بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College Graduate Studies

Assessment of Gram-positive Bacterial contamination on Computer Mouse at Universities in Khartoum State

تقويم التلوث بالبكتريا موجبة للجرام علي فأرة الحاسوب في الجامعات بولاية الخرطوم

A dissertation submitted in partial fulfillment for the requirements of MSc in Medical Laboratory Science (Microbiology)

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الآيـــة

قَالَ تَعَالَىٰ:

﴿ ٱقۡرَأۡ بِٱسۡمِ رَبِّكَ ٱلَّذِي خَلَقَ ١ خَلَقَ ٱلۡإِنسَٰنَ مِنۡ عَلَقٍ ٢ ٱقۡرَأۡ وَرَبُّكَ ٱلۡأَكۡرَمُ ٣
ٱلَّذِي عَلَّمَ بِٱلۡقَلَمِ ٤ عَلَّمَ ٱلۡإِنسَٰنَ مَا لَمۡ يَعۡلَمۡ ٥ ﴾

صدق الله العظيم

سورة العلق: الآيات (1-5)

Dedication

To my mother and father

ACKNOWLEDGEMENT

Thanks to ALMIGHTY ALLAH

I would like to thank my supervisor, **Prof. Humodi Ahmed Saeed** for his spectacular help, starting from topic selection throughout the actual project work till completion.

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ABSTRACT

This is a cross-sectional study carried out during the period from April to Jun 2014. The objective of this study was to assess Gram-positive bacterial contamination on the computer mice at Universities, Khartoum State. A total of 200 specimens were collected under aseptic condition. Computer mice were sampled by sterile cotton swabs immersed in sterile normal saline, then transported to the Research Laboratory. Bacterial load was calculated using Pour Plate Method. Isolated bacteria were identified by standard bacteriological methods, including colonial morphology, Gram's stain and biochemical tests.

The bacterial load present on computer mice was ranged from 43.6 $\times 10^4$ to 61.06 $\times 10^4$ cfu/ml. A total of 108 Gram-positive bacteria were identified. These were as follows: *Bacillus* spp. 52 (42.1%), *S. aureus* 10 (13.9 %), *S. epidermidis* 38 (35.2 %) and co-agulase-negative staphylococci 8 (8.8%).

The study concluded that hygienic practice level was very low. Level of bacterial contamination of computer mice was very high. Regular cleaning and disinfection of computer mice is highly recommended to reduce the microbial contamination. Further studies are required to validate the results of this study.

المستخلص

أجريت هذه الدراسة المقطعية الوصفية خلال الفتره من أبريل إلي يونيو لعام 2014، الهدف من الدراسة تقويم التلوث بالبكتريا الموجبة جرام على فارة الحاسوب في الجامعات – ولاية الخرطوم. تم جمع 200 عينة بطريقة معقمة، أخذت العينات من فأرة الحاسوب عن طريق مسحات قطن معقم مزجت في محلول ملحى معقم ثم نقلت إلى مختبر الأبحاث. تم حساب الحمل البكتيري بأستخدام طريقة صب الطبق . تم تحديد البكتريا المعزولة بالطرق البكتريولوجية المثلى، بما في ذلك شكل المستعمرات، صبغة جرام، والإختبارات البايوكيميائية. تراوح عدد البكتريا الموجودة على فأرة الحاسوب ما بين 43.6×10^4 الى 61.06×10^4 وحدة تكوين المستعمرة/ مل. تم التعرف على 108 بكتريا موجبة الجرام علي النحو التالي: البكتريا العصوية 52 (42.1%)، المكورات العنقودية الذهبية 10 (13.9%)، المكورات العنقودية البشروية 38 (35.2%)، المكورات العنقودية السالبه لانزيم التلزن 8 (8.8%). خلصت الدراسة الى ان مستوى الممارسات الصحية كانت منخفضة وبالتالي مستوى التلوث الجرثومي لفأرة الحاسوب عالي جدا". ينصح بشده التنظيف المنتظم وتطهير فأرة الحاسوب لتقليل التلوث البكتيري. و أن دراسات أخري مطلوبة لتدعيم نتائج هذه الدراسة.

