.2	2 14.2	4 28.6	2 14.2	0 0	0 0	2 14.2	1 7.2	1 7.2	1 7.2
<i>Enterobacter spp</i>	1 16.7	0 0	2 33.2	1 16.7	1 16.7	0 0	0 0	1 16.7	0 0	0 0
<i>Klebsiella pneumonia</i>	2 18.1	0 0	2 18.1	2 18.1	0 0	1 9.2	1 9.2	2 18.1	1 9.2	0 0
<i>Acinetobacter paumannii</i>	1 7.7	0 0	0 0	2 15.3	3 23.1	0 0	2 15.3	3 23.1	1 7.7	1 7.7
<i>Pseudomonas spp</i>	6 37.6	1 6.2	2 12.5	2 12.5	0 0	0 0	3 18.8	1 6.2	0 0	1 6.2
<i>Proteus mirsbilis</i>	1 16.7	1 16.7	0 0	1 16.7	0 0	0 0	0 0	2 33.2	1 16.7	0 0

4.18: Distribution of bacterial contamination from mobile phones between different departments in hospital.

Table (17) showed the distribution of high level bacterial contamination between different department. The high frequency between departments was observed in burns unit and surgery part. In burns unit the most bacteria was *Pseudomonas spp* reach to (21.3%) followed by *S.aureus* and *S. capitis* (14.3%) , *MRSA* and *Bacillus spp* (10.7%) , *Klebsiella pneumonia*(7.1%) . The lowest percentage was *S. heamolyticus* , *Streptococcus spp* , *Escherichia coli* , *Enterobacter spp* , *Acinetobacter paumannii* and *Proteus mirsbilis* (3.6%), while in surgery part the high percentage was observed by *S. heamolyticus* (21.3%), followed by *Bacillus spp* (17.9%), *S.aureus* (10.7%), *S. capitis*, *Escherichia coli*, *Acinetobacter paumannii*, *Klebsiella pneumonia* and *Pseudomonas spp* (7.1%) . The lower percentage was observed by *MRSA* , *Streptococcus spp* , *Enterobacter spp* and *Proteus mirabilis* (3.6%) . Followed by in comment unit were the high frequency was observed by *S.aureus* and *Bacillus spp* (15.4%) , followed by *MRSA* , *S. capitis* , *S. heamolyticus* and *Pseudomonas spp* (11.5%) , *Escherichia coli* and *Acinetobacter paumannii* (7.7%), *Streptococcus spp* and *Klebsiella pneumonia* (3.9%).

Similarly frequency was found in OT and orthopedic , in OT the most bacteria was *MRSA*,*Escherichia coli* and *Bacillus spp* (16%) , followed by *S.aureus* (12%) ,*Klebsiella pneumonia* , *S. capitis* ,*Enterobacter spp* and *Pseudomonas spp* (8%) . Exhibit the lowest frequency *Streptococcus spp* and *S. heamolyticus* reach to (4%) . However the highest percentage in orthopedic was observed by *S. heamolyticus* and *Bacillus spp* (16%), followed by *S.aureus* and *Acinetobacter paumannii*(12%),*MRSA*,*Klebsiella pneumonia*, *S. capitis* and *Proteus mirsbilis* (8%),*Escherichia coli*, *Enterobacter spp* and *Pseudomonas spp* (4%). Among ICU the highest frequency was found by *Bacillus spp* (22.7%) , followed by *MRSA* (18.2%) , *S.aureus* (13.7%) , *S.capitis*,*Streptococcus spp*, *Escherichia coli* and *S. heamolyticus*(9.1%) , *Pseudomonas spp* and *Proteus mirsbilis* (4.5%) . However in Stitich room the higher percentage was observed by *S.aureus* (23%), followed by *Streptococcus spp*, *Bacillus spp* and *S. heamolyticus* (15.4%),*S. capitis*,*Escherichia coli*,*Acinetobacter paumannii* and *Pseudomonas spp* (7.7%). In Physical therapy department the highest percentage was observed by *MRSA* , *Bacillus spp* (18.1%) , followed by *S.aureus* , *S. heamolyticus*, *S. capitis*,*Escherichia coli* , *Klebsiella pneumonia* and *Proteus mirsbilis* (9.1%) . The high level of

contamination in laboratory was observed by *Acinetobacter paumannii* (60%), followed by *S. capitis* and *Enterobacter spp* (20%) . Finally the lower bacterial contamination was observed in Dental Clinics were found *Bacillus spp* (50%)and *Klebsiella pneumonia* (50%)(Fig42) .

Table (17): Distribution of bacterial contamination from mobile phones between different departments in hospital

