The Efficacy of a New Disinfectant in Decontamination of Reusable Medical Equipments

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Abstract

Background: There is good evidence that infection transmission via hospital surfaces and medical equipment can occur. Hospitals implement infection prevention measures to reduce the risk of transmission of pathogens via contaminated hospital surfaces and medical equipment. Hospital environment disinfection is usually performed by using different disinfectants but non is ideal. Objective: to assess the efficacy of a new antibacterial solution in combating bacterial contamination of reusable medical equipments. Materials & Methods : We collected a variety of previously used medical devices, 18 pieces (face masks ,tubing system of ventilator, blades of laryngoscope and stethoscope bell & diaphragm).After These devices had been cleaned ,rinsed then immersed in bleach ,we tested their decontamination using a newly invented antibacterial; Sidr leaves aqueous extract 6.25 % (w/v) and a mixture of the two chemicals ;the extract and hydrogen peroxide 1.5% while normal saline 0.9% was used as control. . The process of testing decontamination was repeated as the period of contact between the devices and any of the three disinfectants was increased starting at 5 ,then increasing to 15and 30 minutes successively . Loopful swabs were taken from the devices before and after contact with the disinfectants and repeated as the period of contact was increased to 15 then 30 minutes.
Results: Mixing hydrogen peroxide 1.5% (v/v) and aqueous sidr extract 6.25 % (w/v) was effective in eradicating contamination of used contaminated medical devices after a period of contact of 30 minutes.
Conclusion: The new antibacterial agent is effective in decontaminating reusable medical devices after 30 minutes of contact.

Key words: Disinfectants, Decontamination, reusable medical devices, Hospital acquired infections

1. Introduction

Hospitals have sanitation protocols regarding uniforms, equipment sterilization, washing, and other preventive measures. Thorough hand washing and/or use of alcohol rubs by all medical personnel before and after each patient contact is one of the most effective ways to combat nosocomial infections.[1] More careful use of antimicrobial agents, such as antibiotics, is also considered vital.[2]

Clostridium difficile is the most common cause of healthcare-associated gastrointestinal infections in the United States and antibiotic exposure is the highest risk for developing *Clostridium difficile*-associated disease (CDAD) [3] The clinical spectrum of *C. difficile* ranges from asymptomatic colonization to severe diarrhea, pseudo membranous colitis, toxic megacolon and death [4].

Enterococcus is the third most common pathogen associated with HAIs . 33% of the isolates from device-associated infections were vancomycin associated enterococci (VRE) [5] Infections caused by VRE are associated with increased morbidity, mortality, and hospital costs when compared to infections caused by vancomycin-sensitive Enterococcus.[6]

Clostridium dificille is particularly challenging for infection control because it produce spores resistant to killing by most disinfectants.[7]

A biofilm is defined as a microbially derived sessile community characterized by cells that are irreversibly attached to a substratum or interface or to each other; are embedded in a matrix of extracellular polymeric substances .[8] Biofilms can occur spontaneously (without deliberate intention to grow them) on a wide variety of surfaces such as metals, plastics, glass, ceramics, wood and cement. Once established, they can accommodate a large number of bacteria per unit area of the surface. While ~10^5 - 10^7 CFU (Colony Forming Units) of bacteria /cm^2 are commonly encountered. [9]Bacterial biofilms causes about 65% of bacterial infections in the clinic. Antibiotics do not have a satisfactory effect on the infections due to the resistance of the biofilm.[10]

Bacteria residing within biofilms are up to 1000 times more resistant to chemical costs when compared to infections caused by vancomycin-sensitive *Enterococcus.*[11]

Environmental surfaces play an important role in transmission of health care-associated pathogens such as *Clostridium dificille,* methicillin resistant *staphylococcus aureus* and vancomycin resistant enterococcus**.**[12]

2. Materials and Methods

we collected 18 pieces of reusable medical devices from the intensive care unit ,6 of them were used by the patients within 1- 2 hours while the other 12 were used within 1-3 days. These pieces were: 4 face masks ,3 tubing system of respirator, 6 laryngoscope blades, 3 mouth pieces of spirometer , 2 stethoscopes (bell and diaphragm parts).

We started decontamination by wiping the devices especially the 1st 6 devices being still wet ,then the other steps of decontamination were performed ; pre rinsing ,washing ,rinsing , disinfection.

Pre rinsing was done through immersion for 1 minute of the pieces into a plastic container (with cover) containing enzymatic detergent 3E-ZYME (Medisafe UK Ltd, Bishops Stortford, Herts, UK) 6ml diluted in 1Liter of distilled water at 45 degrees centigrade. The devices were transferred from the plastic container to a basin containing water with neutral detergent ,after that they were immersed into distilled water for a period of 30 minutes contact followed by immersion into sodium hypochlorite 1000 ppm for 10 minutes along with manual cleaning using soft brush to remove residual blood and debris followed by washing prior to high level disinfection. .

Preparation of the disinfectant: Sidr tree- Ziziphus spina-christi (L) var. inermis Boiss, its leaves were collected and washed by immersion for one hour in a basin of tap water . 62.5 grams of the leaves were put in I liter of distilled water and heated up to boiling. The solution was left in the refrigerator for 12 hours .the remnants of the leaves were discarded, while the liquid extract was mixed with 500 ml of 1.5% hydrogen peroxide to get the new disinfectant .

