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Isolation, Characterization and Antibiotic Susceptibility Patterns of Pseudomonas Aeruginosa and Staphylococcus Aureus from Hospital Environment in Kaduna Metropolis, Kaduna State

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***Abstract*- Background:** Hospital acquired infections are serious problems in patient care, and adversely affect the mortality and morbidity; despite antimicrobial therapy and advances in supportive care. The environment can serve as a source of infection. The aim of this work is to evaluate contamination of the inanimate hospital environment by bacterial agents, particularly *Staphylococcus aureus* and *Pseudomonas aeruginosa*; and to determine the susceptibility of the bacterial isolates to various antibiotics.

Methods: Four different hospitals were included in this study. These are General Hospital Sabo, St. Gerard Catholic Hospital, Barau Dikko Specialist Hospital, and Yusuf Dantsoho Memorial Hospital. Between October 2014 to January 2015, 160 swabs samples (40 each) were taken from environmental surfaces of the four hospitals. Bacterial identification was carried out using routine biochemical tests, and confirmed with polymerase chain reaction. Susceptibility testing for the bacterial isolates was done using the disk diffusion method.

Results: One hundred and seventy (170) bacterial pathogens were isolated, of which 138(81.2%) were identified as *Staphylococcus aureus*, and 32(18.8%) were identified as *Pseudomonas aeruginosa* and all were confirmed with polymerase chain reaction. The total percentage distribution of this pathogen on the surfaces was 53.12%. *S. aureus* was isolated from sinks (43.8%), floor (90.6%), bedrails (96.9%) , door knobs(100%) and table tops(100%). *P. aeruginosa* was isolated from sinks (59.4%), floor (34.4%), table tops (6.3%) with none isolated from door knobs and bedrails. The statistical analysis showed that there was significant difference in the prevalence rate of the organisms on the surfaces. (P=0.000*). Of all the *Staphylococcus aureus* isolates, 41.3% were found to be multi-drug resistant (MDR), while 21.9% of the *P.aeruginosa* isolates were MDR.

Conclusion: Lack of a universal procedure for surveillance of nosocomial infection, presence of pathogenic bacteria with multidrug resistant organism, poor hygiene practices and heavy contamination of some important surfaces are the most important problems in our hospitals.

***Index Terms*-** Hospital acquired infections; Staphylococcus aureus; Pseudomonas aeruginosa; Antibiotic susceptibility patterns; hospital environment.

I. Introduction

Hospital acquired infections are serious problems in patients care and adversely affect the mortality and morbidity despite antimicrobial therapy and advances in supportive care (Anton and David, 2010). It is a major public health concern these days and a cause of substantial mortality and morbidity for hospitalized patients (Thapa *et al*., 2009). Nosocomial infection caused by the nosocomial pathogens has pose a problem of enormous magnitude globally, hospital localities have proven favourable in transmission of infection due to existing suitable pathogens-host-environment relationship (Samuel *et al*., 2010).

The occurrence of multi-drug resistance in hospital-associated pathogens has resulted in the emergence and re-emergence of difficult-to-treat nosocomial infections in patients depicting the pre-antibiotic era. These infections are difficult to eradicate due to resistance to many antibiotics, thus major cause of morbidity and mortality, leading directly and indirectly to an enormous increase in cost of hospital stay for the patients and also emergence of new health hazards for the community.

Hence, this research is aimed to investigate the occurrence, distribution and determine the antibiotic susceptibility pattern of most common potential nosocomial bacteria particularly *Pseudomonas aeruginosa* and *Staphylococcus aureus* in some selected hospital environment in Kaduna metropolis, Kaduna

II. METHODS

Study population and ethical approval

This study was conducted in Kaduna, with specimens collected from the hospital environment in four different hospitals spread across Kaduna metropolis.

Before samples were collected, information regarding the study was explained to the individual hospital managements and consent for participation in the study was gotten following approval by the ethical committee of Kaduna state Ministry of Health.