Bacterial agents	Burns unit	ICU	OT	Surgery	Lab	Dental Clinics	comment unit	orthopedic	Physical therapy	Stitch room
	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
<i>S.aureus</i>	4 14.3	3 13.7	3 12	3 10.7	0 0	0 0	4 15.4	3 12	1 9.1	3 23
<i>MRSA</i>	3 10.7	4 18.2	4 16	1 3.6	0 0	0 0	3 11.5	2 8	2 18.1	0 0
<i>S. capitis</i>	4 14.3	2 9.1	2 8	2 7.1	1 20	0 0	3 11.5	2 8	1 9.1	1 7.7
<i>S. heamolyticus</i>	1 3.6	2 9.1	1 4	6 21.5	0 0	0 0	3 11.5	4 16	1 9.1	2 15.4
<i>Streptococcus spp</i>	1 3.6	2 9.1	1 4	1 3.6	0 0	0 0	1 3.9	0 0	0 0	2 15.4
<i>Bacillus spp</i>	3 10.7	5 22.7	4 16	5 17.9	0 0	1 50	4 15.4	4 16	2 18.2	2 15.4
<i>Escherichia coli</i>	1 3.6	2 9.1	4 16	2 7.1	0 0	0 0	2 7.7	1 4	1 9.1	1 7.7
<i>Enterobacter spp</i>	1 3.6	0 0	2 8	1 3.6	1 20	0 0	0 0	1 4	0 0	0 0
<i>Klebsiella pneumonia</i>	2 7.1	0 0	2 8	2 7.1	0 0	1 50	1 3.9	2 8	1 9.1	0 0
<i>Acinetobacter paumannii</i>	1 3.6	0 0	0 0	2 7.1	3 60	0 0	2 7.7	3 12	1 9.1	1 7.7
<i>Pseudomonas spp</i>	6 21.3	1 4.5	2 8	2 7.1	0 0	0 0	3 11.5	1 4	0 0	1 7.7
<i>Proteus mirsbilis</i>	1 3.6	1 4.5	0 0	1 3.6	0 0	0 0	0 0	2 8	1 9.1	0 0
Total	28 (100)	22 (100)	25 (100)	28 (100)	5 (100)	2 (100)	26 (100)	25 (100)	11 (100)	13 (100)

4.19: Distribution of Bacterial Growth from mobile phones of different health care workers .

Table (17) showed the distribution of Bacterial Growth from mobile phones of different health care workers. The high level of *S.aureus* was observed among nurse's reach to (16.8%), followed by Other health care works (13%). The lowest percentage was observed among doctor's (8.2%) . The contamination of *MRSA* was (15.2%) found among other health care works and (11.5%) among nurse's. In contrast among doctor's reach to (4.9%) . The frequency of *S. capitis* reach to (10.9%) among OHCWs, followed by doctor's (9.8%). However the lower frequency in nurse's (9%). The equal percentage of *S. heamolyticus* was observed among doctor's and nurse's (11.5%) . However the lower frequency was (8.7%) found among OHCWs .

High level frequency of *Streptococcus spp.* was observed doctor's reach to (6.6%), followed by OHCWs (4.4%). The highest percentage was observed nurse's (2.6%) . The high level of contamination of *Bacillus Spp.* Was found doctor's (21.3%). In contrast among nurse's was (14.1%) , followed by OHCWs (13%). *Escherichia coli* was (9%) observed among nurse's, followed by doctor's (6.6%) . The lower percent was found

OHCWs (6.5 %). The frequency of *Enterobacter Spp.* Was observed OHCWs (6.5%), followed by doctor's (3.3%) . However lower percent was found nurse's (1.2%). *Klebsiella pneumonia* high percent was found among doctor's (8.2%) , However this bacteria was (5.1%)Among nurse's and (4.4%) among OHCWs . In contrast *Acinetobacter paumannii*was found more amongOHCWs (10.9%) than among nurse's (6.4%), followed by doctor's (4.8%) . High percentage of *Proteus mirabilis* was (3.8%)observed among nurse's , followed by doctor's (3.3%) . lowest frequency was (2.1%) among OHCWs. Finally *Pseudomonas Spp.* Was found among doctor's (11.7%) , followed by among nurse's (9%) . While among OHCWs was (4.4%) (Fig 43).

Table 18: Distribution of Bacterial Growth from mobile phones of different health care workers .

Type of bacteria	Different health care workers					
	Doctor's		Nurse's		Other health care works	
	No	%	No	%	No	%
<i>S.aureus</i>	5	8.2	13	16.8	6	13
<i>MRSA</i>	3	4.9	9	11.5	7	15.2
<i>S. capitis</i>	6	9.8	7	9	5	10.9
<i>S. heamolyticus</i>	7	11.5	9	11.5	4	8.7
<i>Streptococcus spp</i>	4	6.6	2	2.6	2	4.4
<i>Bacillus spp</i>	13	21.3	11	14.1	6	13
<i>Escherichia coli</i>	4	6.6	7	9	3	6.5
<i>Enterobacter spp</i>	2	3.3	1	1.2	3	6.5
<i>Klebsiella pneumonia</i>	5	8.2	4	5.1	2	4.4
<i>Acinetobacter paumannii</i>	3	4.8	5	6.4	5	10.9
<i>Proteus mirabilis</i>	2	3.3	3	3.8	1	2.1
<i>Pseudomonas spp</i>	7	11.5	7	9	2	4.4
<i>Total</i>	61	100	78	100	46	100

