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Research Article

Isolation and Identification of Bacteria from Electronic devices used by Students and Staffs in Ines Ruhengeri

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Abstract

Background: Electronic devices have become one of the most essential accessories being used in daily lives including schools. Those devices increase the communication and using them makes learning much easier. Microbial contamination of electronic devices and inanimate surface of electronic equipment at INES-Ruhengeri can have a significant role for transmission of pathogenic bacteria.

Aim: The aim of this study was to isolate and identify bacteria from electronic devices used by students and staffs at INES-Ruhengeri University.

Methodology: This cross-sectional study was done on 40 electronic devices such as computers, microscopes, global positioning system (GPS) and total stations A random sampling method was applied from sterile swab soaked in peptone water solution by the technique of bearing on the surface of the entire devices and then placed in a transport medium. Collected samples were then taken in INES-Ruhengeri Microbiology laboratory for further experiments.

Results: All 40 electronic devices were contaminated with bacteria. The most predominant bacteria isolated from electronic devices was *S.aureus* (25.9%) followed by *Bacillus spp*(24.1%), *K.pneumonia*(12.9%), *S.epidermis*(12.9%), *Micrococcus spp*(7.4%), *P.aeruginosa*(5.5%), *E.coli*(3.3%), *Salmonella spp*(3.3%) *and Shigella spp*(3.3%). Antimicrobial susceptibility pattern of selected antibiotics was performed. Norfloxin was the most sensitive antibiotic on all isolated bacteria. Chloramphenicol antibiotic shown no activity over any of the isolated bacteria, to imply that all bacteria had resistance on it.

Conclusion: This study shown that there is bacterial contamination to all devices and antibiotic susceptibility test shown that some antibiotics were sensitive and resistant to the isolated bacteria.

Keywords: Bacterial contamination, electronic devices, antimicrobial susceptibility test

INTRODUCTION

Electronic devices have become one of the most essential accessories being used in daily lives including schools. Those devices increase the communication and using them makes learning much easier[1]. Although their efficiency in uses, they are also an easier mode of transmission of pathogens and people using them can easily be infected. As the use of electronic devices increase day after day, the concern of associated pathogenic transmissions increase worldwide as well as our country[2]. It has been reported that each year an average of 47.8 million people get infected by pathogens from known pathogens and unknown agents, and a huge number of them is in Africa[3].

It is clear that most of the infected people each year a huge percentage doesn't know where and when they were infected[3], and this rises a concern of the electronic devises we use every day, including telephones, portable machines, desktops, workshops and laboratory equipment[4] for students who accesses them for this case. Pathogens can be transmitted a few ways depending on the type. They can be spread through skin contact, bodily fluids, airborne particles, contact with faeces, and touching a surface touched by an infected person[5], and this is a fact that makes them more complicated to prevent transmission from one person to another.

Bacteria that can cause disease are known as pathogenic bacteria. The majority of bacterial species are relatively harmless and frequently helpful, but some can spread infectious diseases. Less than 100 of these pathogenic species are thought to exist in humans[6], Pathogenic bacteria are uniquely adapted and endowed with mechanisms for getting past the body's natural defence. They can enter areas of the body, like the blood, where bacteria are typically absent. Many pathogens travel deeper, spreading through the tissues and disseminating through the lymphatic and blood streams, while others only infiltrate the surface epithelium, skin, or mucous membrane[7]. Different studies conducted in African countries like Nigeria, Ethiopia and Egypt shows that electronic devices are potential reservoir for number of bacteria, All these studies indicated that the isolated and characterized bacteria from electronic devices known to be clinically significant are *Bacillus species*, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Proteus* species, *Pseudomonas aeruginosa*, *Staphylococcus* species and *Streptococcus* species[8] Therefore, this study aimed at isolation and identification of bacteria from electronic devices used by Students and Staffs in Ines Ruhengeri.

METHODOLOGY OF THE STUDY

Study area

The study was conducted at INES-Ruhengeri, located in Musanze District, Northern Province of Rwanda.

Study design

This study was cross-sectional. It was based on laboratory analysis, which used a variety of tools, supplies, and substances to record, label, obtain, and analyse specimen.

Study population and sample size

The study was carried out on electronic devices used by INES-Ruhengeri. The study was carried out on 40 electronic devices used by students and staffs.