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CHAPTER ONE
INTRODUCTION AND OBJECTIVES

CHAPTER ONE
1. INTRODUCTION AND OBJECTIVES

1.1. Introduction

Computers have been described as the latest technological medium which is capable of receiving and accepting data, and performing operation according to instruction (program). Computers continue to have an increased presence in almost every aspect of our occupation (Anderson and Palombo, 2009). Owing to this indispensable nature of computer to the various activities of man in this technologically dominated society, there is an increasing rate of interactions with the computer from day to day (Anastasiades *et al.,* 2009). The presence of viable pathogenic bacteria on inanimate objects has been reported by earlier investigators (Oluduro *et al*., 2011). In the university environment, students have access to computers, some regularly use the Internet and other regularly uses e-mail. To accommodate the extensive use of computer technology, universities have developed multiple-user ‘‘computer laboratories" on campus for general student access (Anderson and Palombo, 2009). The increased availability of multiple-user computers in the university setting means that the mouse is handled by numerous users on a daily basis. Given that computers are not routinely disinfected, the opportunity for the transmission of contaminating microorganisms is great. Despite understanding of the ubiquity of microorganisms in the environment is developing, but the risk of contamination posed by the computer keyboards and mouse is not yet fully understood. No clear legislation or even recognized guidelines have been formulated on the hazards

caused by computer components (Kumar and Srivastava, 2012). Computer mice may spread significant number of pathogens (Enemuor *et al*., 2012).

1.2. Rationale

People believe that microbes are only present in research labs or in hospitals and clinics and thus they have a misleading feeling of security in other places. Lack of knowledge about where bacteria cause the health problems. Researchers considered that 80% of infections are spread through hands contact with hands or other objects (Al-Ghamdi *et al*., 2011). Bacterial contamination of computer mouse can be potential source of infection. A nother cause is thought to be poor personal hygiene such as neglecting to wash hands after going to the bathroom. Dust, also which can trap moisture and enable any bacteria that are already on your mouse to flourish. One potential cause of mouse that can make a person sick, is sharing it among other workers (Eltablawy and Elhifnawi, 2009).

1.3. Objectives

1.3.1. General objective

To assess Gram-positive bacterial contamination on computer mouse at Sudanese universities in Khartoum State.

1.3.2. Specific objectives

A. To calculate of bacterial load on computer mouse.

B. To isolate Gram-positive bacteria thal exist on computer mouse.

C. To identify the isolated Gram-positive bacteria to the level of species.

CHAPTER TWO
LITERATURE REVIEW

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Definition of computer

The computer is the general purpose machine that processes data according to a set of instructions that are stored internally either temporarily or permanently (Jeffery and Sanjay, 2004).

2.2. History of computer

Rudimentary calculating devices first appeared in antiquity and mechanical calculating aids were invented in the 17th century. The first recorded use of the word "computer" is also from the 17th century, applied to human computers, people who performed calculations, often as employment. The first computer devices were conceived of in the 19th century, and only emerged in their modern form in the 1940s (Mario, 2004).

2.3. Uses of computer

A computer is a powerful tool because it is able to perform the information processing cycle operations with amazing speed, reliability, and accuracy; store huge amounts of data and information; and communicate with other computers. Computers allow users to generate correct information quickly, hold the information so it is available at any time, and share the information with other computer users (Ravichandran, 2006).

2.4. Definition of computer mouse

The mouse is a device that allows you to control the movement of the insertion point on the screen. The operator places the palm of the hand over the mouse and moves it across a mouse pad, which provides traction for the rolling ball inside the device (Jeffery and Sanjay, 2004).

2.4. Bacterial contamination

Microorganisms that cause infections can be found in any environment including soil, air, water and food as well as on environmental surfaces or objects, the infections can spread to humans in different ways; directly or indirectly via inanimate objects called vectors (Neely *et al*, 2002). The importance of computer had been identified in various fields such as health, agriculture, finance, education and research institutions. The mouse is component of a computer system that is used on daily basis in accomplishing various computer tasks in almost every aspect of society. In recent years, mouse use with the growing need for computer system applications. Their uses have greatly expanded and can be found in university, schools, banks, offices and hospitals. Thus, contamination of mouse by bacteria may initiate an infection. This was documented by some investigators (Eltablawy and Elhifnawi, 2009). Bacterial contamination of mouse pose as a threat to public health as bacteria can be transferred from person to person by direct contact or indirect contact via an inanimate object and back again. It is essential to identify the

extent to which the people who continually interact with computer mice are aware of the risk associated with its possibilities as source of infection (Hartmann *et al*., 2004).