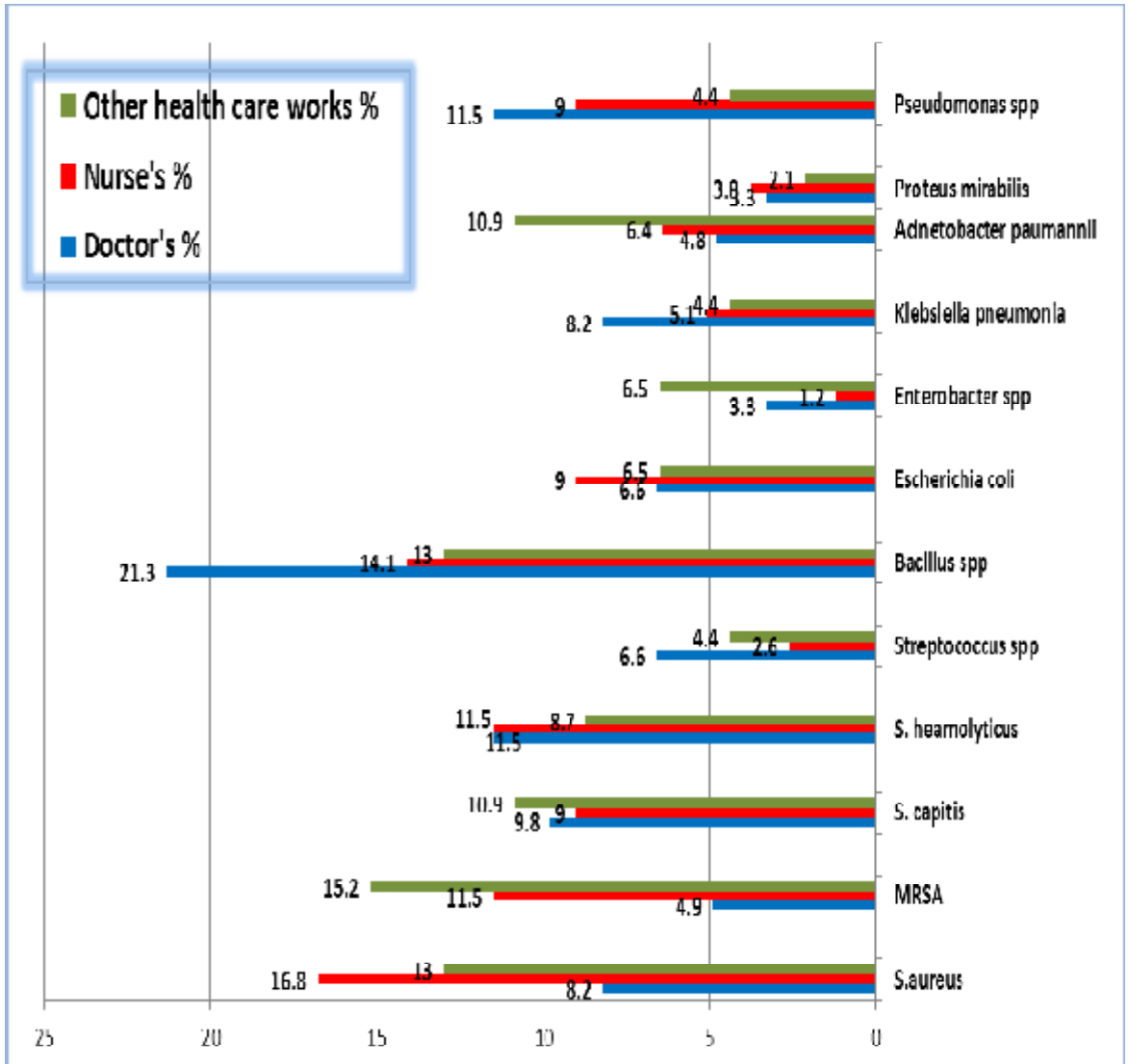


Figure (43):Distribution of Bacterial Growth from mobile phones of different health care workers

4.20:Distribution of sensitivity antibiotic of Gram positive bacteria

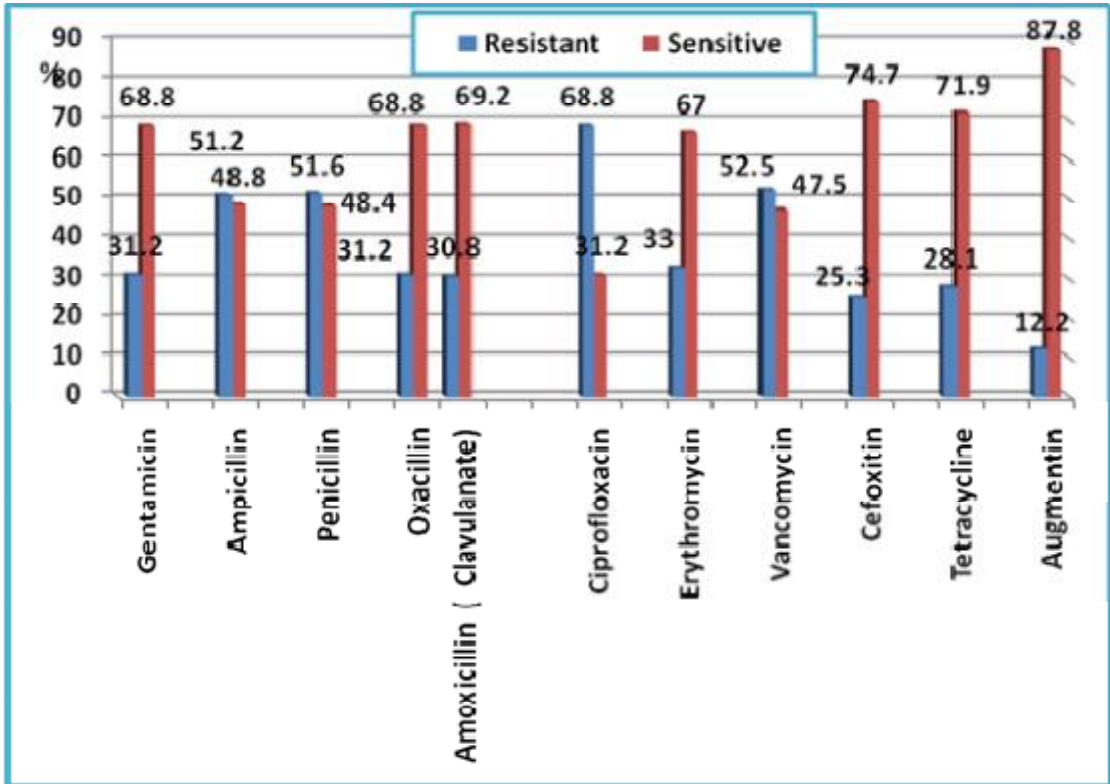
Table (19) showed the antibiotic sensitivity of bacterial Gram positive from mobile phone .The resistant of Gram positive bacteria to Ciprofloxacin was (68.8%) ,followed by Vancomycin (52.5%) , Penicillin (51.6%) ,Ampicillin (51.2%) and Erythromycin (33%) . Similar percentage was observed by Gentamicin (31.2 %), Oxacillin (31.2 %), Amoxicillin-Clavulanate (30.8%), Tetracycline (28.1%), Cefoxitin (25.3%) and Augmentin (12.2%) (Fig 44) .

