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Original Research

Isolation and identification of bacterium on diagnostic pathology laboratory hardware

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Abstract

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Keywords: Mueller-Hinton Agar, Methicillin-resistant Staphylococcus aureus, Clostridium difficile, vancomycin-resistant enterococci, healthcare-associated infections, center for disease control, personal computer

The aim of our study was to monitor the hygiene level of private and government hospital laboratories instruments and to determine isolation and identification of bacteria present on clinical laboratories instrument (computers keyboard, mouse and telephone). An analytical cross-sectional study was conducted in the tertiary private and government hospital laboratories of Islamabad, Pakistan from 1st April to 30th September 2023. Samples were collected aseptically from various sections of the laboratory using sterilized wet cotton swabs; clean each computer keyboard, mouse, and telephone dipped in distal water and rotated on every corner of the keyboard, mouse, and telephone. For the isolation of organism, samples were inoculated on MacConkey agar for overnight at 37 0C, after overnight incubation bacterial colonies of different shape, size and colour were selected. Following the collection of pure colonies, conventional microbiological methods such as Gram staining and biochemical tests were used to identify the organisms. For antibiotic testing, AST was measured using the disk diffusion method Mueller-Hinton Agar (MHA). For statistical analysis, we used MS Excel and SPSS (version no 22) software. Out of 120, 42 (35.0 %) samples were collected from keyboard, 42 (35.0 %) from mouse and 36 (30.0 %) from telephone. A total of 59 (49.2 %) samples were resulted as STAPH SPP, 40 (33.3 %) samples were MRS, 6 (5.0 %) samples were MRSA, and 15 (12.5 %) samples were found with no growth. The fact that some of these bacteria are highly resistant to routinely used antibiotics is quite concerning. Multidrug resistance was also discovered. Antimicrobial resistance to most common antimicrobial agents were also found in high numbers. As a result, pathogenic microorganisms on computer keyboards, mouse and telephones were caused for concern. Because computer keyboards, mouse and telephones provide a surface for colonization, infection control recommendations must focus on proper surface disinfection and hand hygiene, as well as understanding of how to clean such surfaces or disinfect them.

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Introduction: A computer is an electronic data processing device that receives data from the outside world as input, manipulates, calculates, and computes using a set of instructions provided and stored in memory, and then outputs the needed or desired results to the user[1]. Computers can execute information processing cycle activities with incredible speed, reliability, and precision, as well as store and transfer massive volumes of data and information. A telephone is a device or system that sends sounds and messages over a long distance via a cable [2]. Computers are used in clinical laboratories to maintain patients diagnostic test data and to allow laboratory technicians to create accurate information rapidly and save it, so it is available at any time [2], whereas telephones are used for telecommunications [3].

Computers are becoming more and more prevalent in nearly every part of our work, because computers are so important to man's varied activities in our technologically driven world; there are a growing number of contacts with computers. Infection-causing microorganisms may be found in any environment, including soil, air, water, and food, as well as on environmental surfaces or objects. Infections can be transmitted to people in a variety of ways, including directly or indirectly through inanimate objects known as vectors [1]. Doctors, laboratory technologists, laboratory technicians, recording officers, and personal computers from various healthcare workers use computers and telephones, all of those had direct or indirect patient contact. However, most people are unaware that microorganisms may be found on many ordinary inanimate things in the outdoors, at work, and even in their homes, thus common inanimate objects on which microorganisms can be found include office desks, telephones, computer keyboards, computer mouse, door handles, and even kitchen sinks, and in the workplace, a person who contact with these inanimate objects, particularly computer keyboards, mouse, and telephone, can carry microbes [3].

In laboratories, healthcare-associated contaminations are a significant cause of illness and death. A possible source of hospital-acquired infections is healthcare workers [4]. In reality, hand contact with contaminated hands or objects is responsible for 80 percent of virus transmission [5]. Keyboards are one of the most frequently used user interfaces, most keyboards contain over 101 unique keys, making cleaning tedious and labor consuming. Most owners do not clean and disinfect their keyboards for this reason. Infectious agents have also been linked to computer keyboards as a possible reservoir. Because computers aren't cleaned on a regular basis, the possibility of contaminated germs spreading is high. The keyboard and mouse on a computer deal with a lot of activity. Bacteria on our skin, fingernails, hands, and other places where we use our hands have been found to transfer new bacteria to the keyboard. There are likely to be a lot of sick people in an area where a lot of people come in and out, such as a hospital, school, or office, and via them will come fresh germs that will ultimately settle on the keyboard through the air or by direct touch. Inadequate hand hygiene and unclean surfaces are two reasons why computer keys might be a source of microbial contamination, resulting in the indirect transmission of hazardous illnesses. Eating near computer keyboards can also lead to bacterial infection. Spills may accumulate on and between the keys, enabling millions of germs to flourish [6]. The mouse is a component of a computer system that is utilized daily in nearly every sector of society to do various computer activities. In recent years, mouse usage has increased in tandem with the increasing need for computer system applications. Their applications have grown significantly, and they may now be found in universities, schools, banks, workplaces, and hospitals. As a result, bacterial contamination of a mouse may result in illness. Some investigations have confirmed this. It's critical to figure out how significantly individuals who use computer mouse on a regular basis are aware of the dangers of using them as a source of infection. The temperature surrounding the computer mouse affects the ambient circumstances. If the mouse is connected to a laptop, it may supply heat and moisture for long enough to affect bacteria, which is known to thrive in a variety of environments. Bacteria on contaminated surfaces have a longer lifespan whenthe temperature is low and the humidity is high [1].