The presence of viable pathogenic bacteria on inanimate objects has been reported by earlier investigators. Several studies of the human environment have demonstrated colonization and contamination of objects (Oluduro *et al*., 2011). Computers continue to have an increased presence in almost every aspect of our occupation. In the university environment, students have indicated that 100% have access to computers, 92.1% regularly use the Internet, and 73.3% regularly use e-mail, increased availability of multiple-user computers mouse in the university setting means that these equipment are handled by numerous users on a daily basis. Computers are not routinely disinfected (Palmer and Bray, 2001).

The environmental conditions vary depending on temperatures around the computer mouse. If the mouse is on laptop it could possibly provide heat and moisture for long enough durations to have an effect on bacteria, which is known to survive a wide range of environmental conditions. Low temperature, with high humidity results in longer lifetime of bacteria on contaminated surface. Many pathogens can also survive on dry inanimate surfaces for months (Kramer and Kampf, 2004).

Coagulase-negative Staphylococci / *Staphylococcus aureus* usually found on skin or in the nasal environment and only survive on dry skin on the outside of the body. Methicillin-resistant strain of *Staphylococcus aureus* is found on computer mice with a high percentage (Fukata *et al*., 2008). *Clostridium perfringens* usually found in human

gastrointestinal tracts and environments such as sewage and soil, however, can cause gas gangrene (Collee *et al.*, 2000). Probably will not survive long on computer mouse, as it is primary target is living tissue. Found on mouse at lesser degrees. *Enterococcus* is usually find in the bowel and are known to be able to survive adverse conditions that other bacterial usually wont grow in. They are known to survive. *Staphylococcus epidermidis* is normal flora of the skin, it has no pathogenic role in causing human infection but can occasionally assume opportunistic pathogenic role in causing human infection (Anastasiades *et al*., 2009).

Most of the bacteria found by researchers are types that tend to live on people, usually in our skin and in our mouths and nasal passages. So it is likely that most of the bacteria came from our hands. Although many of these bacteria won't hurt you unless your immune system is weak because of another illness, it could still cause infection if you have a cut on your fingers (even a tiny one you can't see). It is still wise to be careful, especially if you are sharing a computer with other people. *S. aureus* is a major component of normal flora of the skin and nostrils. This probably explains its high prevalence as a contaminant, as it can easily be discharged by several human activities including sneezing, talking and contact with moist skin. It has also been associated with numerous infectious disease conditions. It follows that since users constantly touch interfaces and often sneeze (Oluduro *et al*., 2011). Also, the level of knowledge among the computer users in university setting about the possibility of microorganisms on the mice is very poor. Microbes are everywhere, including the air around us, it is therefore

greatly recommended that hand computers to reduce the microbial transmission. Numerous studies have indicated that computer mice can become contaminated with bacteria (Anderson and Palombo, 2009).

2.5. Previous studies

Study was conducted in Salem University Lokoja Kogi State Nigeria Campus is sampled to assess bacteriological contaminations of computer mice. A total of fifteen (15) computer mice were sampled from five locations within the campus. The mice had high bacteria counts: ranging from 7.2 to 92.0 $X10^4$cfu/ml 3.3 to 80.0 $X10^4$cfu/ml for mice respectfully. Four Gram-positive bacterial species were isolated: *Staphylococcus aureus*, *Streptococcus* species, *Bacillus subtilis, Micrococcus luteus* (Awe *et al*., 2003).

Study was conducted at National Center for Radiation Research and Technology (NCRRT). Samples were collected from 24 computers mice, to determine the level of microbial contamination. The tested 24 computer mice, were positive for microbial contamination. The percentage of pathogenic bacteria and non pathogenic for computer mouse Included *Bacillus circulans* (66.6%), *Bacillus brevis* (54.2%), *Bacillus sphaericus* (75.0%), *Micrococcus luteus* (16.6%), *Micrococcus varian* (4.2%), *Staphylococcus epidermidis* (4.2%). Pathogenic bacteria included *Bacillus cereus* (4.2%) (Eltablawy and Elhifnawi, 2009).