4.21:Distribution of sensitivity antibiotic of gram negative bacteria

Table (20) showed the antibiotic sensitivity of bacterial Gram negative from mobile phone . The resistant of Gram negative bacteria to Amoxicillin- Clavulanate was (60%) , followed by Nitrofurantoin (58.6%), Ampicillin (48.5%), Cephalothin (45.8%) ,Cefuroxime (41.4%) , Ertapenem (32.9%) , Cefoxitin (30%) and Amikacin (25.7%) . Similar percentage was observed by Gentamicin and meropenem (22.9%) , Ciprofloxacin (21.4 %) and Piperacillin-Tazobactam (20%)(Fig 45) .

Table (19) : Sensitivity tests antibiotic of Gram positive bacteria

Antibiotic	Resistant		Sensitive	
	Number	Percent	Number	Percent
Gentamicin	69	31.2%	152	68.8%
Ampicillin	113	51.2%	108	48.8%
Penicillin	114	51.6%	107	48.4%
Oxacillin	69	31.2%	152	68.8%
Amoxicillin Clavulanate	68	30.8%	153	69.2%
Ciprofloxacin	152	68.8%	69	31.2%
Erythromycin	73	33%	148	67%
Vancomycin	116	52.5%	105	47.5%
Cefoxitin	56	25.3%	165	74.7%
Tetracycline	62	28.1%	159	71.9%
Augmentin	27	12.2%	194	87.8%



Figure(44): Distribution of sample according to sensitivity tests of gram positive bacteria of antibiotic .

Table (20) :Sensitivity tests antibiotic of Gram negative bacteria

Antibiotic	Resistant		Sensitive	
	Number	Percent	Number	Percent
Gentamicin	16	22.9%	54	77.1%
Ampicillin	34	48.5%	36	51.5%
Ertapenem	23	32.9%	47	67.1%
Amikacin	18	25.7%	52	74.3%
Meropenem	16	22.9 %	54	77.1%
Cefuroxime	29	41.4%	41	58.6%
Cefoxitin	21	30%	49	70%
Amoxicillin Clavulanate	42	60%	28	40%
Piperacillin Tazobactam	14	20%	56	80%
Ciprofloxacin	15	21.4%	55	78.6%
Nitrofurantoin	41	58.6%	29	41.4%
Cephalothin	32	45.8%	38	54.2%

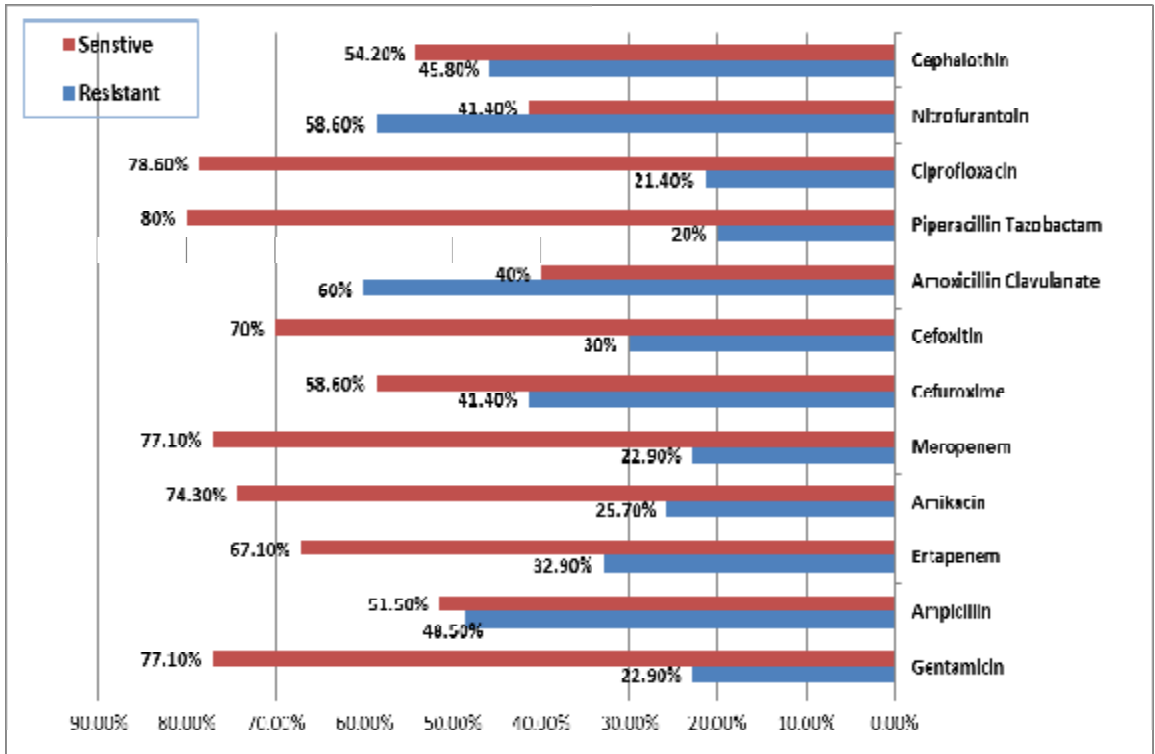


Figure (45) : Distribution of sample according to sensitivity tests of gram negative bacteriaof antibiotic .