Telephones are currently used in a variety by both healthy and sick people. Bacterial triggers can be transmitted to other users by direct contact with bodily parts such as the skin, ear, and mouth, or through secondary interaction with droplets, aerosols, saliva, and contagious atoms, from an affected person or a symptomless carrier of a microbe. Sneezing or coughing can spread organisms from the natural flora to phone receivers. Food particles in the mouth encourage the development of germs, which can be transferred to the telephone receiver as droplet aerosol when communicating; Microorganisms from the user's hand, throat, and skin can potentially infect the telephone receiver. Germs from the oral and nasal canals are continually dispersed when someone coughs, sneezes, talks, laughs, or breathes into the nearby air, and this can be transmitted to healthy persons who are prone to infection. The bacteria have developed to transmit through nasopharyngeal excretions and saliva drops, and they are very anti to drying and desiccation, allowing them to easily move from one host to another. Staphylococcus epidermidis is a typical skin flora that has no pathogenic function in human infection. However, it can occasionally take on an opportunistic pathogenic role in human infection. As a result, most of the bacteria most likely began on our hands. Although many of these bacteria will not affect you until another sickness weakens your immune system, they nevertheless can cause your finger to fall (even if you cannot feel it as a small one). It's still a good idea to be cautious, especially if you use a computer with others. S. aureus is a common component of the skin's and nostrils' natural flora. It is a common contaminant because it is easily released by a variety of human behaviors such as sneezing, talking, and skin contact. It's also been connected to a variety of infectious illness problems. Since users frequently sneeze and frequently touch interfaces, this follows [2].

Furthermore, computer users in academic settings have a limited understanding of the potential of germs on mouse.

Microbes are everywhere, even the air we breathe, thus using hand computers to limit microbial transmission is highly advised. Computer mouse have been found to be infected with germs in several investigations; the growing usage of computer keyboards, mouse and telephones in laboratories has created reservoirs for viruses and bacteria. Existing hand hygiene regulations would prevent the risk of disease transmission to healthcare personnel via computer keyboards, mouse, and telephones [6]. Bacteria, viruses, fungus, and protozoa are among the microorganisms found in the human body. *Bactericides, Streptococci, Staphylococci, Oropharynx, Vagina (lactobacilli)*, Anaerobes, and Digestive Organ (Enteric bacilli) are examples of typical flora in the human skin, while others can be classed as harmful microorganisms [7]. The most exposed surface portions of a computer are the keyboard and mouse devices, which have a 100% contamination rate. Every one of these gadgets and its surroundings might be a potential hotspot for illnesses that might have an impact on people's health. In a study it was demonstrated that the bacterial defilement rate in PC keyboards were 99.9% and in mouse it was 100% in the case of general skin ordinary vegetation [8]. Poor personal hygiene, such as failing to wash hands after using the restroom, is a secondary factor. Dust can also trap moisture, allowing germs already present on your keyboard, mouse, and phone to thrive. Because multiple-user computers and telephones are becoming more common in the medical laboratory, the keyboard, mouse, and telephone receiver are regularly utilized by many users. Because these aren't cleaned on a regular basis, the risk of contaminated bacteria spreading is high. Despite progress in our awareness of the prevalence of microbes in the environment, the danger of infection presented by computer keyboards and mouse is still unknown. There is no clear regulation or even widely accepted standards on the dangers posed by computer components [1].

Many microorganisms have been isolated from computer keyboards, mouse and telephones all over the world, including in industrialized countries, where possible pathogens are commonly found on these. Because they can live for prolonged periods of time and resist cleaning, many bacteria stay significant for contamination such as; *Staphylococcus aureus*, Enterococcus species, *Streptococcus pyogenes, Escherichia coli*, , *Acinetobacter species*, and *Pseudomonas aeruginosa*[3], *Staph aureus, Streptococcus species, Klebsiella species, Bacillus subtilis, Micrococcus luteus*[9], *Staphylococcus epidermidis, Enterobacter cloacae* and *Enterobacter spp*. [10], Methicillin-resistant *Staphylococcus aureus* (MRSA), Clostridium difficile (C. diff), *Acinetobacter baumannii*, and vancomycin-resistant enterococci (VRE), According to numerous nosocomial pathogen literatures, have been proven to survive for months on computer keyboards, mouse, and telephones [11].

Antimicrobial resistance is a global issue that has led to an increase in disease and mortality because of treatment failures and rising health-care expenditures. According to research, infected fomites play an important role in the spread of bacterial infections and antibiotic resistance. Some research indicates that computer keyboards and mouse are contaminated with antibiotic-resistant microorganisms, which may play a key role in the transfer of harmful bacteria in addition to the spread of antimicrobial-resistant bacteria, such as in the United States, University of North Carolina Health Care System, and oxacillin-resistant *Staphylococcus aureus* (4%) Colombia teaching hospital, Methionine-resistant *Staphylococcus aureus* (4%) various studies conducted in several areas of the world examined the levels of bacterial infection on computer keyboards and mouse. Research conducted in the United States, the isolated bacterium Pathogenic microorganisms included vancomycin-susceptible Enterococcus (VSE) species (12 percent), and Gram-negative rods (36 percent). The bacterial colonization rate was 43 percent in research done on notebook computers in Pennsylvania, even though just (1.7 percent) of culture results were pathogens. Among the dangerous bacteria discovered were gram-negative bacilli, *Staphylococcus aureus* and streptococcus species. In Thailand, germs colonized keyboards at a rate of (92.3 percent) in offices and (96.2 percent) in patient care areas. Gram-negative (non-fermentative) bacilli were found on 0% of the keyboards in offices and (11.5 percent) in the patient care areas, respectively. Methicillin-resistant *Staphylococcus aureus* 2 (5.1 percent), Methicillin-susceptible *Staphylococcus aureus* 14 (35.9 percent), Enterococcus 3 (7.7 percent), Gram-negative rods 3 (7.7 percent), and Bacillus species 17 (43.5 percent) were discovered from computer keyboard and mouse in German research (10). Another research from the same region discovered S. aureus 21 (20%) and MRSA 6.67% and hemolyzing streptococcus were also identified from computers. According to an Italian investigation, Several-operator keyboards were shown to have more S. aureus than single-user keyboards. S. aureus was discovered on multiple-user keyboards (47%) rather than single-user keyboards, according to an Australian study (20 percent). In India, 105 microorganisms were discovered from 80 samples (63 percent from hospital setting and 37 percent from non-hospital setting). The bacteria that were highly often isolated were *Pseudomonas species*, *E. coli*, *S. aureus* and *Klebsiella pneumoniae*. Gram-positive cocci (80%) were identified more frequently in the hospital environment than Gram-negative bacteria. Notwithstanding advances in advanced medicine, nosocomial infection even now puts patients at danger of increased illness and death. Surfaces in the environment may have a significant impact on this. As a result, it is critical to find ecological overlays that are high in bacteria and may house diseases [3]. Greater than 2 million individuals worldwide contract healthcare-related infections each year, causing in 90,000 fatalities. According to 34 studies, the average proportion of healthcare workers who follow the CDC (Centers for Disease Control and Prevention's) hand hygiene procedures is about 40%, which might be a factor for computer keyboard contamination. The goal of this study was to find out how microbiologically contaminated computer keyboards and mouse were, as well as the efficiency of various disinfectants and their aesthetic and functional consequences [6]. In acute care hospitals in the