Sample collection

A total of 40 (n=40) electronic devices were selected to collect sample. Samples were collected using disposable sterile cotton swabs moistened with peptone water from the examined surfaces of 20 computers, 4 microscopes, 6 total stations, and 10 GPS used by students and staffs. For sampling, the electronic devices used by students and staffs were taken on voluntary basis. Samples were collected by thorough rotating a cotton swab on the surface and the back of the electronic devices. Then placed in a transport medium which was peptone water. The samples were labeled appropriately and handled carefully in order to avoid contamination. After, the collected samples were transported at INES-Ruhengeri microbiology laboratory for analysis.

Laboratory analysis

Culture media preparation

Blood agar (BA), MacConkey agar (MCA) and Mannitol salt agar (MSA) served as culture media onto which electronic devices samples were cultured. Following, the manufacturer's instructions grams of each of the culture media were separately dissolved in corresponding milliliters of distilled water. This was followed by heating with repeated gentle agitation for 2 min to allow a complete dissolution. The culture media were then autoclaved at 121 °C for 15 min and 15 pounds per square inch. Finally, they were cooled down at 45 °C and poured in different Petri dishes for solidification.

Inoculation, incubation, and Gram staining

Streak method was used to inoculate specimens onto Petri dishes containing blood agar, MCA and MSA. The plates were aerobically incubated at 37 °C for 24 h. Growth was observed in terms of bacterial colonies formation. Identified colonies were separately smeared and fixed on different slides and finally Gram staining technique was performed. After air drying the stained slides were observed under microscope at 100X objective.

Antibiotics susceptibility testing

The antibiotics sensitivity of the isolates was tested against the following antibiotics Gentamicin (10 mcg), Chloramphenicol, Vancomycin, Cefepime, Rifampin, Norfloxin using Kirby Bauer antibiotics disc method. A colony of the test organisms was picked with sterile wire hoop and immersed in peptone water. The turbidity of the suspension was compared against a reference 0.5 McFarland tube. The suspension of the organism was streaked on the entire of Mueller-Hinton agar and the antibiotic disc was placed on the centre of the plate using forceps. The plates were incubated at 37ºc for 24 hours. The diameter of the zone of inhibition was measures using CLSI standard guidelines

Statistical Analysis

The data were analyzed and interpreted using Microsoft Excel 2013 software, the results were presented in figures.

RESULTS

This chapter presents the results of findings based on the isolates of bacteria on electronic devices used by students and staffs at INES-Ruhengeri.

Bacteria isolated from electronic devices

Figure below presents bacteria isolated from the sample collected on electronic devices such as, total station, microscope,computer and G.P.S at INES-Ruhengeri. The prevalence of *Staphylococcus aureus* was the most predominant with 25.9%, the second were *Bacillus spp 24.1%, Staphylococcus epidermidis and Klebsiella pneumonia* were the thirds at the prevalence of 12.9%, the forth was *Micrococcus spp* at 7.4%, *Pseudomonas aeruginosa* was the firth at 5.5%, the lowest prevalence were *3.7%* of *E.coli, Shigella spp* and *Salmonella spp.*