CHAPTER FIVE

5. Discussion

The microbes that cause hospital infections , including bacteria , viruses and fungi can survive on inanimate surfaces (earpiece , fixed phones , computers , clock Wrist, pens and mobile phones) for months and as these tools are not subject to cleaning and disinfection routine in place in hospitals so they transmitted microbes to sensitive patients the most Susceptible to infection Chawla *et al.*, (2009) . These tools are used close to the patients which is banned from use in more places critical , such as operating rooms and intensive care, in this study HCWs were asked about the samples taken of them cleaning their mobile phones and the answer was unanimous not to clean up their mobile phones . Also this study showed high contamination rate with bacteria in Benghazi hospital .

The total of 155 sampled evaluated , the growth was observed in the most of samples , 150 sample showed growth among females 75 (94.9%) and males 75(98.7%) of mobile phone tested . Similar results was reported by Sichani and Vajihek , (2011) who found that the isolated bacteria were about 94% of mobile phone of (HCWs).Also this study showed that the number of samples in females and males, contain multiple organisms. One

type isolates was found among females reach to (41.3%) and lower percent was observed among males reach to (29.3%) .However two type isolates was (40%) among females and (36%) among males . In contrast three or more type isolates was more among male (34.7%) than among females (18.7%). Similar results was reported by Goel and Goel,(2009)who showed one type of microorganism was (54%), two type was (35%) and three or more types was (11%) . The male were comparatively more contamination , it might be due to the reason that female often keep their phones in purses and use less frequently during their mobile phones in their duties. On the other hand male keeps their mobile phone in their pockets and used frequently anywhere any time whenever it is needed and thus contaminated and played an important role in transmission of pathogens.

The present study showed that most of the bacterial isolates were *S.epidermidis*(21.7%), followed by *Bacillus spp* (10.3%), *S.aureus* (8.2%),*S.heamolyticus* (6.9%),*Methicillin resistant Staphylococcus aureus* (MRSA) (6.5 %) ,*S. capitis* (6.2%) ,*Pseudomonas spp.* (5.5%) ,*Escherichia coli* (4.8%) ,*Acinetobacter paumannii* (4.5%) ,*Klebsiella pneumonia*(3.8%) ,*Staphylococcus spp.* (3.8%) , *Streptococcus spp* (2.8%

) , *Bacillus subtilis* (2.4%) , *S.hominis* (2.1%) ,*Enterobacter spp* (2.1%) , *S.saprophyticus* (2.1%),*Proteus mirabilis* (2.1%),*Micrococcus spp.* (1%) , *Macrococcus caseolyticus*(1%),*Pantoea agglomerans*(1%) , *Enterococcus casseliflavus* (0.3%) , *Dermacoccus nishinomiyaensis*(0.3%), *Lenconostoc mesentero*(0.3%) and *Alealigenes faecalis*(0.3%).The observations of the present study coincide with the findings of Amadi *et al.*, (2013) ; Tagoe *et al.* , (2011) whe found that the mobile phones of health care workers revealed high levels of bacterial contamination , such as *S. aureus*, *E. coli*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Klebsiella aerogenes* and *Proteus mirabilis*. However coagulase-negative *Staphylococcus*, *S. epidermidis* were also isolated.Thus results of the present study reveals many microbial isolates from the mobile phones of HCWs indicating that isolates of the present study can also lead to spread of nosocomial infection.

The present study showed that high contamination of *S. aureus* were found on mobile phones of females and males in all departments of hospital . This study showed that bacteria was observed in males more than in females . Among males *S. aureus* reach to (18.7%) in surgery part , ICU and stitch room ,followed by OT and burns unit (12.5%) ,

comment unit , orthopedic and physical therapy department (6.3%) . However among the females the high percentage was observed in comment unit (37.5%) , followed by burns unit and orthopedic (25%) , OT (12.5%) . Similar results was reported by Inweregbu *et al.*, (2005) how found that *S. aureus* is the most common Gram positive bacteria involved in nosocomial infections and is therefore of great concern .

This study showed that the contamination of MRSA was observed among the males in ICU (21.1%) , followed by OT (15.7%) , comment unit , orthopedic and Physical therapy department (10.5%) .The lowest percentage was observed in surgery part and burns unit (5.3%) . In Contrast to females MRSA found only in Burns unit (10.5%) , followed by OT and comment unit (5.3%) .Similar results was observed by Gunasekara *et al.*, (2009), they reported that the contaminated was with human pathogenic bacteria mainly MRSA which accounted for 15% of mobile phone contaminating organisms. Also Bhat *et al.* , (2011) found that Metihcillin-resistant *Staphylococcus aureus* is one of the most frequently isolated bacteria in hospital infections. Thus mobile phones were infected by several microbes, most of which belonged to the natural flora of the human body. This means it is necessary to carryout hygiene

practices after contact with phone since it is a source of disease transmission.