United States, the overall number of healthcare-associated infections (HAIs) is expected to be around 722 000 each year, or around 4% of inpatients. healthcare-associated infections (HAIs) resulted in longer hospital stays, more readmissions, and worse patient outcomes, including an increase in mortality. The US Centers for Disease Control and Prevention (CDC) estimates that preventing healthcare-associated infections (HAIs) in the US would save $5.7 to $31.5 billion a year in direct costs. As a result, the incidence of HAI consequences in outpatient settings has been poorly documented. Cross-infection via staff hands causes between 20% and 40% of healthcare-associated infections (HAIs) with another 20% caused by other environmental factors [11].

Literature review:

Keyboard Sample Contamination: In several investigations, keyboards have been identified as disease reservoirs due to their use in patient rooms, particularly due to constant contact with staff hands. Poor hygiene of health professionals' hands, because of the popularity of computer accessories in hospital settings, the keyboard and mouse have been identified as a possible source of cross-infection, as well as germs transmitted from computer accessory surfaces to the bare or gloved hands of health-care workers. Several investigations have shown that computer equipment is contaminated with microorganisms [12]. According to Awe et al., 2003 research was carried out at Salem University Lokoja Kogi State Nigeria Campus to examine bacterial contaminations of computer mouse. A total of fifteen [13] computer mouse samples were collected from five different places on campus. The exhibited high bacterium counts ranging from 7.2 to 92.0 X104cfu/ml for mouse. Staphylococcus aureus, Streptococcus species, Bacillus subtilis, and Micrococcus luteus were identified as Gram-positive bacteria [9]. A study was conducted by M, Arani JS et al., 2019 on Bacterial infection of Intensive Care Unit (ICU) keyboards and electric apparatus was investigated at Kashan University of Medical Sciences and health service facilities.75 samples were collected from computer keyboards and non-living covers electric apparatus in 5 Intensive Care Units (ICUs) were subjected to this descriptive, cross-sectional research. Computer keyboards and electrical devices were used to gather samples. Seventy-six (76%) of the 75 computer keyboards and electrical equipment tested clear for germs and fungus. The most contaminated bacteria (70.7 percent) were gram positive bacteria, while the most isolated bacteria were coagulase-negative staphylococci [12]. The prevalence of bacteria on door handles and computer keyboards at Staff of Science, University of Kufa in Najaf Governorate by AL-Harmoosh RA et al., 2019, was investigated in the research of probable infective bacterial contaminants of door handles and computer keyboards at the staff site. 100 samples stood gathered and grown to identify microorganisms. Positive samples were found in 95% of bathroom doors handle and computer keyboards, 90% of lab doors handle, 80% of classroom doors handle, and 75% of office doors handles. The present investigation found a significant frequency of aerobic bacteria on several door handles and computer keyboards at the University of Kufa's Faculty of Science. The study provided an image of contagious pollution of door handles and computer keyboards, and how they might be one of the most common causes of illness [14].

Mouse Sampling Epidemiology: In the research of Boyce et al., 2002, fifty (50) samples were taken from mouse on the AL-Mustansiriya computer in the main University of Baghdad, Iraq, and analysed for bacterial contamination. 32 Gram-positive bacteria were found including 15 bacillus spp., 11 *Staphylococcus aureus*, and 6 *Staphylococcus epidermidis*, found that (54.24 percent) of the isolates were gram-positive bacteria, which included S. aureus. Other bacteria include *Staphylococcus epidermidis* (10.17 percent), *Bacillus spp*. (25.42 percent), and *Staphylococcus aureus* (18.64 percent) (45.77 percent). The computer user interfaces were standard office equipment that lacked any unique features such as wipe cleaning capability or disinfection tolerance [8].

A study was conducted by SI, Opere B et al., 2009, about the Antibiotic sensitivity model of Staphylococcus species separated from telephone handsets in Singapore with 1,591 isolates collected from roadside telephone stands in 16 distinct sites across the Lagos city. Providencia, Escherichia, Staphylococcus, Bacillus, Klebsiella, Citrobacter, Enterobacter, Proteus, Streptococcus, Micrococcus, and yeast were among the species studied. The most prevalent was Enterobacter, which accounted for (20.2 percent) of all detected species, followed by Bacillus (18%), and then Citrobacter and Enterobacter, respectively. Antimicrobial susceptibility patterns were found in 44% of the total Staphylococcus tested, with strong resistance to greater part of the antibiotics employed. This finding might be linked towards the rise of Staphylococcus-resistant strains, particularly in densely crowded areas with health and hygiene issues and limited access to antibiotics [2].