Sampling design and techniques

A total number of one hundred and sixty (160) swabs samples for the studies were collected from floors, door knobs, table tops, bedrails, and sink using sterile swab sticks for the purposes of isolating microorganisms from these sources and transported to the laboratory for analysis within one hour for a period of four months (October 2014 –January 2015). These samples were inoculated into two different selective media, to make a total of three hundred and twenty culture plates.

Isolation and characterization of isolates

Organisms were identified by Gram stain, catalase, coagulase test oxidase test. And confirmatory test done by using microgen Gram negative (GNA + GNB) and microgen STAPH identification kits. molecular characterization of the isolates done using PCR

In-vitro determination of antibiotic susceptibility

This was done using the agar disc diffusion method

III. RESULTS

A total of one hundred and sixty (160) samples were collected from the environments of four different selected hospitals in Kaduna metropolis for this study. Eight (8) swab samples from each of the five different surfaces that is, sinks, floor, door knobs, table tops and bed rails in each of the hospitals making a total of forty swab samples per hospital, the swab samples were inoculated each into two(2) different selective media for the purpose of bacterial isolation.

One hundred and seventy bacterial pathogens were also isolated in all. These include General hospital Sabo 36 (21.17%), Saint Gerard hospital 41 (24.11%), Barau Dikko Specialist hospital 43 (25.29%) and Yusuf Dantsoho memorial hospital 50 (29.41%), with the highest number of isolates from Yusuf Dantsoho memorial hospital as shown in table 4.2.

Of all the isolates a total of 138(81.2%) were tested positive for *S. aureus* of which Yusuf Dantsoho is having the highest number 37(26.8%), followed by Barau Dikko Specialist hospital with 35(25.4%), St. Gerard 34(24.6%) and GHS 32(23.2%). 32(18.8%) were tested Positive for *P. aueroginosa*, following the same pattern with Yusuf Dantsoho having the highest number 13(40.6%), followed by Barau Dikko Specialist hospital 8(25.0%), St Gerard 7(21.9%) and GHS 4(12.5%).

The total percentage distribution of this pathogen on the surfaces was 53.12%. *P. aeruginosa* was isolated from sink (59.4%), floor (34.4%), table tops (6.3%) with no *P. aeruginosa* isolated from door knobs and bedrails. 43.8% of *S. aureus* was isolated from sink, 90.6% on floor, 96.9% from bedrails and 100% from door knobs and table tops. The statistical analysis showed that there was significant difference in the prevalence rate of the organisms on the surfaces of the four hospitals $P < 0.05$.

Table 4.5 shows the Prevalence rate of *S. aureus* isolated from various surface in the four selected hospitals with 138 pathogens isolated from the 160 samples screened. At the General Hospital Sabo 6.3, 21.9, 25.0, 25.0, and 21.9 % of *S. aureus* was isolated from sinks, floor, door knobs, table tops and bed rails respectively and the percentage distribution for this hospital among the four hospitals is 23.2%. In St. Gerard the percentage isolated was 12.5, 18.8, 25.0, 25.0, and 7.0% from sinks, floor, door knobs, table tops and bed rails respectively with the percentage distribution of 24.6%. Barau Dikko Specialist hospital has sinks, floor, door knobs, table tops and bed rails with 9.4 and others 25% respectively. The percentage distribution was 25.4% .Yusuf Dantsoho has 15.6, and others equal of 25% from sinks, floor, door knobs, table tops and bed rails respectively. The percentage distribution of the pathogen is 26.8%.

Table 4.6 shows the Prevalence rate of *P.* aeuroginosa isolated from various surface in the four selected hospitals with 32 pathogens isolated from the 160 samples screened. At the General Hospital Sabo, 9.4 and 3.1% of *P. aeuroginosa* was isolated from sinks and floor respectively with none from the door knobs, table tops and bed rails and the percentage distribution among the hospitals is 12.5%. In St. Gerard the percentage isolated also was 12.5 and 9.4% from sinks and floor respectively while none from the other surfaces with the percentage distribution of 21.9%. Barau Dikko Specialist hospital has 15.6 and 9.4% isolated from sinks and floor, while door knobs, table tops and bed rails have none isolated. The percentage distribution was 25.0%. Yusuf Dantsoho has it isolated from sinks (21.9%), floor (12.5%), table tops (6.3%) while none from door knobs and bed rails. The percentage distribution of the pathogen is 40.6%.