In this study the contamination of *S.capitis*, among females the highest percentage in surgery part ,OT, burns unit and comment unit (11.1%) , followed by ICU (5.6%) . However the highest percentage of *S.capitis* among males in burns unit and orthopedic reach to (11.1%) , followed by Physical therapy department, comment unit , laboratory , Stitch room and ICU (5.6%) .

The present study showed the high level of contamination of *S.heamolyticus* was observed among females in surgery part (40%) , followed by in orthopedic and comment unit (20%) . The lowest frequency was observed in stitch room and ICU (10%) ,while the rate among males was highest in surgery part and orthopedic (20%) , followed by ICU, OT , burns unit , stitch room , comment unit and Physical therapy department (10%).Similar results was observed by Annand *et al.*, (2009), who reported that the most public telephones in the large urban USA University contained bacteria commonly found such as *S. haemolyticus* .

This study showed, the high level of contamination of *Streptococcus spp.*, was observed among the males in ICU (40%) ,followed by OT , comment unit and burns unit (20%) ,while among females the high frequency of *Streptococcus spp.* in Stitch room (66.7%) , followed by in surgery part (33.3%) . The laboratory was free from *Streptococcus spp* during this study. In contrast results was observed by Roy *et al.*, (2013)reported the highest prevalence of *Streptococcus spp.* was observed in laboratory attendants mobile phones reach to (64%) .

This study showed the frequency of *Bacillus spp.* was observed among males in surgery part (18.7 %) , followed by ICU , OT , stitch room , orthopedic and physical therapy department (12.5%) . The lower percentage was observed in burns unit, comment unit and dental clinical (6.3%) . The high contamination of *Bacillus spp* was observed among females in ICU and comment unit (21.4 %) , followed by surgery part , OT , orthopedic , burns unit (14.3%). Similar results was observed by llusanya *et al* .,(2012), who found the rate of contamination of *Bacillus spp.* on the mobile phone reach to (30%) . The *Bacillus spp.* giving it greater colonization ability as well as the ability of its spores to resist

environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods.

This study showed that *Escherichia coli* were found on mobile phones of females and males in hospital. The high level of contamination was observed among male in OT reach to (33.3%) ,followed by comment unit (22.2%) , surgery part , ICU , orthopedic and in Physical therapy department (11.1%) . However the contamination was observed among females reach to (20 %) in surgery part , ICU , OT , burns unit and stitch room. The observations of the present study coincide with the findings of Amadi *et al.*, (2013), who found the frequency of *E. coli* isolates collected from MPs was 14% each for nurses and doctors,medical students,physiotherapists . Presence of *E. coli* signifies fecal contamination of hands through bed pans or poor personal hygiene, this stresses the need for better sanitary measures amongst medical personnel reported byGaynes and Edward(2005) .

This study showed, the high frequency of *Enterobacter spp.*was observed among males in OT reach to (50 %) , followed by burns unit and surgery part (25%) . The high contamination of *Enterobacter spp* among females

in laboratory and orthopedic (50%) . Similar results was observed by,Marthi *et al.*, (1990). They reported that the *Enterobacter spp.* was found in hospital to be greatest in high relative humidity and low temperature .Given the high humidity and cool conditions inside the hospital, pathogenic agents isolated from health personnel are therefore likely to persist in the environment for long periods of time .

The present study demonstrated that, the most isolates of *Klebsiella pneumoniae* was observed among males reach to (28.6%) in surgery part and OT , followed by burns unit , orthopedic and Physical therapy department (14.3%) . Among female frequency was observed was in burns unit , comment unit , orthopedic and dental clinics (25%).In contrast results was observed by Jaya *et al.*, (2011),whoreported that frequency of pathogenic bacterial isolates were *Klebsiella pneumoniae* reach to (3.5%) .

The contamination of *Acinetobacter paumannii* was observed among male in orthopedic reach to (28.5%) ,followed by surgery part , laboratory , comment unit , stitch room and Physical therapy department (14.3%) . However highest percentage among females was observed in

laboratory reach to (33.2%) , followed by surgery part , burns unit ,orthopedic , comment unit (16.7%) . In contrast results was observed by Neely *et al.*,(1999),who found that the one of most isolated was *A. baumannii* on dry surface as a reservoir in burn units and ICU and causing nosocomial infection diseases .Depending on environmental conditions, pathogens may remain infectious on surfaces for weeks after being contaminated. In humid conditions, pathogens may actively colonize surfaces, transforming a passive reservoir into an active one.

The contamination of *Proteus mirabilis* was observed among females in orthopedic (40%) , followed by surgery part , burns unit and ICU (20%) . Among males all departments was free form this bacteria expect Physical therapy department (100%). Similar results was observed by , Tagoe *et al.*,(2011) who reported that *P. mirabilis* comprised 19% of bacterial isolates from 100 mobile phones randomly collected from University students in Ghana.

The present study showed that the high level of *Pseudomonas aeruginosa* in burns unit were bacterial contamination was equal in percentage of both male and female reach to (37.5%) , followed by surgery part and

comment unit (25%). Lower frequency was observed among OT (12.5%) . The percentage was observed among males inICU, comment unit , OT , Stitch room and orthopedic reach to (12.5%) . Similar results was observed by Todar (2004),who reported that *P. aeruginosa* has been reported in the United States by the Centre for Disease Control and Prevention to be the most isolated nosocomial pathogen accounting for 10.1% of all hospital acquired infections, and has been implicated in gastrointestinal infection, primarily in immunocompromised individuals. In general the greater the concentration of the microbe, the longer it survives and survival can range from minutes to months. This is a cause for concern since these pathogenic isolates are capable of causing diseases in anyone who gets contaminated whilst using the mobile phone.