Telephone Sample Contamination:A study was conducted by Olu-Taiwo M et al., 2021, 240 swabs were collected from the surfaces of telephone and computer keyboards used by healthcare university students in Ghana. In a cross-sectional study on Multidrug-Resistant Bacteria on the Telephone and Computer Keyboards of Healthcare University Students in Ghana. MacConkey and blood agar were applied to culture the swabs. A conventional bacteriological technique was used to identify the bacteria. The devices yielded 91 bacterial isolates, which were evaluated using Kirby–Bauer disc technique against nine frequently used antibiotics which showed contamination levels of (83.3 percent) and (43.3 percent), respectively, according to the research. Staph epidermidis (25.4 percent), *Klebsiella spp.* (12.9 percent), Staphylococcus aureus (9.2 percent), Pseudomonas spp. (5.4 percent), *Enterobacter cloacae* (2.1 percent), Escherichia coli (6.7 percent), and *Enterobacter spp.* were among the bacteria identified (1.7 percent). The findings of this investigation indicated that harmful germs had been found on the phones and computer keyboards of health care learners at the institution. To prevent the transmission of resistant bacterium infections, regular hand cleanliness and cleaning of telephone and computer keyboard overlays are recommended [10].

The goal of the study on biochemical characterization and antibiotic resistance of bacteria isolated from computer keyboards was to study the rate of germ pollution and the spread of types of computer keyboards from computer labs of some department technical institutes (Nursing, Pathological Analysis, Electronic, and electricity) and some hospitals in Basra by Hussein A et al., 2019. Samples carried from computer keyboards NA (Nutrient agar) and MacConkey agar (MA) was used to culture the samples. The biochemical and morphological characteristics of agar and growing bacteria were used to identify them. Bacteria infected the 70th and 75th colonies out of 75 samples. Gram positive bacteria (Gr+) were the most polluted (99 percent). Bacillus was the most isolated bacterium, and a significant degree of contamination was observed on computer keyboards (Shifa General Hospital) [15].

Nosocomial infections cause serious health and cost problems for both individuals and healthcare institutions were conducted by Anastasiadis P et al., 2009. The study's goal was to find Staph aureus on computer mouse and keyboard in the intensive care units at Academic Hospital in Bloemfontein, as well as Intensive care unit (ICU) staff awareness about cleaning computer mouse and keyboard and their possible danger as infection reservoirs. S. aureus was found in 14 swab samples from computer mouse and keyboard. Six months later, the swabbing was repeated. To cultivate and identify organisms, standard microbiology laboratory procedures were utilized. S. aureus was first recovered from one computer mouse, then six months later from two keyboards and five mouse, in addition to different ambient bacteria and normal human flora. The response rate to the questionnaire was (85.6 percent). Seventy-one percent of responders said keyboards and mouse were a major cause of hospital infections. Despite this, 62% of doctors and 40.3% of nurses said they certainly not cleaned their hands before or after using a computer. 97% of suspects were unaware of a formal computer equipment cleaning policy. Proper cleaning practices should be adopted to avoid nosocomial infections caused by microbial transfer between equipment, employees, and patients [16].

Bacteria Isolation and Identification from computer keyboards and mouse at various business centers in Dutse Metropolis, Jigawa State, Nigeria the current study sought to isolate and detect harmful bacteria on the exterior surfaces of computer keyboards and mouse were studied by Muhammad RH et al., 2016. A total of 60 samples were gathered for this purpose from various computer facilities in Dutse, Jigawa State. The obtained samples were grown on Nutrient Agar and then on selected medium for further identification. Pathogenic bacteria were discovered in all 60 samples (*E. coli, B. epidermidis and Staphylococcus, B. licheniformis, E. aerogenes*). Gram-positive *S. aureus* isolates predominated. B. epidermidis was the most frequent bacterial growth in all samples. Possible pathogens identified from all findings demonstrate that computer mouse and keyboard are 100 percent contaminated when compared to other things. The existence of pathogenic bacteria on these objects suggests that they might serve as environmental carriers for the spread of potentially harmful microorganisms [4].

Kassem II et al., 2007 a study examined the role of computer keyboards used by students at a metropolitan university as reservoirs of antibiotic-resistant staphylococci in a paper titled Community computer surfaces are reservoirs for methicillin-resistant staphylococci. After a combination of biochemical and genetic studies, putative methicillin (oxacillin)-resistant staphylococci isolates were discovered from keyboard swabs. The staphylococci that grew in the presence of oxacillin were found on 17 of the 24 keyboards (2mgl1). Staphylococcus aureus (MRSA), Staphylococcus epidermidis (MRSE), and Staphylococcus hominis (MRSH) were identified on keyboard surfaces and may have an influence on the transmission and prevalence of infections in the general population [16].

This is cross-sectional research that was conducted by Ahmed TKF, 2014. The goal of this study was to evaluate Gram-positive bacterial contamination on computer mouse at Khartoum State Universities. Under aseptic conditions, 200 specimens were collected. The bacterial burden on computer mouse varied from 43.6 ×104 to 61.06 ×104 CFU/ml. There was a total of 108 Gram-positive bacteria found. Bacillus spp. 52 (42.1%), *S. aureus* 10 (13.9%), coagulase-negative staphylococci 8 and epidermidis 38 (35.2%) (8.8 percent). As a result, the study found that sanitary practice was extremely poor. Computer mouse have a significant level of bacterial contamination. To minimize microbiological contamination, computer mouse should be cleaned and disinfected on a regular basis. More research is needed to confirm the findings of this study [2].

According to Olu-Taiwo M et al.,2021 in Ghana, Ethiopia, Egypt, and Pakistan, research on Multidrug-Resistant Bacteria on Telephone and Computer Keyboards in Healthcare found that bacterial pollution frequency was hundred and 61.3 percent. According to Tagoe et al., (81 percent) of bacterial isolates were found to be infective, and 100 percent of these bacterial isolates were anti-ampicillin, cloxacillin, and penicillin. Another research in Nigeria found an 80% frequency of bacterial contamination, with *Staph aureus* (53.6%), E. coli (25.11%), and Klebsiella spp. being the most common bacteria identified (14,5%) [10].