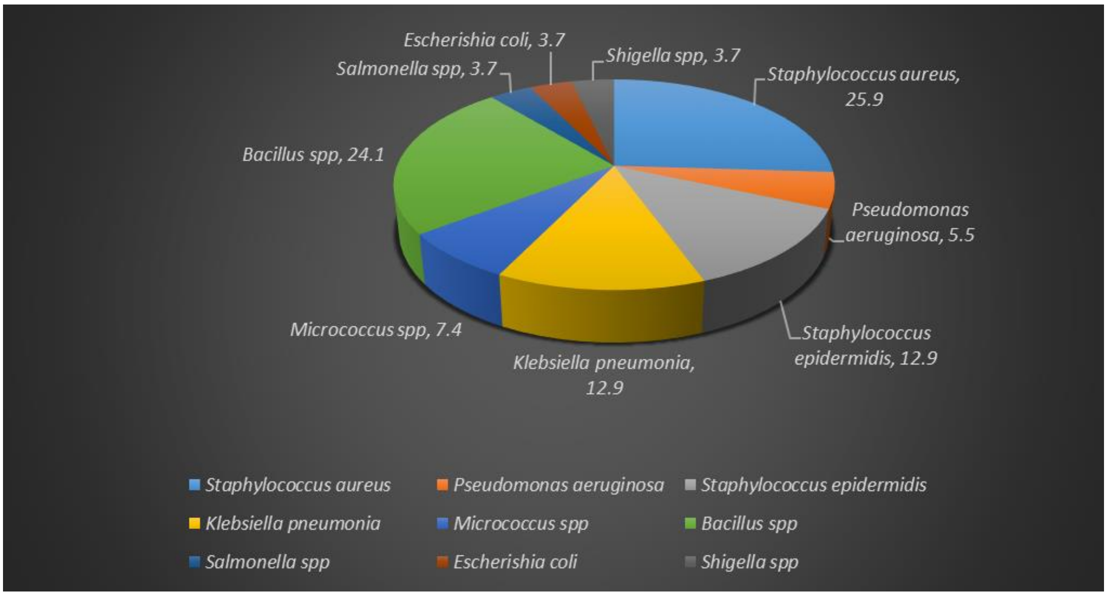

Figure 1: All isolated bacteria from electronic devices

Prevalence of isolated bacteria from different electronic devices

The figure below represents the prevalence of isolated bacteria based different electronic devices at INES-Ruhengeri: computer, total station, G.P.S and microscopes. There were 20 computers to which 7 bacteria were isolated. The prevalence of *Bacillus spp* was the most predominant with 26.47%, the second were *Staphylococcus aureus* at the rate of 23.52% %, *Staphylococcus epidermidis* was the third at the prevalence of 14.7%, *Micrococcus spp* was fourth at the rate of 11.76%, *Klebsiella pneumonia* and *Pseudomonas aeruginosa* were the firth at prevalence of 8.82% and the lowest prevalence was *Salmonella spp* at the rate of 5.88%.

Six total stations were among the devices, 4 bacteria were identified including *Staphylococcus aureus* and *Bacillus spp* that had the same prevalence of 33.33%. *Klebsiella pneumonia* and *Staphylococcus epidermidis* with the prevalence of 16.66%. The figure also shows 6 bacteria isolated on 10 G.P.S including *Klebsiella pneumonia* with highest prevalence of 30.00%. *E.coli* and *Staphylococcus aureus* with the prevalence of 20.00%. The lowest prevalence was *Shigella spp*, *Bacillus spp* and *Staphylococcus epidermidis* with the prevalence of 10.00%. 4 microscopes were found to have *Staphylococcus aureus* with the rate of 50.00%, *Shigella spp* and *Bacillus spp* were identified with prevalence of 25.00%.

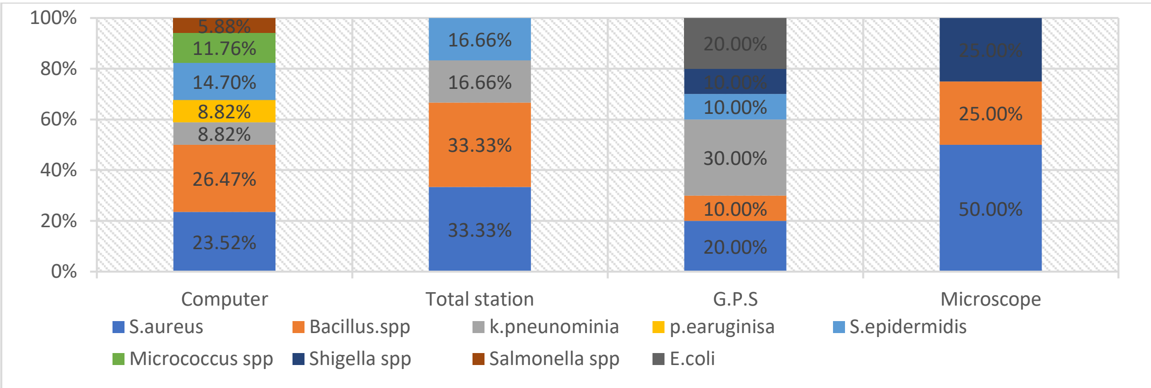

Figure 2: Isolated bacteria based on different electronic devices

Antimicrobial susceptibility pattern of selected antibiotics

Figure 3 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *S.aureus. S.aureus* was sensitive to two antibiotics Gent(20mm) and NX(30mm), half sensitive to two antibiotics Rif(17mm) and CIP(15mm) and resistance to two antibiotics C(0mm) and VA(14mm).