The present study showed the presence of high level of bacterial contamination between different department . In burns unit the most bacteria was *Pseudomonas spp* followed by *S.aureus* , *S. capitis* , *MRSA*,*Bacillus spp*, *Klebsiella pneumonia*, *S.heamolyticus*, *Streptococcus spp* , *Escherichia coli*, *Enterobacter spp* , *Acinetobacter paumannii* and *Proteus mirsbilis* . Similar results was reported byIbraheemet al.,(2009),they founda high percentage of contaminated samples were

indicated in the burns ward . This may be due to patients themselves, or particles capable of being air borne and low hygiene and sanitation conditions in the ward . While in surgery part the high percentage was observed by *S. heamolyticus* , followed by *Bacillus spp* , *S.aureus* , *S. capitis*, *Escherichia coli*, *Acinetobacter paumannii* , *Klebsiella pneumonia* and *Pseudomonas spp* . The lower percentage was observed by *MRSA* , *Streptococcus spp* , *Enterobacter spp* and *Proteus mirabilis* . Followed by in comment unit were the high frequency was observed by *S.aureus* followed by *Bacillus spp.* , *MRSA* , *S. capitis* , *S. heamolyticus* , *Pseudomonas spp.* , *Escherichia coli* , *Acinetobacter paumannii*, *Streptococcus spp.* and *Klebsiella pneumonia* . If mobile phones are used carelessly in surgical words or ICU, they may act as a source of infection to patients while handling them. In OT the most bacteria was *MRSA*, *Escherichia coli*, *Bacillus spp* , *S.aureus*, *Klebsiella pneumonia* , *S. capitis* , *Enterobacter spp* and *Pseudomonas spp* . Exhibit the lowest frequency *Streptococcus spp* and *S. heamolyticus*. Similar results was reported by Janabi (2000) how Found that contamination rate in operating room and hospital ward were 42.6% and 62.8% respectively . However the highest percentage in orthopedic was observed by *S. heamolyticus*

followed by *Bacillus spp* , *S.aureus* , *Acinetobacter paumannii* , *MRSA* , *Klebsiella pneumonia* , *S. capitis* , *Proteus mirsbilis*, *Escherichia coli* , *Enterobacter spp* and *Pseudomonas spp* . Among ICU the highest frequency was found by *Bacillus spp* , followed by *MRSA*, *S.aureus* , *S. capitis* , *Streptococcus spp*, *Escherichia coli* , *S. heamolyticus* , *Pseudomonas spp* and *Proteus mirsbilis* . However in Stitich room the higher percentage was observed by *S.aureus* , followed by *Streptococcus spp*, *Bacillus spp* , *S. heamolyticus* , *S. capitis* , *Escherichia coli* , *Acinetobacter paumannii* and *Pseudomonas spp* . In Physical therapy department the highest percentage was observed by *MRSA* , *Bacillus spp* , *S.aureus* , *S. heamolyticus* , *S. capitis* , *Escherichia coli* , *Klebsiella pneumonia* , *Proteus mirsbilis* . The high level of contamination in laboratory was observed by *Acinetobacter paumannii* , followed by *S. capitis* , *Enterobacter spp* . Finally the lower bacterial contamination was observed in Dental Clinics were found *Bacillus spp* and *Klebsiella pneumonia* .

The present study showed the antibiotic sensitivity of bacteria Gram positive from mobile phone . All isolated were resistant to Ciprofloxacin , followed by Vancomycin , Penicillin , Ampicillin , Erythromycin

,Gentamicin , Oxacillin , Amoxicillin -Clavulanate , Tetracycline , Cefoxitin and Augmentin . In contrast by Sue *et al.*, (2013) who reported that antimicrobial sensitivity testing revealed that over 66% of the isolates were susceptible to Ciprofloxacin . However isolation of Methicillin-resistant *S. aureus* (MRSA) strains from the mobile phones of HCWs had been documented.

This study showed that the antibiotic sensitivity of bacteria Gram negative from mobile phone . The resistant of Gram negative bacteria to Amoxicillin- Clavulanate was , followed by Nitrofurantoin , Ampicillin , Cephalothin ,Cefuroxime , Ertapenem , Cefoxitin , Amikacin , Gentamicin ,meropenem , Ciprofloxacin and Piperacillin-Tazobactam . Similar results was reported by Roy *et al.*,(2013)how found that the highly resistant to Amoxycillin-Clavulonic , Amoxycillin, Ampicillin and Gentamicin.

These results were in coordination with other results reported by sue *et al.*,(2013) who considered that the contaminated bath equipment acts as a source of infection by bacteria and the cross infection due to failure of the

staff to disinfect their hands is probably the main route of spread of nosocomial infection.