Methodology:

Analytical cross-sectional study was conducted by the students of master's in biological sciences in the tertiary private and government hospital laboratories of Islamabad, Pakistan. All laboratory work was performed at the pathology department of the Pakistan Institute of Medical Sciences, Islamabad. Study sample size was 120 according to WHO sample size calculator. The samples were representative of the overall population of laboratory instruments. Sampling technique used in study was Cluster sampling. Laboratory computer keyboard, mouse and telephone which used by clinical laboratory personals inside laboratory sections were included for examination. Computer keyboards, mouse and telephone which were used rather than laboratory sections were excluded from study. Samples were collected aseptically from various sections of the laboratory such as phlebotomy, hematology, microbiology, chemical chemistry, blood bank, clinical chemistry and histopathology using sterilized cotton swabs, dipped in distal water, and rotated on every corner of the keyboard, mouse, and telephone. For the inoculation and characterization of bacterium isolates, appropriate medium, namely MacConkey agar, were utilized. The infected specimens on MacConkey agar plates were incubated for 24 hours at 37˚C for colony isolation and morphological identification, and then re-incubated for 48 hours. Bacterial colonies of varied sizes, shapes, and colours were selected from the several plates and progressed. Following the collection of pure colonies, conventional microbiological methods such as Gram staining and biochemical tests were used to identify the organisms. Isolated pure colonies were Gram separated and biochemically analyzed using Catalase. All the parameters which were examined in study, their kits and protocols were performed taking the quality controls (positive and negative) as a standard according to international protocol kit and manual literature.

For antibiotic testing, Antibiotic Susceptibility Test (AST) was measured using the dick diffusion method Mueller-Hinton Agar (MHA). The colonies were collected in their whole and emulsified in sterile distal water. Before inoculating the suspension in Muller Hinton agar (MHA), the turbidity was assessed to the 0.5 MacFarland standards using a modified Kirby- Bauer disc-diffusion technique. Using sterile forceps, the antibiotic discs were put aseptically on the Muller Hinton agar. Antibacterial medicines such cefoxitin were added to the plates and incubated for 18-24 hours at 35°C (30ug fox). The Clinical and Laboratory Standards Institute (CLSI) criteria were used to determine whether the test isolate was susceptible (S) or resistant (R) to each antibiotic by measuring the zone width of inhibition in millimetres using a ruler and interpreting the results according to the guidelines. By measuring the inhibitory zone diameter in millimetres using a ruler and interpreting the findings using the standards [12]. For statistical analysis, MS Excel and SPSS (version no 22) were used.

Results:

A total number of 120 samples were aseptically collected from the computer keyboard, mouse and telephone which were used by laboratory personals of different six private and government hospital laboratory sections including Clinical Pathology, Microbiology, Haematology, and Chemical pathology, Blood Bank, Phlebotomy and Histopathology, from each section of different hospital laboratories 20 (16.7 %) samples were collected from the devices equally. Out of 120, 42 (35.0 %) samples were collected from keyboard, 42 (35.0 %) from mouse and 36 (30.0 %) from telephone. A total of 59 (49.2 %) samples were resulted as Staph spp, 40 (33.3 %) samples were MRS, 6 (5.0 %) samples were MRSA, and 15 (12.5 %) samples were found with no growth as mentioned in table 1.

From hospital 1 out of 20 samples investigation, the percentage of bacteria that were found in clinical pathology (Staph spp. 5.1 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 0.0 %) in microbiology (Staph spp. 5.1 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 0.0 %) in haematology (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) in chemical pathology (Staph spp. 5.1 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 0.0 %) in blood bank (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) in phlebotomy (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) and in histopathology (Staph spp.1.7 %), (MRS 0.0%), (MRSA 0.0 %), (no growth 6.7 %) the overall percentage of bacteria and is (Staph spp. 25.4 %), (MRS 10.0 %), (MRSA 0.0 %) and (no growth 6.7 %) in hospital 1 mention above in table 2.From hospital 2 out of 20 samples investigation, the percentage of bacteria that were found in clinical pathology (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in microbiology (Staph spp. 0.0 %), (MRS 5.0 %), (MRSA 16.7 %), (no growth 0.0 %) in hematology (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in chemical pathology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 6.7 %) in blood bank (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) in phlebotomy (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) and in histopathology (Staph spp. 1.7 %), (MRS 2.5%), (MRSA 0.0 %), (no growth 0.0 %) the overall percentage of bacteria (Staph spp. 13.6 %), (MRS 25.0 %), (MRSA 16.7 %) and (no growth 6.7 %) in hospital 2 mention above in table 3.

From hospital 3 out of 20 samples investigation, the percentage of and were found in clinical pathology (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) in microbiology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 16.7 %), (no growth 0.0 %) in haematology (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in chemical pathology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 6.7 %), (no growth 6.7 %) in blood bank (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in phlebotomy (Staph spp. 0.0 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 6.7 %) and in histopathology (Staph spp. 0.0 %), (MRS 5.0%), (MRSA 0.0 %), (no growth 0.0 %) the overall percentage of bacteria is (Staph spp. 10.2 %), (MRS 27.5 %), (MRSA 16.7 %) and (no growth 13.3%) in hospital 3 mention above in table 4.

From hospital 4 out of 20 samples investigation, the percentage of bacteria that were found in clinical pathology (Staph spp. 3.4 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 6.7 %) in microbiology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 6.7 %) in haematology (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in chemical pathology (Staph spp. 3.4 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 6.7 %) in blood bank (Staph spp. 0.0 %), (MRS 2.5 %), (0.0 %), (no growth 13.3 %) in phlebotomy (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) and in histopathology (Staph spp. 0.0 %), (MRS 5.0%), (MRSA 0.0 %), (no growth 0.0 %) the overall percentage of bacteria (Staph spp. 13.6 %), (MRS 17.5 %), (MRSA 0.0 %) and (no growth 33.3%) in hospital 4 mention above in table 5.