The devices after retrieval from the bleach ,they were rinsed by distilled water for a period of 2 minutes for each piece followed by taking 6 loopful swabs, which were distributed as one loopful per agar, 2 nutrient agars, 2 MacConkey's agars and 2 Bile Bacteroides Esculin (BBE) media,. The media were cultivated for 48 hours in 37 degrees centigrade both in aerobic and anaerobic conditions. The media were put inside anaerobic jar using gas- pack. After that ,the devices were separated into 3 groups, the 1st group was immersed into normal saline 0.9% ,the 2^{nd} into the sidr extract, while the 3^{rd} group into the mixture of the extract with hydrogen peroxide 1.5% .the contact time for each group was 5 minutes. Then a loopful swabs from a device from each group were taken and cultivated the same way and in conditions as just mentioned.

The procedure was repeated thrice ,each turn we changed the time of contact of six washed devices with the disinfectants ,to 15 and 30 minutes in the 2^{nd},and 3rd repetition trials successively. Serial dilutions: 1 ml of the disinfectant of each group was taken added to 9 ml distilled water , 0.1 ml from the 3rd dilution of each group was cultivated in three media as mentioned previousely.

3. Results:

The antibacterial mixture of sidre extract and hydrogen peroxide was not successful in eradicating the contamination of used contaminated medical devices whether the time of contact was 5 or15 minutes. The mixture was effective only if the period of contact was 30 minutes.

The cultivation results were shown by the table.

A table shows the bacteriological results of cultivation of the medical devices after 30 minutes contact with different disinfectants

Condition	**Sidr extract 6.25%**	**Mixture of sidr extract 6.25% and hydrogen peroxide** 1.5%	**Normal saline (control)**
non –aerobic	2 colonies	No growth	3 colonies
Aerobic	Heavy growth	No growth	heavy growth

4. Discussion

Device associated hospital acquired infections DA-HAIs are considered the principal threat to patient safety in the ICU, and are among the main causes morbidity and mortatality. [13]

There are several factors to be considered when choosing a particular way of decontamination including compatibility of decontamination agent with particular pieces of equipment, manufacturer guidelines for decontamination should always be followed where possible as these will take into account risk of equipment corrosion through inappropriate decontamination. The need to clean the equipment before decontamination is very critical step for the success of the procedure.[14]

Effective decontamination is compromised by the presence of various organic matter[15] , a very large number of microorganisms[16] and situations where microorganisms are dried to equipment[17]. We tested semi critical and non critical devices as the level of disinfection or sterilization is dependent on the intended use of the object. Critical items such as surgical instruments which contact sterile tissue ,semi critical items such as endoscopes which contact mucus membranes and non critical items such as stethoscopes which contact only intact skin requires sterilization, high level disinfection, respectively.

Prior to cleaning proper preparation aids in exposing all device surfaces to the cleaning solution. This includes opening scissors ,box locks, jaw type devices; in our reprocessing laryngoscope blades and stethoscope parts were disassembled, disassembling .it should be noted that more health care associated infections have been linked to contaminated endoscopes than to any other medical device.

Decontamination of surfaces with dried inocula is invariably more difficult than when microorganisms are in suspension.[18] we had tested contaminated devices 1-3 days following usage; to evaluate the microbicidal action on representative carrier materials contaminated with a dried challenge.

We used 3E-ZYME which is a non foaming triple enzyme containing isopropyl alcohol, a bacteriostatic and cleaner .It was diluted 6 ml/ liter warm water according to manufacturer ' directions [19]. It was indicated to dissolve and remove organic matter(protein ,blood) because hydrogen peroxide is ineffective in their presence.

Risk of infection develops from improperly processed devices which allow for accumulation of microbial biofilms ; collections of bacteria and fungi ,these biofilms adhere to each other and to the surfaces of medical devices especially those with lumens, and increase the difficulty of thorough cleaning.[20] We practiced and recommend cleaning the devices immediately after use because it has the potential to eliminate this problem of biofilm contamination .

A medical device may become damaged by cleaning solutions or medical soils that are not removed properly after cleaning process. Using cleaning solutions that are not compatible with a device may cause damage as

well .We practiced brushing the devices using soft, smooth brush and avoided wool wire brushes or powders. As these agents will scratch & may remove the protective finish on metal, thus increasing the likelihood of corrosion . the finish on stainless steel instrument protects the base metal from oxidation.[21]

We insisted on rinsing the devices with plenty distilled water and good flow following contact with disinfectants to avoid the complications from chemical irritation .A chemical irritation resembling pseudomembranous colitis caused by either 3% hydrogen peroxide or a 2%. gluteraldehyde has been reported [22] . an epidemic of pseudomembranous like enteritis and colitis in 7 patients in a gastroenterological endoscopy unit also has been associated with inadequate rinsing of 3% hydrdgen peroxide from the endoscope.[23] .

Our reprocessing revealed significant contamination of the stethoscopes with Gram-negative organisms which pose a real risk of spreading potentially serious infections , especially in the setting of intensive care departments. [24]

5. Conclusion

The efficacy of the mixture of sidr extract 6.25%(w/v) with hydrogen peroxide 1.5%(v/v) was excellent in decontamination of used, contaminated medical devices after a period of contact of 30 minutes following perfect cleaning .

6. References:

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