

Full Length Research Paper

The efficacy of the commonly used hospital disinfectants on *Pseudomonas aeruginosa*

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Pseudomonas aeruginosa is an important opportunistic pathogen, and one of the leading causes of nosocomial infections especially in immunocompromised patients. Disinfection is one of the basic components of any infection control program, but the constant use of some disinfectants has led to the development of resistance among some nosocomial organisms such as *P.aeruginosa*, and a cross resistance to antibiotics. This study was conducted to evaluate the activities of 3 commonly used hospital disinfectants on *P.aeruginosa* at the University College Hospital, Ibadan, Nigeria. Fifty-five clinical isolates of *P.aeruginosa* were subjected to the 3 commonly used disinfectants namely jik, izal and dettol at different concentrations including the use-concentration of 10% by disc diffusion, MIC and MBC methods. The susceptibility of *P.aeruginosa* to the 3 disinfectants were found to be concentration-dependent. At the use-concentration of 10%, *P.aeruginosa* demonstrated good susceptibility to only izal while susceptibilities to Jik and dettol were intermediate and resistant. The highest activity of these disinfectants against *P.aeruginosa* was recorded in izal while the lowest activity was recorded in dettol. Based on the results of this study, izal can be effectively used in U.C.H. as a disinfectant while dettol and Jik are either discarded or the use-concentration increased.

Keywords: *Pseudomonas aeruginosa*, hospital disinfectants, efficacy

INTRODUCTION

Pseudomonas aeruginosa is an important opportunistic pathogen. It is one of the leading causes of nosocomial infections especially in immunocompromised patients (Lycksak et al., 2000). It was the most frequently isolated pathogen among the non-fermentative Gram-negative bacilli isolates in the report of the SENTRY Antimicrobial Surveillance Program Medical Centers of 1997–2001 (Jones et al., 2003).

Infections by this microorganism are often difficult to treat because of its virulence, intrinsic and acquired antibiotic resistance, which subsequently limit the choice for effective antimicrobial agents (Zavascki et al., 2005). This results in significant morbidity and mortality in

immunocompromised patients.

Ever since the identification of microorganisms as the causative agents of infectious diseases, various methods have been devised in order to reduce the population and prevalence of these organisms. These methods include chemotherapy, immunization, sterilization and disinfection (Kim et al., 2007). Subsequently, decontamination, disinfection and sterilization became basic components of any infection control program (Rutala et al., 2001).

A wide variety of clinical agents are used as disinfectants in healthcare settings, and these include, glutaraldehyde, sodium hypochlorite, phenolics, quaternary ammonium compounds (QAC), and chlorhexidine. QAC are cationic surfactants that are widely used for the control of bacterial growth in clinical and industrial environments. They have been used for a variety of medical, pharmaceutical and other purposes.

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They are generally low-level disinfectants showing activity against Gram-positive and Gram-negative bacteria (MacBain et al., 2004). However, *P.aeruginosa* has been reported to particularly demonstrate resistance to biocides (Higgins et al., 2001).

The antimicrobial activity of disinfectants have been influenced by their formulation effects, level of organic load, synergy, temperature, dilution rate and tests methods (Russel et al., 1995). Gram-negative bacilli have been tested for susceptibility to disinfectants with various disagreeing results (Rutala et al., 1997; Saurina et al., 1997). The widespread use of antiseptic and disinfectant products has also prompted some specialists to speculate on the development of microbial resistance to them and the subsequent cross-resistance to antibiotics (McDonnel et al., 1999).

Therefore, the selection, use, and control of the effectiveness of the disinfectants have been emphasized, since environmental surfaces, medical and surgical instruments can serve as vehicles to infectious agents in susceptible hosts associated with the hospital setting (Rutala, 1997). In view of the importance of disinfection in the prevention of nosocomial infections, and some reports which claimed that antimicrobial activity of disinfectants are concentration-dependent, the aim of this study is to evaluate the activities of the various concentrations of the frequently used disinfectants at University College Hospital, Ibadan, Nigeria. The study will also verify whether the use-concentration of 10% employed by the hospital is effective.

MATERIALS AND METHODS

Bacterial isolates

Fifty-five clinical isolates of *P.aeruginosa* obtained from various clinical specimens brought to the diagnostic medical microbiology laboratory of University College Hospital, Ibadan, Nigeria, between April and July 2009, were included in this study.

Disinfectants

The commonly used commercial disinfectants at University College Hospital were obtained from the same source as the hospital. These disinfectants were Jik (sodium hypochlorite), Izal(phenolic compound), and dettol (chloroxylonol). The use-concentration of these disinfectants in this hospital was 10%.

Disinfection susceptibility test

The susceptibility of *P.aeruginosa* to these disinfectants was determined by the disc diffusion test as described by WHO in 2003 (WHO, 2003), minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) methods as described by Turnidge et al in 2003.

Serial dilutions of each of the disinfectants were made at 100%, 50%, 25%, 12.5%, 6.25% and 3.125%. The use-concentration of 10% of each of the disinfectants was also included in the evaluation tests. The susceptibility of *P.aeruginosa* strains to the various concentrations of these disinfectants were then determined by the above-mentioned methods (i.e. the disc diffusion tests, MIC and MBC).

For the disc diffusion method, the diameters of the zones of inhibition were measured by a meter rule and the values obtained were compared with those of the interpretive chart for standardization (Johnson et al., 1995).

In the interpretive chart, the diameters of zones of inhibition in the susceptible strains were 16mm or more, for intermediate resistance, the diameters were between 11mm and 15mm and for the resistant strains, the diameters of zones of inhibition were 10mm or less (Johnson et al., 1995).