From hospital 5 out of 20 samples investigation, the percentage of bacteria that were found in clinical pathology (Staph spp. 3.4 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 0.0 %) in microbiology (Staph spp. 3.4 %), (MRS 0.0 %), (MRSA 16.7 %), (no growth 0.0 %) in haematology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 6.7 %) in chemical pathology (Staph spp. 3.4 %),(MRS 0.0 %), (MRSA 0.0 %), (no growth 6.7 %) in blood bank (Staph spp. 3.4 %), (MRSA 0.0 %), (MRS 16.7 %) , (no growth 0.0 %) in phlebotomy (Staph spp. 0.0 %), (MRS 5.0 %), (MRSA 16.7 %), (no growth 0.0 %) and in histopathology (Staph spp. 1.7 %), (MRS 0.0%), (MRSA 0.0 %), (no growth 6.7 %) the overall percentage of (Staph spp. 16.9 %), (MRS 10.0 %), (MRSA 50.0 %) and (no growth 20.0%) in hospital 5 mention above in table 6.

From hospital 6 out of 20 samples investigation, the percentage of bacteria that were found in clinical pathology (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 0.0 %), (no growth 6.7 %) in microbiology (Staph spp. 3.4 %), (MRS 0.0 %), (MRSA 16.7 %), (no growth 0.0 %) in haematology (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %), (no growth 0.0 %) in chemical pathology (Staph spp. 3.4 %),(MRS 0.0 %), (MRSA 0.0 %), (no growth 6.7 %) in blood bank (5.1 %), (0.0 %), (0.0 %), (no growth 0.0 %) in phlebotomy (3.4 %), (2.5 %), (0.0 %), (no growth 0.0 %) and in histopathology (Staph spp. 1.7 %), (MRS 0.0 %), (MRSA 0.0 %), (no growth 6.7 %) the overall percentage of (Staph spp. 20.3 %), (MRS 10.0 %), (MRSA 16.7 %) and (no growth 20.0 %) in hospital 6 mention above in table 7.

From each device of clinical pathology sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 8.5 %), (MRS 2.5 %), (MRSA 0.0 %), mouse (Staph spp. 6.8 %), (MRS 5.0 %), (MRSA 0.0 %) and telephone (Staph spp. 3.4 %), (MRS 5.0 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (18.6 %), MRS (12.5 %) and the percentage of no growth was (13.3 %) mention above in table 8.

From each device of microbiology sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 1.7 %), (MRS 2.5 %), (MRSA 33.3 %), mouse (Staph spp. 5.1 %), (MRS 0.0 %), (MRSA 33.3 %) and telephone (Staph spp. 8.5 %), (MRS 2.5 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (15.3 %), MRS (10.0 %), MRSA (66.7 %) and the percentage of no growth was (6.7 %) mention above in table 9.

From each device of haematology sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 0.0 %), (MRS 15.0 %), (MRSA 0.0 %), mouse (Staph spp. 6.8 %), (MRS 5.0 %), (MRSA 0.0 %) and telephone (Staph spp. 5.1 %), (MRS 5.0 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (11.9 %), MRS (25.0 %), MRSA (0.0 %) and the percentage of no growth was (6.7 %) mention above in table 10.

From each device of chemical pathology sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 8.5 %), (MRS 2.5 %), (MRSA 0.0 %), mouse (Staph spp. 5.1 %), (MRS 2.5 %), (MRSA 0.0 %) and telephone (Staph spp. 5.1 %), (MRS 5.0 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (18.6 %), MRS (5.0 %), MRSA (0.0 %) and the percentage of no growth was (33.3 %) mention above in table 11.

From each device of blood bank sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 5.1 %), (MRS 2.5 %), (MRSA 16.7 %), mouse (Staph spp. 5.1 %), (MRS 5.0 %), (MRSA 0.0 %) and telephone (Staph spp. 6.8 %), (MRS 5.0 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (16.9 %), (MRS 12.5 %), (MRSA 16.7 %) and the percentage of no growth was (13.3 %) mention above in table 12.

From each device of phlebotomy sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 18 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 3.4 %), (MRS 7.5 %), (MRSA 16.7 %), mouse (Staph spp. 5.1 %), (MRS 7.5 %), (MRSA 0.0 %) and telephone (Staph spp. 3.4 %), (MRS 7.5 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (18.6 %), MRS (5.0 %), MRSA (16.7 %) and the percentage of no growth was (6.7 %) mention above in table 13.

From each device of histopathology sections, we collected individual sample from computer keyboard, mouse and telephone, after examination of 12 samples the percentage of isolated bacteria were found on the keyboards (Staph spp. 5.1 %), (MRS 7.5 %), (MRSA 0.0 %) and mouse (Staph spp. 1.7 %), (MRS 5.0 %), (MRSA 0.0 %). On the devices the overall percentage of Staph spp. was (6.8 %), MRS (12.5 %), MRSA (0.0 %) and the percentage of no growth was (20.0 %) mention above in table 14.

Discussion:

In our investigation total number of 120 samples were aseptically collected from the computer keyboard, mouse and telephone which were used by laboratory personals of different six private and government hospital laboratory sections. A total of 59(49.2 %) samples were resulted as Staph spp 40(33.3 %) samples were MRS, 6(5.0 %) samples were MRSA, and 15(12.5 %) samples were found with a mixed flora of Gram-negative and Gram-positive, and potentially pathogenic or non-pathogenic bacteria. On computer keyboard of different sections of laboratories, different species that is Staph spp 19(32.2%), MRS 18(45.0%), MRSA 4(66.7%) were found. While same study was conducted by Hartmann et al., (1987) who found the Staphylococcus epidermidis on the keyboard from one hospital while Staphylococcus aureus). Coagulase-positive Staphylococcus colonized 22.7 % from another hospital of instruments which were multiuser computer keyboards. according to the findings. Coagulase positivity is a cause for concern. When the appropriate conditions exist, Staphylococcus can become a pathogen [17]. while another study was conducted on keyboard by Graham et al., 2006 and America in 2005 by American society of microbiology they were found also that keyboard was responsible for contamination and spread of infection (20). another study on keyboard were done by Rutala et al. (2006) and Fukada T et al., 2008 at Japan and they were found that Bacillus spp, Streptococcus species and MRSA on computer and keyboard respectively [18].