Fifty sample were collected from mice of multiple-user internet of AL-mustansiriya computer used in the main University of Baghdad, Irag, and examined for bacterial

contamination, 32 of Gram-positive bacteria were identified these icluded 15 bacillus spp, 11 *Staphylococcus aureus* and 6 of *Staphylococcus epidermidis*. The isolate percentage of gram-positive bacteria was 54.24% (Uyehara *et al*., 2000) which include *S. epidermidis* (10.17%), *Bacillus* spp (25.42%) and *Staphylococcus aureus* (18.64%), other bacteria are (45.77%). The computer user interfaces were conventional office equipment that did not feature any specific properties in terms of amenability to wipe disinfection or disinfection tolerance (Boyce and Pittet, 2002).

Work stations proved positive for growth of potentially pathogenic microorganisms (*Staphylococcus aureus*, 12%; viridians streptococci, 11%; Enterococci, 8%) The highest contamination rates were found when samples were collected immediately after the computer workstation had been touched by users. In study a study aimed at investigating the status of bacterial contamination of daily used objects, computer keyboards, computer mice, a total of 400 samples were collected from 4 different objectives. Samples were collected from different places in the city of Jeddah, Saudi Arabia. 75% of the total samples collected were contaminated with mixed bacterial growth. Coagulase negative staphylococci dominated the isolates. The second most common bacterial growth in all specimens was Gram-positive bacilli. Potential pathogens isolated from all specimens were 30 control samples from brand new untouched computer mice with sterile water moistened swabs were wiped firmly over the entire surface of the specific object (Tagoe and Kumi-Ansah, 2011).

Significant amount of bacteria on computer mice in healthcare environments is transferred through wet gloves, contaminated gloves, or poor hygiene from healthcare specialists. Bacterial swabs specimens were collected from surfaces of 250 computer keyboards and mouse. It was found that all the tested computer keyboards and mice devices, were positive for microbial contamination. The percentages of isolated bacteria (*Staphylococcus* species, and *Bacillus* species.) were 43.3% and 40.9%. (Wilson *et al.*, 2006).

Bacteria that are often found in a healthcare environment include coagulase-negative *Staphylococcus*, *Bacillus species*, *Corynebacterium* species, streptococci, *Clostridium. Perfringens, Enterococcus* species, *Staphylococcus aureus*. Of significant importance in healthcare environments involve antibiotic resistant strains of microbes which include *Staphylococcus aureas*, Vancomycin-resistant enterococci, and methicillin-resistant *Staphylococcus aureas* (MRSA). The capability of these bacteria to survive for more than 24 hours increases their chances of contamination in other places (Rutala *et al*., 2006).

Scientists sampled the exterior of 24 computer mice for bacteria using swabs. The sampling was carried out during the usual student traffic in computer stations. The swabs that contained the bacteria were incubated in a broth containing oxacillin. After 48 hours, growth was seen on 17 of the samples. They were black, round, and shiny which is what *Staphylococcus* looks like. After further testing using PCR analysis, it was determined that two of the five computer mice that contained *Staphylococcus aureus* were methicillin-resistant. This finding proposes that the MRSA came from humans. In

addition, the investigation showed that five out of the ten mice that were contaminated tainted with *Staphylococcus epidermidis* that were methicillin-resistant. Few of mice pathogene, were methicillin-resistant *Staphylococcus hominis* (Kassem *et al*., 2007).

Transmission results from tapping on the keys and regular usage of the device, which may incur contamination such a healthcare environment (Fukata *et al*., 2008). From tests carried out, 95% of cultures from mouse tested positive for microorganism though most were simple skin flora (Schultz *et al*., 2003). The focus of research has been on pathogenic bacteria that pose threats to infections. May decrease the bacterial load, cleaning or routine use of surface disinfection is often not followed due to lack of sufficient evidence to support the use of appropriate disinfectants that are suitable for clinical applications as well as compatibility with the surface material (Rutala *et al*., 2006). Compliance rates with hand hygiene have been found to vary between 16 - 50% (Kramer and Kampf, 2004) which may allow for cross transmissions of pathogens.

CHAPTER THREE
MATERIALS AND METHODES

CHAPTER THREE
3. MATERIALS AND METHODS

3.1. Study Design

3.1.1. Type of study

This study is a cross-sectional study conducted to assess the bacterial load and Gram-positive bacteria on computer mouse in selected universities in Khartoum State**.**

3.1.2. Study area

The study was conducted in Sudan University of Science and Technology (SUST)**,** AL neleen University, University of Khartoum, University of Science and Technology, Almogtarbeen University. The experimental work was done in the Research Laboratory of SUST.