Different antibiotic tested against *S.aureus* were shown in table 4.9. The pattern at the GHS shows resistance rates were high in the use of ampicillin (100%) and amoxicillin (96.9%), The number of strains resistant to tetracycline were 2 (6.3%), Chloramphenicol 5(15.6%)and erythromycin 3(9.4%) . A good sensitivity rate of 100 and 93.7% were recorded with vancomycin and streptomycin respectively. Some were sensitive to erythromycin 25(78.1%), Tetracycline 20(62.5%), Gentamycin 17(53.1%), and chloramphenicol 12(37.5%).

Isolates from St. Gerard also showed high resistance of *S.aureus* to both ampicillin 31(91.2%) and Amoxillin 30(88%), the sensitivity rates were high with Vancomycin 34(100%), Streptomycin 34(100%), chloramphenicol 30(88.2%), Tetracycline and erythromycin 85.3% each while chloramphenicol sensitive to 24(70.6%) of the isolates. Barau Dikko Specialist hospital has similar pattern with Ampicillin and Amoxillin resistance to *S.aureus* 97.1 and 91.4 % respectively. 100% were susceptible to Vancomycin and streptomycin, Tetracycline 31(88.6%), Chloramphenicol 30(85.7%) with erythromycin and gentamycin 71.4% each.

The resistance rates follow the same pattern in Yusuf Dantsoho hospital with Ampicillin 35(94.6%) and amoxicillin 34(91.9%). Vancomycin also showed 100% susceptibility with good number susceptible to streptomycin 34(91.9%), erythromycin 33(89.2%), chloramphenicol and Gentamycin 81.1% each and Tetracycline 27(73%).

DISCUSSION

The results of this study showed that a total of 170 *Staphylococcus aureus* and *Pseudomonas aeruginosa* were isolated in four different hospitals environment in Kaduna metropolis. *Staphylococcus aureus* 138 (86.3%) is the most frequently occurring bacteria isolated, then *Pseudomona aeruginosa 32*(20.0%). Isolation of more Gram positive organisms is consistent with previous reports (Neely and Maley, 2000; Chikere et al., 2008 and Aminu et al., 2014). Similar study done in selected hospitals in Akoko, Ondo State Southwest Nigeria (Alabi et al., 2013) showed that the frequency of isolation of gram positive bacteria was higher than the gram negative which also corroborate the findings of this study and agree with the statement that Gram-positive bacteria have overtaken the Gram-negative as the predominant bacteria isolated from fomites (Inweregbu et al., 2005).

The result of this study is also consistent with Jalalpoor *et al.* (2009) who reported that *Staphylococcus species* (54.7%) was the most frequent bacteria isolated in hospital environment; same with 55.6% reported by Anyadoh-Nwadike et al. (2011) in Owerri, Imo State South Eastern, Nigeria. It also correlates with the findings of Atata (2008) among hospitals in Ilorin, North central Nigeria with similar result from Onche and Adeayi, 2004; Oguntibegu and Nwobu, (2004). Also previous studies in this environment confirmed *Staphylococcus aureus* to be the leading organism on surfaces of hospital environments. The result of this study is similar to the report of Okesola and Oni (2009) which showed that *Staphylococcus aureus* is the most frequent bacteria isolated in the hospital environments. It is also quite similar to the result of Ijioma *et al* (2010) which reported that *Staphylococcus aureus* was the most prevalent bacteria isolated in the environment of labour ward of Umuguma and Umezuruike general hospital, Owerri, while Bouzada *et al* (2010) reported that *coagulase negative Staphylococcus* was the most prevalent accounting for 43.7% of the total isolates in tertiary health care hospital, Brazil. Also the result of this study correlates with the report of Chikere *et al (*2008) which showed that *Staphylococcus epidermidis* and *Staphylococcus aureus* were the most prevalent bacteria isolated in the hospital environments. It is also consistent with the report of Swain and Otta (2012) who showed that *S. aureus* was the most prevalent pathogen isolated in hospital specimen (Wound).

