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Article

Effects of Disinfectants on Bacteria Isolated from the Hospital Environments

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Abstract: The hospital environment is a known reservoir for microbial contamination, particularly on inert surfaces, medical devices, and apparatus, posing significant health risks. This study addresses the antibacterial efficacy of four synthetic disinfectants—M.P.C. Hand Gel, M.P.C. Save Spray, Sani Wash, and Actoman Plus—against various bacterial strains isolated from Nasiriyah hospitals, including Gram-negative bacteria (Escherichia coli, Enterobacter spp., Acinetobacter spp.) and Gram-positive bacteria (Staphylococcus aureus). Despite the widespread use of disinfectants in healthcare settings, the comparative effectiveness of these specific products remains underexplored. Using standard microbiological techniques, the study evaluates the disinfectants' effectiveness against the targeted pathogens. Results indicate varying degrees of antibacterial activity, with implications for improving infection control protocols in hospital environments.

Keywords: Hospital Environment, Microbial Contamination, Synthetic Disinfectants, Antibacterial Efficacy, Infection Control

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1. Introduction

Disinfectants, often known as "Main group 1" biocides [1], play a crucial role in preventing infectious disease transmission. Disinfectants, when administered appropriately, can prevent germs from spreading, particularly in nosocomial illnesses. Disinfectants and virucidal sanitizing chemicals are increasingly used to prevent life-threatening illnesses caused by antibiotic-resistant bacteria and novel viruses [2, 3].

The patient's surroundings, especially hospital rooms and related equipment, are a significant source of infection that is resistant to drugs and may spread to other patients [4]. They serve as a central point of interaction for the hospital environment, caregivers, and patients with a variety of ailments, whether or not they are infectious [5]. They have the capacity to directly contaminate the healthcare environment, including instruments, surfaces, air, and water if precautions are not taken. [6].

Hospital surfaces can harbor harmful germs, leading to healthcare-associated infections (HCAIs). Monitoring disinfectant efficacy is crucial for preventing and controlling hospital-acquired infections (HAIs). Nonetheless, most resource-limited countries do not frequently assess disinfectant performance and efficacy [7].

To prevent the emergence of healthcare-associated illnesses (HCAIs), disinfectants are essential components of infection control intervention techniques in healthcare institutions [8]. Hospital environments, such as patients' beds, side tables, carriages, and benches, employ these compounds to mitigate the presence of bacteria, viruses, and fungi, thereby preventing HCAIs [8, 9].

Some bacteria, like methicillin-resistant Staphylococcus aureus (MRSA) and some Gram-negative bacilli, become resistant to widely used disinfectants. This implies a need for more frequent replacement of sanitizer active ingredients [10].

Research has demonstrated that bacteria exhibit resistance to quaternary ammonium, peroxides, phenols, chlorine, and glutaraldehyde [11–14]. As a result, this study looked at how well four types of bacteria found in hospital plants were killed by common disinfectants used in Nasiriyah hospitals (center of Thi Qar).

The disinfectants tested include M.P.C Hand Gel, an alcohol-based disinfectant for hands and skin that is simple to use. Waterless hand disinfectant is intended to promote skin health and reduce the spread of infection. Moisturizes and protects the skin, and contains 70% ethyl alcohol.

M.P.C Safe Spray is an alcohol-free, ready-to-use product. It is used to quickly clean alcohol-sensitive medical equipment but is not used during surgery. Sani Wash is a surgical-grade hand cleaner that belongs to the quaternary ammonium compound (QAC) made of Didecyldimethyl¬ammonium chloride (60 g/ℓ), Glutaraldehyde (70 g/ℓ), and Actoman Plus, which contains 4% chlorhexidine gluconate and dexpanthenol. These disinfectants are used to sanitize surfaces and medical equipment because they have antibacterial properties.

2. Materials and Methods

2.1. Collection of Samples:

We gathered 30 samples using swabs from hospitals and health centers in Nasiriyah (Nasiriyah Hospital, Al-Hussein Hospital, Al-Haboubi Hospital, Bint Al-Huda Hospital, and Heart Center) from corridors, lobbies, patient beds, intensive care units, doors and windows, operating rooms, and surgical tools.

2.2. Isolation and Identification of Bacteria:

After culturing samples on Blood agar and MacConkey medium, we placed them in an incubator for 24 hours at 37oC, and the next day we saw robust microbial growth. Conventional biochemical procedures like Gram staining, oxidase, catalase, and anaerobic tests were used to identify isolates.

2.3. Disinfectants and Active Compounds Tested:

We prepared Mueller Hinton media by drilling holes with a cork drill and then filling the holes with disinfectants using a sterile syringe. We incubated it at 37oC for 24 hours. Four disinfectants were chosen to evaluate their antibacterial activity.

Disinfectants are studied on isolated strains at Nasiriyah hospitals (Center of Thi Qar): Staphylococcus aureus, Escherichia coli, Acinetobacter spp., and Enterobacter spp. The disinfectants utilized include M.P.C. Hand Gel, M.P.C. Safe Spray, Sani Wash, and Actoman Plus.

3. Results

3.1.Bacterial Diagnosis:

Thirteen isolates were found after culturing 30 samples from various hospitals and centers. The remainder of the isolates did not grow. Growing isolates are identified by phenotypic examination, Gram staining, and biochemical testing.