3.1.3. Study duration

The study was conducted during the period from April to Jun 2014.

3.2. Collection of specimens

Sterile cotton swab moistened in sterile normal saline was wiped firmly over the entire surface of the computer mouse. Each swab was placed in 2 ml of normal saline in small tube, labeled and immediately transported to the Research Laboratory without any delay, the content of tube vortex for one minute. Ten-fold serial dilutions (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4},

10^{-5}) were made by adding 1ml from homogenized sample to sterile test tube containing 9 ml sterile normal saline and mixed properly as done by Greenwood, (2003).

3.3. **Bacterial load**

The pour plate technique was used to determine the number of bacteria/ml in specimen. Each colony represents "colony forming unit" (CFU) for optimum accuracy of count, the preferred range for total CFU/plate is between 30-300 colonies/plate (Collee, 2000). The technique was carried out as follows:

a. 1 ml of the dilution was placed into each of three sterile Petri-dishes.

b. About 15 ml of molten sterile nutrient agar was added to each plate with temperature rang between 45-47^{o}C.

c. Each plate was mixed well by moving it five times in, clockwise and anticlockwise direction.

d. Plates were incubated at 37^{o}C for 24hr.

Calculation

Count all colonies were counted (the embedded colonies will be much smaller than those formed on the surface). A magnifying colonies counter was used in counting small embedded colonies. The bacterial load was calculated by the following formula:

CFU/ml = CFU/plate × dilution factor × 1/aliquot.

3.4. Identification of Gram-positive bacteria

3.4.1. Colonial morphology

Colonies pickup from plats of counting and purification in sterile nutrient agare media, after incubation colonial morphology such as elevation, color, size, were studied and recorded.

3.4.2. Gram stain

Bacterial smear was prepared by transferring portion of discrete colony to a drop of normal saline. The smear covered with crystal violet stain for 30-60 seconds, rapidly washed off the stain with clean water, then the smear was covered with lugol's iodine for 30-60 seconds, washed off the iodine with clean water, decolorized rapidly (few seconds) with acetone-alcohol, washed immediately with clean water, then the smear was covered with neutral red or safranin 2 minutes, washed off the stain with clean water, wiped back of the slide clean and placed it in draining rack for the smear to air dry, the smear examining microscobically with the oil immersion objective to report bacterial colony and cells shape (Cheesbrough, 2006). Gram positive bacteria; stain dark purple, Gram negative bacteria; stain red.

3.4.3. **Biochemical tests**

1. Catalase

2-3 ml of the hydrogen peroxide solution was transported into test tube, good growth of the test organism was removed with sterile wooden stick then immersed it in hydrogen peroxide solution. The positive result was showed as active bubbling that indicated staphylococcus species by Cheesbrough (2006).

2. Coagulase test

Drop of physiological saline was placed on each end of a slide, then the colony of the test organism was emulsified in each of the drops to make two suspensions, drop of the plasma was added to one of the suspension, mixed gently. The positive reaction was shows as clumping organisms within 10 seconds indicated *Staphylococcus aureus*.

3. Deoxyribonuclease (DNAse) test

The test organism was cultured on medium which contains DNA after overnight incubation. The colonies were tested for DNAse production by flooding the plate with weak hydrochloric acid solution. The acid precipitates unhydrolyzed DNA. DNAse producing colonies are therefore surrounded by clear areas indicating DNA hydrolysis (Cheesbrough, 2006).

4. Mannitol fermentation

Test organism was inoculated into mannitol salt agar, incubated at 37^{o}C and examined after 24 hours for mannitol fermentation, it was indicated by formation of yellow color around the growth (Cheesbrough, 2006).

5. Novobiocin

To a molten medium a filter sterilized solution of novobiocin was added the test organism was inoculated in the media, incubated aerobically at 37^{o}C for 24 hours and examine for the presence (resistant) or absence (sensitive) of growth (Cheesbrough, 2006).

6- Sugar fermentation test

Bacteria act as breakdown organic component to obtain energy.

$(CH_2O)N + 6\ O_2 \rightarrow 6CO_2\uparrow + 6\ H_2O$ + energy o_2= electron acceptor

Bromocersol blue carbohydrate broth complex then inoculated by the test organism and incubated up to 5 days, during aerobic respiration organism produced pink color due to break down of carbohydrate, while the organism not fermenting carbohydrate remain yellowish in color (Waghorn *et al.*, 2005).