In contrast, the result of this study did not agree with the work of Orji *et al (2005)* which showed that *Staphylococcus aureus* was the least among the isolated bacteria in his study. However, the prevalence rate gotten in this study for *Staphylococcus aureus* and *Pseudomonas aeruginosa* is still higher than the rate noted by Jalalpoor et al (2009), rates of 30.2% and 12.0% by Muhamad et al (2013) from some hospital surfaces in Sokoto. A study carried out in some selected hospitals in Abeokuta Southwest Nigeria (Okonkwo et al, 2009), recorded prevalence of 20.0% and 13.3% respectively comparatively lower than that obtained in this study.

The high level of recovery of these pathogens could also be as a result of inadequate decontamination of the microbial load from the surfaces (Addy *et al*., 2004) even though statistically, there was no significant association between organisms isolated from the surfaces and the hospital environment that is at $P > 0.05$

This finding corroborates earlier report of Hassan *et al.* (2004) and Page *et al.* (2009) that surfaces can act as reservoirs of microbes which could in turn lead to the spread of infection upon being touched, by either healthcare workers, patients or visitors. Carvalho *et al*. (2007) reported 46.1% cases of *Staphylococcus aureus* from hospital surfaces and Weber *et al.* (2010) also in their work have reported the role play by hospital surfaces in the transmission of emerging healthcare-associated pathogens. Crowded conditions within the hospital, frequent transfer of patients from one unit to another, and concentration of patients highly susceptible to infection in one area (e.g. newborn infants, burn patients, and intensive care) all may contribute to development of nosocomial infections due to contaminated surfaces. Microbial flora may contaminate surfaces of objects, devices, and materials which subsequently contact susceptible body sites of patients (Chikere *et al*., 2008). The role of hospital environment in the distribution of nosocomial pathogen cannot be overemphasized.

The prevalence of *Staphylococcus aureus* on table tops of the four hospitals that is, 100% of the isolates is greatly higher compared with 14.3% as reported by Ekrami *et al*. (2011). This finding is corroborated by the report of Carvahlo *et al*. (2007) that the surfaces of hospital environments serve as a secondary reservoir for multi-resistant microorganisms, such as MRSA.

Also, 38% of *Staphylococcus aureus* reported on door handle by Carvalho *et al*. (2007) is lower to the prevalence of the pathogen on door knobs of 100% from all the four hospitals.Similar prevalence of 100% of *Staphylococcus aureus* on door knobs in all the selected hospitals confirms the early report of Nworie *et al.* (2012) for Abuja metropolis that the contamination of door knob/door handle can be as a result of poor hand hygiene after using toilet. Bhalla *et al*. (2004) and Boyce (2007) reported that environmental contamination in healthcare settings occur when healthcare workers touch the surfaces with their hands or gloves especially after their routine patients care or when the patients come in direct contact with the surfaces.

High prevalence rate of *Staphylococcus aureus* on bedrail, 96.9% with GHS has 87.5% and others 100% is in agreement with 100% prevalence on bedrail as reported by Boyce (2007). The prevalence of 90.6% on the floor with 87.5, 75, 100, and 100% each from GHS, St. Gerard, Barau Dikko Specialist hospital and Yusuf Dantsoho memorial hospital respectively is higher than 8.6 and 16.7% reported by Hammuel C et al (2014) in two different hospitals' environment in Zaria likewise 30.8% by Boyce et al. (1997) and 50.0% by Carvhalo K.S (2007) in Brasil probably different environmental hygiene in these locations could be the reason for this variation.

The lowest prevalence is from the sinks and it's 43.8% with the percentages of 25%, 37.5%, 50% and 62.5% of all the samples screened in GHS, St. Gerard, Nursing home and Yusuf Dantsoho Memorial hospital respective.