In this study on computer mouse, Staph spp. 21(35.6%), MRS 12(30.0%), MRSA 2(33.3%) and no Growth 7(46.7%) were found. While same as a study was done by Awe et al., 2003 research was carried out to examine bacterial contaminations of computer mouse. The exhibited high bacterium counts ranging from 7.2 to 92.0 X104cfu/ml for mouse. *Staphylococcus aureus*, *Streptococcus species*, *Bacillus subtilis*, and *Micrococcus luteus* were identified as Gram-positive bacteria [9]. While in the research of Boyce et al., 2002, fifty (50) samples were taken from mouse on the AL-Mustansiriya computer in the main University of Baghdad, Iraq, and analyzed for bacterial contamination. 32 Gram-positive bacteria were found including 15 bacillus spp., 11 Staphylococcus aureus, and 6 *Staphylococcus epidermidis,* found that (54.24 percent) of the isolates were gram-positive bacteria, which included *S. aureus.* Other bacteria include *Staphylococcus epidermidis* (10.17 percent), Bacillus spp. (25.42 percent), and *Staphylococcus aureus* (18.64 percent) (45.77 percent). The computer user interfaces were standard office equipment that lacked any unique features such as wipe cleaning capability or disinfection tolerance [8]. According to Taraneh M et al., (2018), keyboards were shown to be much more contaminated than computer mouse. It's possible that this is because cleaning a keyboard takes longer and is more difficult than cleaning a computer mouse. Furthermore, the keyboard's uneven surface causes dirt and germs to collect [19].

The large difference in the number of colonizing isolates and their rates of isolation from multiple user keyboards and mouse vs single user keyboards and mouse, as reported, indicates that multiple user computers have a greater degree of colonization. As a result, anyone using a multi-user appliance should be more hygiene vigilant to avoid self-infection or cross-infection.

From this study on telephone, Staph spp. 19 (32.2%), MRS 10(25.0%), MRSA 0(0.0%) were seen. While Singh et al., (2010) reported that the most frequent isolates from mobiles were coagulase negative staphylococci (39.78 percent), 16 percent for *S. aureus*, (22) whereas our data revealed Staph spp. 19(32.2 percent), MRS 10(25.0 percent), and MRSA 0(0.0 percent). However, our investigation confirms that Staphylococcus spp. was the most common among all isolated species, with *S. aureus* accounting for 8.4% (27) of the total. Its resilience to drying, which favour's transmission, and its existence as part of the natural flora of the nose, mouth, and skin might explain its great prevalence. It's spread from one vulnerable host to another is thought to be the cause of pandemic pyogenic infections in hospitals and epidemic illnesses [1]. The organism is continually distributed from the nasal cavity when talking, breathing, and even exercising, according to Salle AJ et al., (1985). Antimicrobial susceptibility patterns were found in 44 percent of the total number of strains tested, with significant resistance to most of the antibiotics tested. This might be linked to self-medication and indiscriminate antibiotic usage, which has resulted in *S. aureus* developing resistance to relatively harmless medicines. It's spread from these locations produces endemic and pandemic illnesses. As a result, staphylococcal infection can be spread by holding *S. aureus*-infected telephones. *Streptococcus pneumoniae* was also isolated from the mouth and nose. Pneumonia, meningitis, endocarditis, otitis media, bronchitis, bacteremia, and sinusitis are only a few of the infections caused by it. Micrococcus spp., which causes micrococcal infections and is related to Staphylococcus spp., were among the other species found.

Conclusion: Microorganisms such as staph species, MRS, and MRSA were detected on computer keyboards, mouse, and telephones in hospital settings, according to this study. Some of the bacteria recovered in this study were extremely resistant to frequently used medicines. As a result, harmful germs found on computer keyboards, mouse, and telephones should be avoided. Infection control principles apply to computer keyboards, mouse, and telephones because they provide a surface for colonization. Antibacterial wet wipes, which are commercially available, can help to minimize the presence of germs on everyday equipment including telephones and computer keyboards and mouse.

Because disinfecting computer keyboards is difficult, users should take precautions such as hand washing and practicing good hygiene to avoid these devices becoming vehicles for pathogen transmission. Regular education and training should include the fundamentals of proper hygiene, respiratory etiquette, and hand washing. Decontamination and disinfection techniques for computers and telephones, particularly those used by laboratory personnel, should also be included. We must concentrate on appropriate surface disinfection and hand hygiene, as well as knowledge on how to clean and disinfect such surfaces. These precautionary measures can provide a validity of sample testing and assuring the results quality. Indeed, that is helpful for patient's accurate diagnosis and better prognosis.

Recommendation: The operatives cleaning techniques are ineffective in considerably decreasing bacterial contamination levels. Computer and telephone users have a very low degree of understanding. It is highly suggested that these devices must be cleaned to prevent microbiological transmission by hand washing. This will enhance the quality of diagnostic as well as research lab testing. In future these practices can ensure the quality of research which is a significant contribution to scientific community.