The diameters of zones of inhibition obtained from the test organisms, when compared with those in the interpretive chart, were interpreted as susceptible, intermediate resistance and resistant.

RESULTS

In this study, the susceptibility of *P.aeruginosa* to the disinfectants were found to be concentration-dependent. The susceptibility pattern of *P.aeruginosa* to the various disinfectants at different concentrations of 100%, 50%, 25%, 12.5%, 10%, 6.25% and 3.125% are shown in tables 2 and 3.

At the use-concentration of 10% in the study hospital, *P.aeruginosa* demonstrated good susceptibility to only izal with diameters of zones of inhibition range between 12mm and 17mm with majority in the range between 16mm and 17mm. For jik, the susceptibility was intermediate, while for dettol, *P.aeruginosa* demonstrated mainly intermediate resistance and in some of the strains, resistance.

The highest MIC and MBC (i.e. the lowest activity) of these disinfectants against *P.aeruginosa* was recorded

Table 1: Frequency of isolation of *P.aeruginosa* from different clinical specimens.

Clinical Specimens	Frequency	Percentage (%)
Wound Swabs	22	40.0
Ear Swabs	22	40.0
Urine	2	3.6
Stool	1	1.8
Sputum	3	5.5
Pus	1	1.8
Catheter tips	4	7.3
Total	55	100.0

Table 2: Activities of disinfectants on *P.aeruginosa* at various concentrations. Diameters of zones of inhibition (mm)/Interpretation

Concentrations of disinfectants (%)	JIK (mm)	Interpretation	IZAL (mm)	Interpretation	DETTOL (mm)	Interpretation
100	16-18	Susceptible	19-23	Susceptible	14-16	Intermed resist /susceptible
50	14-16	Intermed resist/ susceptible	16-21	Susceptible	14-15	Intermed resist
25	12-14	Intermed resist	15-20	Intermed resist / susceptible	11 -14	Intermed resist
12.5	12-14	Intermed resist	13– 19	Intermed resist	11 – 14	Intermed resist
*10.0	11-13	Intermed resist	12 -17	Intermed resist/ susceptible	10 – 13	Resistant / Intermed resist
6.25	11-12	Intermed resist	12 -17	Intermed resist / Susceptible	9 -11	Resistant/ Intermed Resist
3.125	7-10	Resistant	11 -14	Intermed resist	6-10	Resistant

*Use-concentration of disinfectants in study hospital (U.C.H).

Table 3: MIC and MBC range of disinfectants against *P.aeruginosa*

Disinfectant	MIC range (ug/ml)	MBC range (ug/ml)
JIK	0.07 – 0.10	0.10 – 0.13
Izal	0.03 – 0.06	0.06 – 0.10
Dettol	0.13	0.25

for dettol while the lowest MIC and MBC (i.e. the highest activity) was recorded for izal (Table 3).

DISCUSSION

This study has further confirmed that the antimicrobial activities of 3 commonly used disinfectants at University College Hospital, Ibadan, Nigeria, against clinical isolates of *P.aeruginosa* are concentration-dependent. This is in keeping with the work done by Awodele et al, in 2007. The use-concentration of 10% of the disinfectants in this

hospital showed good susceptibility to only izal with diameters of zones of inhibition that range between 16mm and 17mm. Susceptibility to the other disinfectants, i.e. Jik and dettol, were however, found to be either intermediate resistance or resistant (Table 2).

Pseudomonas aeruginosa is a known contaminant of skin, laboratory surfaces, toilets and pools. It is also known to be one of the organisms implicated in nosocomial infection outbreak especially in intensive care units (Jones et al., 2003). Furthermore, its susceptibility is known to be limited to only a few antimicrobial agents. Some disinfectants are reported to share the same

mechanism of action with some antibiotics and this can cause resistance to disinfectants used in cleaning our environments. Therefore, based on this fact, it is obvious that resistance to disinfectants especially in the hospital setting could be antibiotic-resistance related as a result of cross-resistance (Heath et al., 2001). Some other studies have also suggested a potential molecular link between reduced susceptibility to some disinfectants and antibiotic resistance. Increased resistance to antiseptics and disinfectants have been associated with mutation, and, or presence of plasmids (Kaulfers et al., 1987), and both have been observed in some strains of *P.aeruginosa* (Sulton et al., 1978).

Most antimicrobial agents show both inhibitory and lethal effects depending on the concentration used and other factors such as degree of contamination and duration of treatment. The MIC is a helpful parameter used to assess the bacteriostatic activity of a given disinfectant while the MBC is used to detect bactericidal activity under similar conditions. The MIC and MBC values of dettol, jik and izal obtained in this study showed that concentration of the active ingredients in the recommended dilutions of the disinfectants is lethal to the organism.

CONCLUSION

In conclusion, the reduced activity of the disinfectants under study may be due to indiscriminate use of these disinfectants in sub-optimal concentrations over a long period of time. The use of sub-optimal concentrations might lead to the development of resistant and virulent strains of organisms. The use of concentrations of disinfectants lower than that quoted by the manufacturers might have serious consequences in the management of patients in hospitals.

This study therefore emphasizes the need for hospitals to adhere strictly to standard disinfection policy which gives a guide for proper use of disinfectants and antiseptics.

In this study, only izal is effective against *P.aeruginosa* among the disinfectants used in U.C.H at the use-concentration of 10%. The others, dettol and jik employed, have intermediate activity to *P.aeruginosa*, and therefore, may have to be either discarded and replaced by more effective disinfectants or used at higher concentrations.

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