CHAPTER FOUR
RESULTS

4. CHAPTER FOUR
RESULTS

A total of 200 computer mice swabs from different Universities in Khartoum State were cultured on nutrient agar. Out of them 49 were from Sudan University of Science and Technology (SUST), 42 from Alneelin University, 37 University of Khartoum, 42 from University of Science and Technology and 31 from Almogtarbeen University (Table 1). A total of 123 (61.5%) of the samples yielded with the highest percentage of bacterial isolation (69.0%) from specimen collected from Alneelain University followed by Sudan University Of Science and Technology (Table 2).

Data was simple statistically analyzed to determine the mean bacterial load (CFU/ml) among Universities. Alneelin University (61.06×10^4) show the highest mean bacterial load, followed by Almogtarbeen University (60×10^4), University of Science and Technology (57×10^4), Sudan University of science and technology (SUST) 54.78×10^4 and University of Khartoum 43.6×10^4 (Table 3).

Depending on microscopic examinations, cultural characteristic and biochemical tests (Table 4). 108 Gram-positive bacteria were identified, the predominant were Bacillus spp (52; 42.1%), *S. epidermidis* (38; 35.2%), *S. aureus* (10; 13.9%), *S. haemolyticus* (6; 5.6%) and *S. lugdunensis* (2; 3.2) (Table 5).

Table 1. Distribution of mice sampled according Universities

Universities	Number of sample	percentage
Sudan University of science and technology	49	24.5
ALneleen University	42	21
Khartoum University	37	18.5
University of science and technology	41	20.5
Almogtarbeen University	31	19.5
Total	200	100

Table 2. Bacterial growth obtained after cultivation of the collected samples from different Universities

Universities	Collected samples	Growth frequency	growth percentage
Sudan University of Science and Technology	49	33	67.3
ALneleen University	42	29	69.0
Khartoum University	37	15	40.5
University of Science and Technology	41	25	61.0
Almogtarbeen University	31	21	53.8
Total	200	123	60.5

Table 3. Mean Bacterial load according to Universities

Universities	No of samples	Mean CFU\ml
Sudan University of Science and Technology	49	54.78×10^4
ALneleen University	42	61.06×10^4
Khartoum University	37	43.6×10^4
University of Science and Technology	41	57×10^4
Almogtarbeen University	31	60×10^4

Table 4. Biochemical tests adopted for identification of Gram-positive bacteria

Isolate code	Biochemical Tests										Suggested organism
	Cat	Co	DNAse	Novo	Glu	Mal	Suc	Manni	Manno	Tre	
1M	+	+	+	**S**	+	+	+	+	+	+	**S. *aureus***
2M	+	-	-	**S**	+	+	+	-	$+^{SI}$	-	**S. *epidermidis***
3M	+	-	-	**S**	+	+	+	**V**	-	+	**S. *heamolyticus***
4M	+	-	-	**S**	+	+	+	-	+	+	**S. *lugdunensis***

(+): positive reaction; (-): negative reaction; ($+^{SI}$): slow positive reaction; (V): variable

(S): sensitive; (Cat)= Catalase; (Co)= Coagulase; (Novo)= Novobiocin; (Glu)= glucose; (Mal)= Maltose; (Suc)= Sucrose; (Manni)= Mannitol; (Manno)= Mannose; (Ttre)= Trehalose.

Table 5. Number and percentage of Gram-positive bacterial isolated during this study

Bacterial isolated	Number of bacteria	%
Bacillus spp.	52	42.1
S. aureus	10	13.9
S. epidermidis	38	35.2
S. haemolyticus	6	5.6
S. lugdunensis	2	3.2
Total	108	100