The high prevalence of *Pseudomonas aeruginosa*, 59.4% in sinks of the four hospitals is also higher compared with a work reported by Pal *et al*. (2010) that 4.47% of the pathogen was isolated from sinks in hospital environment in Iran. The isolation of this pathogen from the sinks confirms the report of Udeze *et al*. (2012) that sinks are the most common place in hospital environment were *P. aeruginosa* are predominantly found. The finding also confirms the report of Silva *et al*. (2003) that hospital surfaces have been implicated in the outbreaks of *P. aeruginosa* infection.

The prevalence of 9.1, 27.3, 27.3 and 36.4% of *Pseudomonas aeruginosa* from floors of GHS, St. Gerard, Nursing home and Yusuf Dantsoho respectively is higher compare to findings of Ekrami *et al.* (2011) which in their report stated that only 4.47% of this pathogen was isolated from floor in a hospital environment.

Pseudomonas aeruginosa was not isolated from door knobs and bed rails of the four hospitals. This corroborates the report of Sabra (2013) that *Pseudomonas aeruginosa* are mainly isolated from moist environment in hospitals.

Infections caused by *Staphylococcus aureus* and *Pseudomonas aeruginosa* are increasing both in hospitals and in general community (Hauser and Sriram, 2005; Maltezou and Giamarellou, 2006). The efficacy of many antibiotics for treatment of severe infections has become quite limited due to the development of resistance. High resistance of *Staphylococcus aureus* to ampicillin; that is 100% resistance from GHS, 91.2% from St. Gerard, 97.1% from Barau Dikko Specialist hospital and 94.6% from Yusuf Dantsoho Memorial hospital is in agreement with 97.0% of *Staphylococcus aureus* resistance to ampicillin as reported by Terry-Alli *et al*. (2011) from south western Nigeria and also substantiate previous study of Adegoke and Komolafe (2009). This research confirms the earlier report of Dudhagara *et al*. (2011) that a high percentage of *S. aureus* were resistant to ampicillin and other β – lactam drugs, and is also agreement with research work carried out by Akindele *et al.* (2010) that of the 100 total number of *S. aureus* isolated from hospital environment 90% of them were resistant to ampicillin. Amoxicilin also shows similar pattern with resistance ranges from 88.2%, 91.4, 91.9 and 96.9% of the isolates at St. Gerard, Barau Dikko Specialist hospital, Yusuf Dantsoho and GHS respectively which also corresponds to findings at Aminu Kano Teaching Hospital, Kano by Gbonjubola eta al(2012).

The resistance of *Staphylococcus aureus* to these antibiotics may be as result of the ability of β-lactamase enzyme to break the β-lactam ring of the antibiotic and render it ineffective because *S. aureus* produces β-lactamase in the presence of ampicillin (Oncel *et al*., 2004). Akindele *et al.* (2010) reported in their work that β-lactamase production by staphylococci is the recognized mechanism of resistance to β-lactam antibiotics such as ampicillin and penicillin. Penicillins and Cephalosporins are the β-lactam antibiotics which inhibit cell wall synthesis. Resistance against these antibiotics revealed that the resistance is purely plasmid based since β-lactamase production is plasmid based (Rigby, 1986). Kondo et al. (1991) had reported good activities of streptomycin against all tested strains of MRSA.

Staphylococcus aureus resistance to antibiotics, especially methicillin is a serious medical problem worldwide (Felten et al., 2002; O'sullivan et al. 2003; Darini et al., 2004). The high rate of methicillin resistance and that observed with other beta-lactams with our isolates notably Ampicillin and Amoxicillin corroborates earlier reports (O'sullivan and Keane, 2000; Mi-Na et al., 2002; Liu and Chambers, 2003; Kesah et al., 2003; Taiwo, 2004;). The pattern of resistance observed might be due to the fact that beta lactams are used in auto-therapy in this locality, which may result in a multitude of antibiotics used at sub therapeutic levels heralding the emergence of resistant strains. Although we did not investigate the production of ß-lactamase by our strains, it is also likely that the enzyme maybe playing a role in the observed resistance.