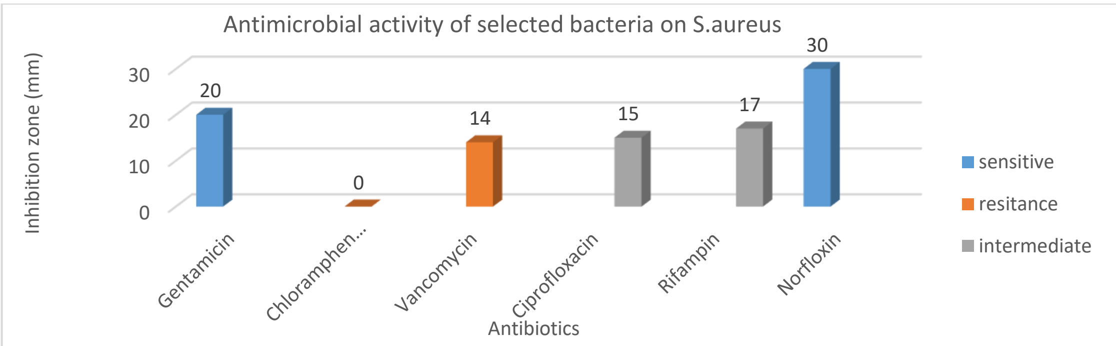

Figure 3: Antimicrobial activity on *S. aureus*

The figure 4 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *S.epidermidis. S.epidermidis* was resistance to one antibiotic C (0mm), half sensitive to two antibiotics Rif (19mm), CIP (14mm) and sensitive to three antibiotics Gent (23mm), Nx (29mm) and VA (20mm).

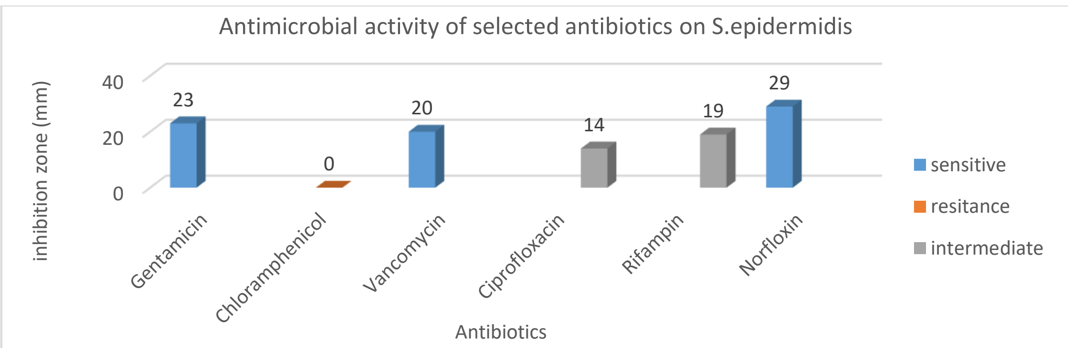

Figure 4: Antimicrobial activity on *S.epidermidis*

The figure 4 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *Micrococcus spp. Micrococcus spp* was resistance to three antibiotics Rif (8mm), C (0mm) and CIP (0mm) and sensitive to Gent (22mm), Nx (27mm) and VA (23mm).

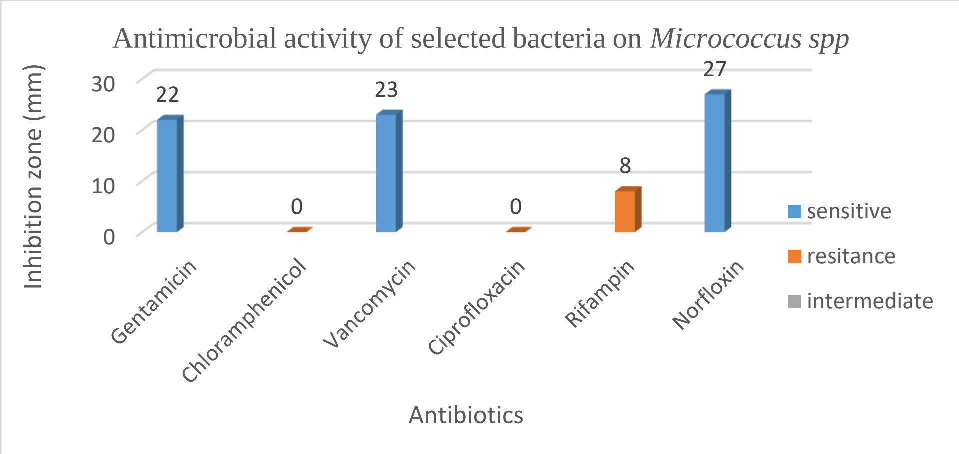

Figure 5: Antimicrobial activity on *Micrococcus spp*

The figure 6 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *K.pneumonia. K.pneumonia* resisted to two antibiotics CPM (11mm) and Rif (12mm) and sensitive to four antibiotics Nx (26mm), VA (20mm), CIP (20mm) and Gent (32mm).