Conclusion

This study showed the microbial contamination of HCWs' mobile phones, which some of the contaminated microorganisms in hospital in Benghazi such as *S. epidermidis* , *Bacillus spp* , *S. aureus* , *S. haemolyticus* , *Methicillin resistant Staphylococcus aureus (MRSA)* ,

S. capitis , *Pseudomonas spp* , *Escherichia coli* , *Acinetobacter paumannii* , *Klebsiella pneumonia* , *Staphylococcus spp* , *Streptococcus spp* , *Bacillus subtilis* , *S. hominis* , *Enterobacter spp* , *S.saprophyticus* , *Proteus mirabilis* , *Micrococcus spp* , *Macrococcus caseolyticus* *Pantoea agglomerans* , *Enterococcus casseliflavus* , *Dermacoccus nishinomiyaensis* , *Lenconostoc mesentero* and *Alealigenes faecalis* . Also some bacterial isolates were resistant to commonly used antimicrobials such as Ciprofloxacin , Vancomycin , Penicillin , Ampicillin , Erythromycin ,Gentamicin , Oxacillin , Amoxicillin Clavulanate . However, this study suggested that routine daily disinfection of mobile phones by 70% alcohol. In an effort to prevent contamination of mobile phones, HCWs should not touch the devices with contaminated hands. Therefore, mobile phones could be an important source of nosocomial infections and the spread of bacterial resistance bacteria in medical healthcare settings. Further such this studies surely will help the community or hospitals alert the use of mobile phones which is in close contact. In hospitals the use of mobile phones during working hours should be strictly prohibited.

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Preparation of culture media :

Blood Agar BASE (infusion agar)

Formula	g/l
Beef heart , infusion form	500g
Tryptose	10.00g
Sodium chloride	5.00g
Agar	15g

Direction :

Suspend 40g in 1liter of purified water , bring to boil to dissolve completely . sterilize by autoclaving at 121C for 15min . cool to 45-50C for blood agar add 7 % sterile defibrinated blood .

TRYPTONE SOY AGAR

Formula g/l

Tryptone15.0g

Soy peptone.....5.0g

Sodium chloride5.0g

Agar15g

Direction :

Suspend 40g in 1liter of purified water , mix well and heat agitaing frequently to boiling .distribute into appropriate containers and sterilize by autoclaving at 121C for 15min . cool to 50C and distribute into petri dishes .

THIOGLYCOLLATE MEDIUM

General purpose medium and for sterility test .

Formula g/l

Tryptone15.0g

Glucose5.5g

Sodium chloride2.5g

Yeast Extract.....5g

L. cysteine0.5 g

Sodium Thioglycollate0.5 g

Agar0.75 g

Resazurin0.001 g

Direction :

Suspend 30g in 1liter of cold distilled water . Heat to boiling with frequent agitation . Distribute and sterilize by autoclaving at 121C for 15min .

MacConkey Agar Medium:

Formula g/l

Peptic Digest of Animal Tissue	15.0g
Casein enzymic hydrolysate.....	1.5g
Sodium chloride	5g
Lactose	10.0g
Bile salts	1.50 g
PancreaticDigest of Gelatin	17 g
Agar	15.00 g
Neutral red	0.03 g
Crystal violet	0.001 g

Direction :

Suspend 51.5g of the medium in 1liter of purified water . Heat to boiling with frequent agitation for one minute to completely dissolve the medium autoclaving at 121C for 15min .

Muller Hinton Agar

Formula g/l

Beef infusion form.....300 g

Casein acidhydrolysate.....17.50 g

Starch1.50 g

Agar.....17 g

Direction:

Suspend 38.0 g in 1000 ml. distilled water Bring to boil to dissolve completely. Sterilize by autoclaving at 121C for 15 min.

المخلص

الهواتف النقالة في هذه الأيام قد تنقل أكثر من مجرد معلومات داخل المستشفيات . كما إنها يمكن أيضا أن تشارك في نقل العدوى في أنظمة الرعاية الصحية . تكشف هذه الدراسة أن الهواتف المحمولة تستخدم عادة من قبل العاملين في الرعاية الصحية أثناء الكشف عن المريض ويمكن أن تكون بمثابة وسيلة ممكنة لانتشار مسببات المرضية الخاصة بالمستشفيات . كان الهدف من هذه الدراسة هو عزل وتعريف البكتيريا المتواجدة على الهواتف النقالة الخاصة بالعاملين في مستشفى الجلاء في بنغازي . أجمالي العينات كان 155 عينة ، 150 من العزلات أظهرت نمو البكتيري ، وكانت البكتيريا المعزولة (*S. epidermidis* (21.7%) ، تليها (*Bacillus spp* (10.3%) ، *S. aureus* (8.2%) ، *S. heamolyticus* (6.9%) ، *Methicillin resistant Staphylococcus aureus* (MRSA) (6.5 %) ، *S. capitis* (6.2%) ، *Staphylococcus spp.* (3.8%) ، *Streptococcus spp.* (2.8%) ، *Bacillus subtilis* (2.4%) ، *S. hominis* ، *Enterobacter spp* and *S. saprophyticus* (2.1%) ، followed by *Micrococcus spp.* and *Macrooccus caseolyticus* (1%) . ومع ذلك كانت أدنى نسبة *Enterococcus casseliflavus* ، *Dermacoccus nishinomyaensis* and *Lenconostoc mesentero* (0.3%) .

و البكتيريا سالبة الجرام كانت الأكثر شيوعاً هي (5.5%) *Pseudomonas spp* ,
تليها , *Escherichia coli* (4.8%)*Acinetobacter paumannii* (4.5%) ,
Klebsiella pneumonia (3.8%) , *Proteus mirabilis* (2.1%) , *Pantoea*
agglomerans (1%).

معظم البكتيريا أظهرت أنها حساسة للمضادات :

Gentamicin, Amoxicillin-Clavulanate , Tetracycline , Cefoxitin ,
Augmentin ciprofloxacin , Vancomycin, penicillin , Ampicillin .