The 100% susceptibility of *Staphylococcus aureus* to vancomycin from the four hospitals in this finding agreed with the findings of Terry-Alli *et al*. (2011) and Anyanwu et al. (2013) in Zaria. Vancomycin is a glycopeptide and is currently a drug of choice for *Staphylococcus aureus* infections, especially MRSA infections (Stevens *et al*., 2005). The range of 91.9 to 100% susceptibility to Streptomycin is in agreement with 100% susceptibility of *Staphylococcus aureus* to streptomycin as reported by Kaleem *et al.* (2010) that 100% of the isolates of *Staphylococcus aureus* were susceptible to vancomycin and streptomycin and slightly higher than 93% susceptibility pattern as reported by Seza and Fatma (2012). This is in agreement with previous studies (Kesah et al., 2003; Shittu and Lin, 2006). We speculate that the effectiveness observed with the drug might be due to its high cost in our environment making it less readily available and hence less misused. However, regular monitoring of the drug's sensitivity is of importance because resistance has been reported in the USA, Japan and Korea (CDC, 2002; Classen et al., 2005; Shittu and Lin, 2006).

According to the findings of this investigation, *Staphylococcus aureus* was found to have good percentage susceptibility to erythromycin between 71.4 and 89.2% and similar to report of between 80-82.5% at Ile-Ife Southwest, Nigeria by Akindele at al. (2010), It should also be noted that erythromycin was found to be the best antistaphylococal drug in that study. Also this result is in consonance with the study of kesah *et al* (2003). However, Kesah *et al* (2003) and Brooks *et al* (2001) recommended vacomycin for empiric therapy in life threatening staphylococcal infection.

The 13.5% resistance in Yusuf Dantsoho and 0.0% in other hospitals of *Staphylococcus aureus* to gentamicin in this finding is not similar with report of Akindele *et al*. (2010) that 39% of this pathogen was resistant to gentamicin.

Ceftazidime, Cefipime, Amikacin, and imipinem exhibit 100% effectiveness against *P. aeruginosa*. The resistance of *Pseudomonas aeruginosa* to ciprofloxacin from GHS (25.0%), 28.6% in St. Gerard and Barau Dikko Specialist hospital (37.5%) is in agreement with earlier report of Pal *et al*. (2010) where they reported 36.2% resistance of *Pseudomonas aeruginosa* to this antibiotic unlike an exceptionally high resistance to quinolones that was reported by Enabulele *et al.,* (2006) in Benin, Edo state. Apart from the findings in Benin, similar resistance pattern have also been reported in *Pseudomonas aeruginosa* isolated from other parts of Nigeria (Oguntibeju & Nwobu, 2004; Anupurba *et al.,* 2006). This goes to show that regional differences probably play a role in the resistance profiles of bacteria and further justifies the need to undertake antibiotic susceptibility studies on bacterial isolates from different parts of Nigeria on a regular basis.

Otherwise, the quinolones were found to be effective against *Pseudomonas aeruginosa* isolates tested except in few resistant cases; Norfloxacin have excellent response to the isolates and Levofloxacin were effective with few strains from Nursing home 1(12.5%) and Yusuf Dantsoho 2(15.4%) resistant to it. This is in consonance with a study done in Kano Northwest, Nigeria by Adamu et al (2009) where there was generally a low level of resistance to quinolones to both *Staphylococcus aureus* and *Pseudomonas aeruginosa* isolated.

Also, the resistance to Gentamycin in both GHS (25%) and Yusuf Dantsoho(15.4%) is not unexpected since *Pseudomonas aeruginosa* is a Gram negative bacterium coupled with their well known complex cell structure that has been reported to enhance their innate resistances to antimicrobial agents. In other words, Gram negative bacteria as a group are inherently resistant to a number of important antimicrobial agents that are very effective against Gram positive organisms. One logical reason for this has been found in the differences in structural and chemical compositions of the outer layers of the cells (Russell & Gould, 1988). *Pseudomonas aeruginosa* as reported by Harris *et al.* (2010) is resistant to most antibiotics because it is found naturally in soil; it has developed many resistances to naturally occurring antibiotics produced by bacilli, actinomycetes and moulds and their resistance to most antibiotics is attributed to efflux pumps which pump out some antibiotics before the antibiotics are able to act.