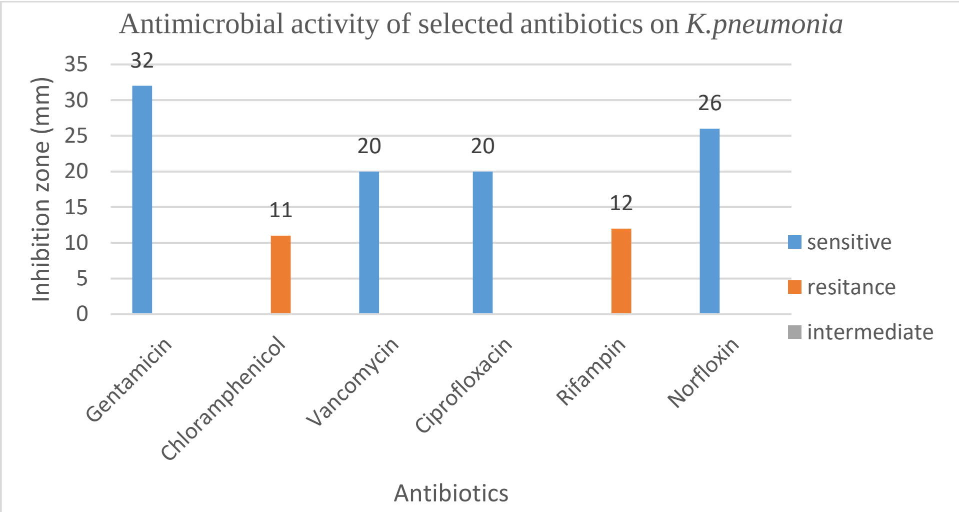

Figure 6: Antimicrobial activity on *K.pneumonia*

The figure 7 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *Shigella spp. Shigella spp* resisted to three antibiotics Cpm (0mm), Rif (0mm) and VA (0mm) and sensitive to three antibiotics CIP (38mm), Nx (37mm) and Gent (20mm).

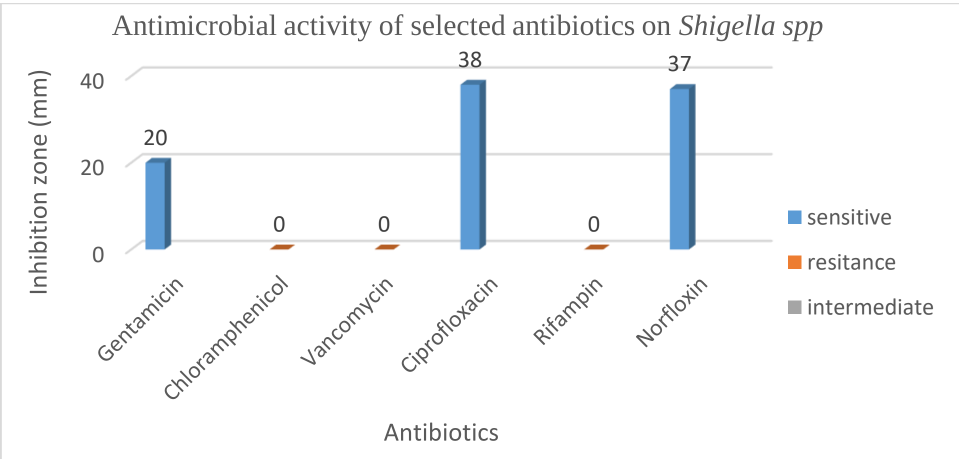

Figure 7: Antimicrobial activity on *Shigella spp*

The figure 8 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *E.coli. E.coli* resisted to four antibiotics Gent (0mm), Cpm (0mm), VA (0mm) and Rif (14mm) and sensitive to two antibiotics C (30mm) and Nx (18mm).