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Table 1. Frequency of species

Species		Frequency	Percent %	Valid Percent	Cumulative Percent
	STAPH SPP	59	49.2 %	49.2 %	49.2 %
	MRS	40	33.3 %	33.3 %	82.5 %
	MRSA	6	5.0 %	5.0 %	87.5 %
	NO GROWTH	15	12.5 %	12.5 %	100.0 %
	Total	120	100.0 %	100.0 %	

Table 2. Percentage of species in hospital 1

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 1	Clinical pathology	3	0	0	0
	Microbiology	3	0	0	0
	Hematology	2	1	0	0
	Chemical pathology	3	0	0	0
	Blood bank	2	1	0	0
	Phlebotomy	1	2	0	0
	Histopathology	1	0	0	1
	Total no. and percentage	15 25.4%	4 10.0%	0 0%	1 6.7%

Table 3. Percentage of species in hospital 2

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 2	Clinical pathology	1	2	0	0

	Microbiology	0	2	1	0
	Hematology	1	2	0	0
	Chemical pathology	1	1	0	0
	Blood bank	2	1	0	0
	Phlebotomy	2	1	0	0
	Histopathology	1	1	0	1
	Total no. and percentage	8 13.6%	10 25.0%	1 16.7%	1 6.7%

Table 4. Percentage of species in hospital 3

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 3	Clinical pathology	2	1	0	0
	Microbiology	1	1	1	0
	Hematology	1	2	0	0
	Chemical pathology	1	1	0	1
	Blood bank	1	2	0	0
	Phlebotomy	0	2	0	1
	Histopathology	0	2	0	0
	Total no. and percentage	6 10.2%	11 27.5%	1 16.7%	2 13.3%

Table 5. Percentage of species in hospital 4

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 4	Clinical pathology	2	0	0	1
	Microbiology	1	1	0	1
	Hematology	1	2	0	0
	Chemical pathology	2	0	0	1
	Blood bank	0	1	0	2
	Phlebotomy	2	1	0	0
	Histopathology	0	2	0	0
	Total no. and percentage	8 13.6%	7 17.5%	0 0.0%	5 33.3%

Table 6. Percentage of species in hospital 5.

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 5	Clinical pathology	2	1	0	0
	Microbiology	2	0	1	0
	Hematology	1	1	0	1
	Chemical pathology	2	0	0	1
	Blood bank	2	0	1	0
	Phlebotomy	0	2	1	0
	Histopathology	1	0	0	1
	Total no. and percentage	10 16.9%	4 10.0%	3 50.0%	3 20.0%

Table 7. Percentage of species in hospital 6

Hospital	Sections	Species			
		Staph spp.	MRS	MRSA	No growth
Hospital 6	Clinical pathology	1	1	0	1
	Microbiology	2		1	0

	Hematology	1	2	0	0
	Chemical pathology	2	0	0	1
	Blood bank	3	0	0	0
	Phlebotomy	2	1	0	0
	Histopathology	1	0	0	1
	Total no. and percentage	12 20.3%	4 10.0%	1 16.7%	3 20.0%

Table 8. Cross tabulation of Chemical pathology sections with species and devices

Section	Species	Devices			
		Keyboard	Mouse	Telephone	Total no. and percentage
Clinical pathology	**Staph spp.**	5 8.5%	4 6.8%	2 3.4%	11 18.6%
	MRS	1 2.5%	2 5.0%	2 5.0%	5 12.5%
	MRSA	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	No growth	0 0.0%	0 0.0%	2 13.3%	2 13.3%

Table 9. Cross tabulation of Microbiology sections with species and devices

Section	Species	Devices			
		keyboard	Mouse	Telephone	Total no. and percentage
Microbiology	**Staph spp.**	1 1.7%	3 5.1%	5 8.5%	9 15.3%
	MRS	3 7.5%	0 0.0%	1 2.5%	4 10.0%
	MRSA	2 33.3%	2 33.3%	0 0.0%	4 66.7%
	No growth	0 0.0%	1 6.7%	0 0.0%	1 6.7%

Table 10. Cross tabulation of Hematology sections with species and devices

Section	Species	Devices			
		Keyboard	Mouse	Telephone	Total no. and percentage
Hematology	**Staph spp.**	0 0.0%	4 19.0%	3 5.1%	7 11.9%
	MRS	6 15.0%	2 5.0%	2 5.0%	10 25.0%
	MRSA	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	No growth	0 0.0%	0 0.0%	1 6.7%	1 6.7%

Table 11. Cross tabulation of Chemical pathology sections with species and devices

Section	Species	Devices			
		Keyboard	Mouse	Telephone	Total no. and percentage
Chemical pathology	**Staph spp.**	5 8.5%	3 5.1%	3 5.1%	11 18.6%

	MRS	1 2.5%	1 2.5%	0 0.0%	2 5.0%
	MRSA	0 0.0%	0 0.0%	0 0.0%	0 0.0%
	No growth	0 0.0%	2 13.3%	3 20.0%	5 33.3%

Table 12. Cross tabulation of Blood bank sections with species and devices

Section	**Species**	**Devices**			
		Keyboard	**Mouse**	**Telephone**	**Total no. and percentage**
Blood bank	**Staph spp.**	3 5.1%	3 5.1%	4 6.8%	10 16.9%
	MRS	1 2.5%	2 5.0%	2 5.0%	5 12.5%
	MRSA	1 16.7%	0 0.0%	0 0.0%	1 16.7%
	No growth	1 6.7%	1 6.7%	0 0.0%	2 13.3%

Table 13. Cross tabulation of Phlebotomy sections with species and devices

Section	**Species**	**Devices**			
		Keyboard	**Mouse**	**Telephone**	**Total no. and percentage**
Phlebotomy	**Staph spp.**	2 3.4%	3 5.1%	2 3.4%	7 11.9%
	MRS	3 7.5%	3 7.5%	3 7.5%	9 22.5%
	MRSA	1 16.7%	0 0.0%	0 0.0%	1 16.7%
	No growth	0 0.0%	0 0.0%	1 6.7%	1 6.7%

Table 14. Cross tabulation of Histopathology sections with species and devices

Section	**Species**	**Devices**		
		Keyboard	**Mouse**	**Total no. and percentage**
Histopathology	**Staph spp.**	3 5.1%	1 1.7%	4 6.8%
	MRS	3 7.5%	2 5.0%	5 12.5%
	MRSA	0 0.0%	0 0.0%	0 0.0%
	No growth	0 0.0%	3 20.0%	3 20.0%