The multidrug resistant *Staphylococcus aureus* 41.3% was not higher than 87.75% multidrug resistant *Staphylococcus aureus* as reported by Fagade *et al*. (2010). This finding has corroborated the report of Seza and Fatma (2012) that among the Gram-positive microorganisms, staphylococci are the most frequently resistant pathogen to antibiotics. The surfaces of the hospital environment can serve as important secondary reservoir for multi-resistant microorganisms, such as the MRSA as reported by Carvahlo *et al*. (2007); this has to be emphasized because of the apparent ability of these pathogens to survive on dry surfaces. Therefore, the spread of multidrug resistant *Staphylococcus aureus* in this research can be a great threat to everyone in these selected four hospital environments and the public.

The multidrug resistance of *Pseudomonas aeruginosa* from the selected hospital 7(21.9%) confirms the report of Hota *et al.* (2009) that outbreaks of multidrug-resistant *Pseudomonas aeruginosa* colonization or infection occurred in urology wards, a burn unit, haematology/oncology units, and adult and neonatal critical care units and that various medical devices and environmental reservoirs was implicated in the outbreak. *Pseudomonas aeruginosa* has been increasingly recognized for its ability to cause significant hospital-associated outbreaks of infection, particularly since the emergence of multidrug resistant strains. Infection caused by *P. aeruginosa* are often severe, life threatening and difficult to treat because of limited susceptibility to antimicrobial agents and high frequency of emergence of antibiotic resistance during therapy (Carmelli et al(1999).

The resistance mechanisms include the acquisition of extended-spectrum Β-lactamases, carbapenemases, aminoglycoside-modifying enzymes and 16S ribosomal ribonucleic acid methylases. Mutational changes causing the up-regulation of multi-drug efflux pumps, depression of ampC, modification of antimicrobial targets and changes in the outer membrane permeability barriers are also described. Moreover, the propensity of *P. aeruginosa* to exist in vivo and in the environment as slow growing organisms embedded in its extracellular matrix adds to its resistance mechanisms.

The widespread use of antimicrobials, especially over or inappropriate use of antibiotics, has contributed to an increased incidence of antimicrobial-resistant organisms. Hospital-acquired infections are often caused by antimicrobial-resistant microorganisms. Resistance to antimicrobial agents is a problem in communities as well as health care facilities, but in hospitals, transmission of bacteria is amplified because of the highly susceptible population. Factors that could be associated with transmission of resistant strains of these microorganisms include poor attention to hygiene, overcrowding, lack of an effective infection control program, and shortage of trained infection control providers.

IV. CONCLUSION

The result of this study showed that inanimate surfaces near infected patients and those frequently touched surfaces within the hospital environment are contaminated by *Staphylococcus aureus* and *Pseudomonas aeruginosa* following the isolation and confirmation with polymerase Chain Reaction. This suggests that contaminated environmental surfaces are reservoirs of these pathogens. Some of the isolates of pathogen were multidrug resistant and are common but Vancomycin and Cephalosporin may present a unique opportunity in the management of infections caused by these pathogens. Regular surveillance of hospital and community associated *S. aureus and Pseudomonas aeruginosa* and their susceptibility to antibiotics is necessary to prevent an outbreak and spread of resistant strains in the locality.

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Table 4.5: Prevalence of *S. aureus* isolated from various surface in the selected hospitals

Surface	No. of sample screened	Total Number of Organism Isolated	GHS n(%)	St Gerard n(%)	Nursing home n(%)	Yusuf Dantsoho n(%)	χ^2	P value
Sinks	32	14(43.8)	2(6.3)	4(12.5)	3(9.4)	5(15.6)	2.540	0.468
Floor	32	29(90.6)	7(21.9)	6(18.8)	8(25.0)	8 (25.0)	4.046	0.257
Door Knobs	32							