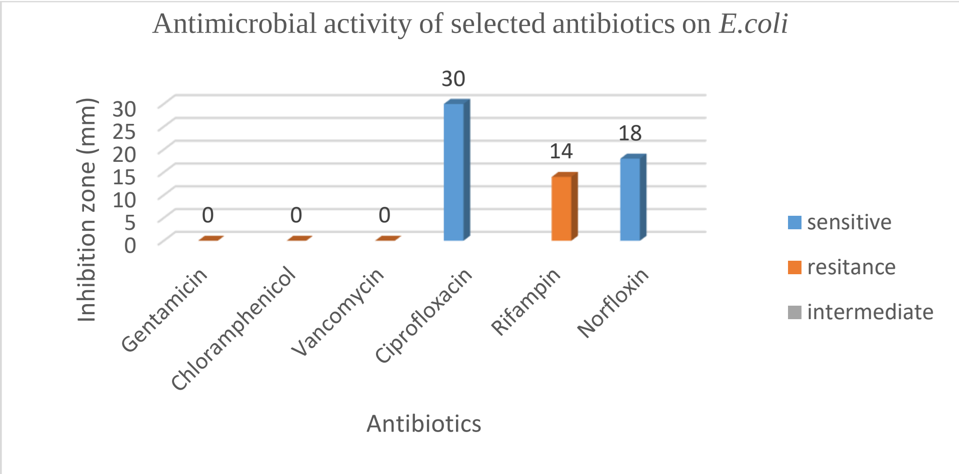

Figure 8: Antimicrobial activity on *E. coli*

The figure 9 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *Salmonella spp. Salmonella spp* resisted to one antibiotic Cpm (0mm) half sensitive to Rif (19mm) and sensitive to Nx (28mm), VA (25mm), CIP (30mm) and Gent (33mm).

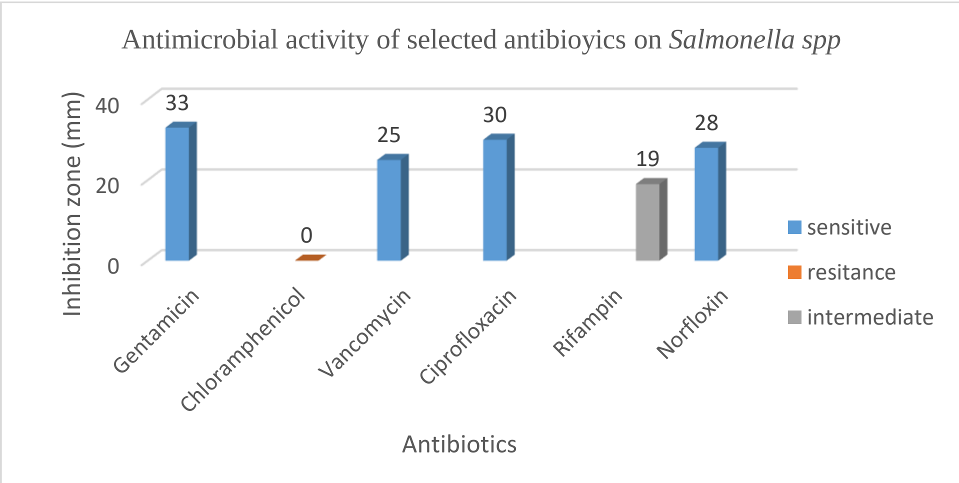

Figure 9: Antimicrobial activity on *Salmonella spp*

The figure 10 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *Pseudomonas aeruginosa. Pseudomonas aeruginosa* resisted to three antibiotics Rif (8mm), C (0mm) and VA (0mm) half sensitive to Gent (17mm) and sensitive to C (24mm) and Nx (26mm).