The identified species were as follows: Enterobacter spp (n = 5), Acinatobacter spp (n = 3), Staphylococcus aureus (n = 3), dnd Escherichia coli (n = 2) (Table 1).

Table 1. Bacterial species were isolated from hospital samples.

No.	Type of bacteria	Number of Isolated strain
1	*Enterobacter spp*	5
2	*Acinatobacter spp*	3
3	*Staphylococcus aureus*	3
4	*Escherichia coli*	2

3.2. Testing the Disinfectants' Antibacterial Activity Against Bacterial Strains:

Table 2 demonstrates Actoman Plus disinfection's efficacy against Gram-positive and Gram-negative bacteria with an 84.6% inhibition rate, and the M.P.C-safe spray's efficacy against Gram-positive bacteria like S. aureus. Furthermore, the efficacy of this disinfectant against three kinds of Gram-negative bacteria, including Escherichia coli, Acinatobacter spp., and Enterobacter spp., were 100%, 66.6%, and 20%, respectively. While M.P.C. Hand Gel is exclusively active against S. aureus, Enterobacter spp., and E. coli, it has an inhibitory efficacy of 33, 3%, 20%, and 100%, respectively. The current results also revealed that Sani disinfectant wash was 0% effective against Gram-positive and Gram-negative bacteria.

Table 2. Antibacterial activity of the three disinfectants on the tested strains.

The strains tested	Inhibition zone of disinfectant (mm)			
	M.P.C. Hand Gel	M.P.C.Safe Spray	Sani Wash	Actoman Plus.
Enterobacter spp.	R	R	R	15
Enterobacter spp	R	R	R	17
Acinatobacter spp	R	R	R	10
Staphylococcus aureus	12	R	R	16
Enterobacter spp	R	9	R	20
Acinatobacter spp	R	28	R	13
Escherichia coli	26	12	R	14
Escherichia coli	15	15	R	16
Staphylococcus aureus	R	15	R	32
Staphylococcus aureus	R	R	R	R
Enterobacter spp	R	R	R	R
Acinatobacter spp	R	18	R	15
Enterobacter spp	10	R	R	18

*R: Resistant

4. Discussion

The risk of infection for immunocompromised patients is elevated due to the hospital environment's susceptibility to contamination, particularly by resistant microorganisms such as bacteria [15, 16]. Hospitals must sterilize all surfaces and medical instruments to prevent microorganism spread and infection risk, especially in response to antibiotic resistance [17]. Controlled disinfection reduces healthcare-associated infections (HAIs) by preventing cross-contamination between patients, visitors, caregivers, surfaces, and hospital equipment [18].

Resistant bacteria, including vancomycin-resistant enterococci, MRSA, Pseudomonas aeruginosa, and Acinetobacter baumannii, are routinely recovered from hospital surfaces. Healthcare facilities may now be cleaned and disinfected using standardized procedures [19], however, some research has shown that bacteria can develop resistance to disinfectants [20,22].

Our investigation revealed that Actoman Plus was effective against resistant bacteria (E. coli resistant to beta-lactam) as a result of its high concentration. The bacterium may have developed resistance to antibiotics, potentially reducing disinfectants' effectiveness in reducing methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus in previously infested rooms [23, 24].

The study revealed that the effectiveness of disinfectants is influenced by various factors including the active molecule, genus, and structure of the bacteria, as well as the disinfection protocol. Disinfectants can either limit bacterial growth or kill germs, depending on their spectrum of action [25]. However, certain antimicrobial medicines may only target specific microbes. Depending on the physical and chemical properties of the microbial surface, the response to biocides may differ. Disinfectants can target pathogenic organisms by coagulating and oxidizing microbial cell proteins, as well as denaturing bacterial enzymes after they enter the cell wall [26]. Microorganism features, strain, biofilm development, and concentration, as well as environmental conditions such as UV light and temperature, all have an impact on the survival of nosocomial infection on inanimate surfaces and equipment [27].

Furthermore, some disinfectants might annoy consumers or be harmful when applied in excessive doses [28]. Even though data show that rotation of active chemicals can fail to maintain high disinfection efficiency [29, 30], it remains the method used in hospitals. Other studies indicate that susceptibility reduces with repeated exposure to microbicides [31, 32]. Therefore, future research should ideally investigate a greater number of isolates, compare alternative analytical methodologies, and monitor disinfectant activity over time.

Recently, several microorganisms, including Staphylococcus aureus, Escherichia coli, Acinetobacter spp, and Enterobacter spp. were discovered on hospital surfaces in Nasiriyah. It would be fascinating to investigate the effectiveness of various disinfectants and seek natural alternatives.

5. Conclusion

The study revealed that the effectiveness of disinfectants is influenced by various factors including the active molecule, genus, and structure of the bacteria, as well as the disinfection protocol. The study found that the disinfectants tested had varying degrees of efficacy. Sani wash does not have an antibacterial impact on Gram-positive and Gram-negative microorganisms. Actoman Plus and disinfectant spray were efficacious against specific positive and negative strains. The study's findings will benefit healthcare-associated infection control committees and hygiene departments responsible for preventing and correcting environmental and surface risks.

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