CHAPTER FIVE
DISCUSSION

CHAPTER FIVE

5. DISCUSSION

5.1. Discussion

The overall assessment of the mice samples analyzed bacteriologically indicated high bacterial load, 61.5% yielded growth, the number of bacterial load ranged from 43.6×10^4 to 61.06×10^4. Among of the samples, *bacillus* spp. (42.1%) are the most common were isolate followed by the skin flora *S.epedermidis* (35.2%), *S.aureuse* (13.9%) and other Co-agulase negative staphylococci (8.8%). The result of current study agrees with finding reported in city of Jeddah, saudi Arabia (Al-Ghamdi *et al*., 2011), 75% of the total samples collected were contaminated with mixed bacterial growth and with study In University Baghdad Irag, AL-mustansiriya 54.24% of Gram-positive bacteria isolated. Qualitative analysis of bacterial isolates revealed the abundance of normal flora isolates belonging to Coagulase negative Staphylococci (ConS) and Gram positive bacilli. Pathogens such as *Staphylococcus aureus* also isolated but in lower frequencies. In our study Gram-positive bacteria were more frequently isolated (88%) from all computer mice. This could be in part due to the fact that survival of Gram-positive species on laminate surfaces is greater. The result of the current study was also compatible with study on Salem University lokaja Kogi State Nigeria ; bacterial load ranged from 3.3×10^4 to 80.0×10^4 CFU/ml. Normal skin is inhabited with two categories of bacteria: transient and resident. Resident flora which are attached to deeper layers of the skin, are more resistant to removal by routine washing. Coagulase-negative staphylococci and Gram-positive diphtheroids are members of this group (Boyce and Pittet, 2002). On the other

hand, transient flora colonizes the superficial layers of the skin, and is more amenable to removal by routine hand washing (Boyce and Pittet, 2002).

The result of the current study disagree with the finding reported from Mecca City 2012. The quantitative analysis of most tested computer mice samples was negative bacterial count (71%). Alternatively, total positive samples were (29%) of counted bacteria (Samy *et al.,* 2012). The probable reason for the discrepancy may be geographical variation, time of sample collection, hygiene, and incubation time.

5.2. **Conclusion**

In conclusion, overall *Bacillus* spp. was the significant number because the ubiquitous nature of this bacteria giving it greater colonization ability as well as the ability of its spores to resist environmental changes, withstand dry heat and certain chemical. On the other hand most of these isolates were traditional skin flora, revealed a general level of contamination of this widely used computer mice. Majority of the isolates obtained were micro-organisms considered to be pathogenic or probable pathogens.

5.3. Recommendation

The cleaning procedures adopted by the operators, is not effective in significantly reducing the level of the bacterial contamination. The level of knowledge among the computer users is very poor. It is therefore greatly recommended that clean computers to reduce the microbial transmission by hand washing, further studies are required to validate the results of this study..

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APPENDICES

. **APPENDICES**

Appendix 1

Ingredient of media

1. Nutrient agar

Formula and preparation gram/liters

Lab-lemco p…….……..…….. 1.0

Yeast extract……..……..……. 2.0

Peptone……..…… 5.0

Sodium chlorid……...…….……. 5.0

Agar……..…….…… 15.0

2. Ma$_c$conky agar

Peptone…….…….. 20.0

Lactose ……..……..…….. 10.0

Bile salt ……..…. 5.0

Sodium chloride …….……..…… 5.0

Neutral red ……..……..... 0.075

Agar …….. 12.0

3. Mannitol salt agar

Lab-lemco powder ……..……...…….1.0

Peptone ……..…… 10.0

Mannitol …….…….…….. 75.0

Phenol red ……...…….…….. 0.025

Agar ……..…….…… 15.0

4. DNAse agar

Tryptose ……..……..…… 20

Deoxyribonucleic acid ……..……. 2

Sodium chloride …….……...…….. 5

Agar …….……. 12

5. Blood agar

Nutrient agar ……...……... 500 ml

Sterile defibrinated blood ……..……..25 ml

Appendix 2

Reagents and stain

1. Sodium chloride, 8.5 g/l (0.85% w/v)

Sodium chloride ……...…… 8.5 g

Distilled water ……..……..…..…… 1 liter

2. Acetone-alcohol decolorizer

Acetone ……..…….500 ml

Ethanol or methanol, absolute …….. 475 ml

Distilled water ……..……..…. 25 ml

3. Crystal violet Gram stain

Crystal violet ……..…… 20 g

Ammonium oxalate ……..…… 9 g

Ethanol or methanol, absolute……. 95 ml

Distilled water ……..…..…. 1 liter

3. Lugol`s iodine solution

Potassium iodide ……..….. 20 g

Iodine …….. 10 g

Distilled water …….……... 1 liter

4. Safranin

Safranin O ……..…….. 2.5 g

Ethanol …….……. 100 ml

Distilled water …….…… 90 ml