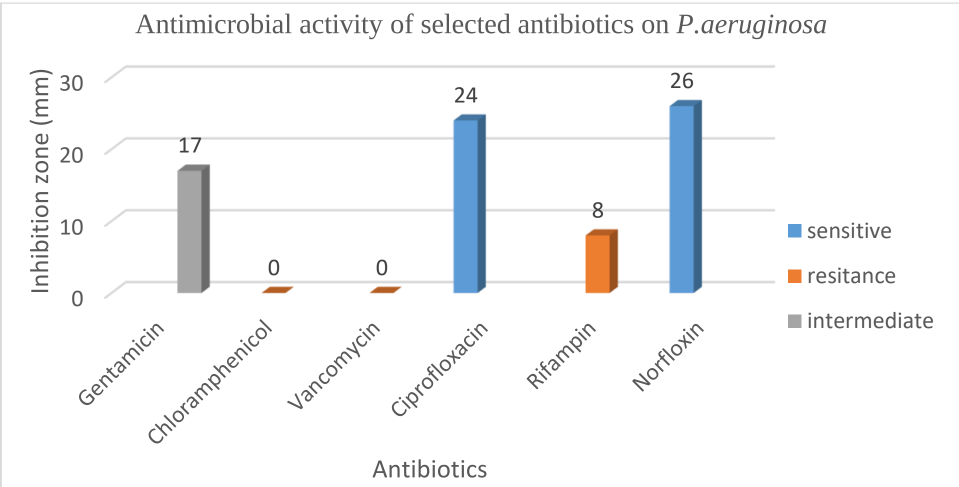

Figure 10: Antimicrobial activity on *P.aeruginosa.*

The figure 11 shows the antimicrobial activity of six antibiotics which are Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin on *Bacillus spp. Bacillus spp* resisted to Cpm (0mm) and Rif (11mm) and sensitive to Gent (17mm), VA (28mm), C (31mm) and Nx (31mm).

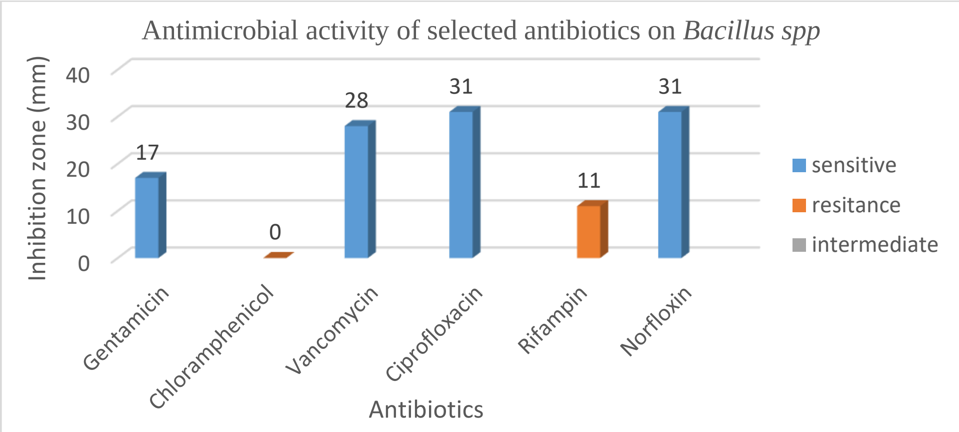

Figure 11: Antimicrobial activity on *Bacillus spp*

DISCUSSION

The current life makes it impossible to not meet microbes but microbiological standards and hygiene practices should be adapted by the society for a healthy life. It is to this end that this study revealed high levels of bacterial contamination were detected on electronic devices at INES-Ruhengeri taken as samples in this study to imply Computers, Mobile phones, GPS and Total stations. A total frequency of 54 bacterial isolates comprising 9 different species, were isolated. The isolates showed different species to which some were Gram positive and others Gram negative bacteria, however Gram-positive bacteria were found to occur more than Gram negative bacteria, because most of the skin flora bacteria are Gram positive.

The species isolated were *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, *Klebsiella pneumonia*, *Micrococcus spp*, *Bacillus spp*, *Salmonella spp*, *Escherishia coli* and *Shigella spp.* This result is similar to the findings reported by other researchers that was conducted in Ethiopia, where species like *Pseudomonas aeruginosa, Staphylococcus aureus, Escherishia coli* were reported in these studies[9], as well as this study carried out on electronic divices in INES-Ruhengeri. This is to imply that electronic devices can be a source of infections and transmission of pathogens.

Staphylococcus aureus, with 14 isolates (25.9 %), was the most predominant bacterial contaminant of the electronic devices. This result is similar to the findings reported by [8] that was conducted in Nigeria, where Staphylococcus aureus was predominant. *Staphylococcus aureus* is a major component of the normal flora of the skin and nostrils, which 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 and nosocomial infections[8]. It follows that since users constantly touch interfaces and often sneeze, there is every chance of introducing *S. aureus* on to the interface in use[10].

Bacillus spp, with 13 isolates (24.1%), was the second most frequent contaminant of electronic devices isolated. They are mostly found in soil and the gastrointestinal tract of ruminants and humans, to imply that they are passed from person to electronic devices when the person using that device didn't have a good hand hygiene before using it, as it was found also by the study conducted in Slovakia, on the degree of contamination of cell phone and computer interface and keyboards[11].

Pseudomonas aeruginosa, showed 3 isolates (5.5%). *Pseudomonas aeruginosa* is a Gram negative bacteria that different studies reported that it has become an antibiotic resistant bacteria and that causes many infections including being dominant in causing chronic lung infections and contributing to death of patients with chronic fibrosis[12]. And other studies also presented *Pseudomonas aeruginosa* as one of the dangerous bacteria and were present on electronic devices[8].

Staphylococcus epidermidis, Klebsiella pneumonia both showed the same number of isolates 7 each (12.9%) were other major contaminants on electronic devices user interfaces at INES Ruhengeri. The presence of these organisms on electronic hardware user interfaces is a cause for some alarm, because they have been shown to possess the potential to cause infections. These bacteria were also reported in other studies to mean that their origin might be common in different regions and countries[13].

Micrococcus spp, Salmonella spp, Escherishia coli and Shigella spp also were present where *Micrococcus spp* showed 4 isolates (7.4%) and *Salmonella spp, Escherishia coli and Shigella spp* presented the same isolates number 2 each (3.7%). The presence of these bacteria is the indication of faecal contamination on electronic devices[14]. Moreover, all electronic devices were 100% contaminated because no single device which didn´t show the presence of bacteria. Therefore, from the knowledge of different studies related on bacteria isolation on electronic device, this study complied with them as it presented the image of how electronic devices in INES-Ruhengeri are contaminated with different pathogens.

Moreover, antimicrobial susceptibility pattern of selected antibiotics such as Gentamicin, Chloramphenicol, Vancomycin, Ciprofloxacin, Rifampin and Norfloxin, was performed to asses that antibacterial activity of these drugs as well as to know the resistant bacterial species on these antibiotics.

Norfloxin was the most sensitive antibiotic on all isolated bacteria where it exhibited zone of inhibition of 30mm on *Staphylococcus aureus,* 26mm on *Pseudomonas aeruginosa,* 29mm on *Staphylococcus epidermidis,* 27mm on *Micrococcus spp,* and 31mm on *Bacillus spp* and 37mm on *Shigella spp,* it also sensitive on *Klebsiella pneumonia, Salmonella spp* and *E. coli* bacteria. This result is in agreement with other study conducted in largest teaching hospital at the northwest of Iran[15].

Gentamicin antibiotic showed high sensitivity of antimicrobial activity on *Klebsiella pneumonia* and *Salmonella spp* of 32mm and 33mm of zone of inhibition respectively and *E. coli* had resistance on this Antibiotic. This result is similar to the findings reported by another researcher, that was conducted in Zimbabwe, where by *E.coli* were sensitive[16]. Chloramphenicol antibiotic shown no activity over any of the isolated bacteria, to imply that all bacteria had resistance on it. Vancomycin shown intermediate activity on almost every bacteria except for *Pseudomonas aeruginosa, E. coli* and *Shigella spp* that showed resistance on this Vancomycin, this result is in agreement with other study conducted in largest teaching hospital at the northwest of Iran[17].

Ciprofloxacin showed high sensitive on all gram negative bacteria such as *E.coli, K.pneumonia, Shigella* spp, *Salmonella spp*, *P.aeruginosa and Bacillus spp* which was gram positive bacteria of 30mm, 20mm, 38mm, 30mm, 24mm and 31mm of inhibition zone respectively, however *Micrococcus spp, S.epidermidis* and *S.aureus* exhibited the resistance on Ciprofloxacin.

CONCLUSION

The isolation and characterization of bacteria was done based on biochemical test of differential staining. The finding identified *S.aureas, Bacillus spp, K.pneumonia, S. epidermis, Micrococcus spp, P.aeruginosa, E.coli, Salmonella spp and Shigella spp* bacterial species. This study showed that computers, microscopes, total stations and GPS would serve as a vector to transmit these bacteria from one individual to another. Moreover, electronic devices used by students and staffs at INES-Ruhengeri were found to be contaminated with potentially pathogenic bacteria, highly resistant to some commonly used antibiotics. These electonic devices are therefore potential vehicles for the transmission of clinically important pathogens through human own hands.

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Author Contributions

All authors contributed equally for this study.

Conflict of interest

Authors declare no conflict of interest

Fundings

N/A

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