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Research Article

The Use of Neutral Electrolyzed Oxidizing Water for Disinfection of 3.0T MRI Scanner

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Abstract

Introduction: Devices for Magnetic Resonance Imaging (MRI) represent the specific conditions for disinfection. Among the relevant facts include the presence of electronic equipment in a single device that limits the possibility of selecting the appropriate biocide to disinfect the device. Disinfectants of choice are therefore expected to possess properties such as rapid, residue-free action without any damaging effect on the sensitive electronic equipment. The purpose of this study was to determine the reliability of Neutral Electrolyzed Oxidizing Water (NEOW) using two different methods of disinfection on 3.0 T MRI Scanner.

Materials and Methods: The MRI room disinfection was completed by using the sprayer and the method of cold fogging. The presence of micro-organisms before and after the aerosolization was recorded with the help of sedimentation andanalyse the total number of Colony-Forming Units CFU. The CFU was evaluated in absolute and log values.

Results: After disinfection we found reduction of microbial NEOW over 90% or more than 1log10 CFU/cm2. With cold fogging disinfection, we found a reduction in the number of microorganisms by an average of 3.32 log10 CFU/cm2. Based on the results of the experiment we can conclude that with the model of NEOW Steriplant®N in practical terms we can see over 90% reduction of microorganisms (> 1log10 CFU/cm2) on MRI. The use of NEOW proved to be efficient and safe in all applied ways. Also, no eventual damage to exposed devices or staff was recorded.

Discussion: The use of the biocide aerosol Steriplant®N in practical terms in prepared space in which substantially reduces the burden of microorganisms. We believe that this helps to establish a bio-security between operational and diagnostic interventions. Considering the fact that the biocide aerosolization needs 6-8 ml of biocide solution / 1m3 can reach very small amounts of disinfectant effects on equipment.

Introduction

Disinfection procedures are an important part of preventive measures to prevent the spread of contagious and infectious diseases. Given what we disinfected, and the purpose (prevention, decontamination) should choose an effective biocide [1]. From reliable biocide performance demand quickly with as wide a spectrum of the microorganisms that do not harm the patient and staff should not be residue on the surface, should not affect the surface of materials and must be biodegradable [2]. Especially in recent years faced increasing number of resistant microorganisms. We have contributed to the resistance, both with an inappropriate choice of biocides, and their use (inadequate concentrations, time of performance, and the replacement of biocides). However, obstinate strains of microorganisms, which are becoming increasingly resistant to the procedures of disinfection, have emerged [3-12]. Devices for Magnetic Resonance Imaging (MRI) represent the specific conditions for disinfection. Among the relevant facts include the presence of electronic equipment in a single device that limits the possibility of selecting the appropriate biocide to disinfect the device. It is also not negligible exposure to the patient surface of the device, particularly contamination of equipment or transfer agent in the surface of the device in a patient or staff [1,10,13, 14,15,16]. Patient couches of MRI scanners are very hard to access when it comes to cleaning and disinfection [17, 18,19]. Consequently, new approaches to disinfection procedures have been studied. Thanks to its mechanism of action, Neutral Electrolyzed Oxidizing Water (NEOW) has been considered as a possible biocide of the new generation [20,21,22,23]. The principle of the EOW production has been known for some time now. Basically, the alkaline ionized water and acid oxidized ionized water are generated from diluted non-iodized cooking salt (NaCl solution), whereby the alkaline fraction reaches a pH of 11-12, while the acid one has a pH of 1-3. While the alkaline ionized water is considered to have a cleaning effect, the acid one has extremely biocidal effect. Mostly, the effect of the NEOW action has been attributed to the pH change only. However, more detailed analysis has revealed that electro-oxidized water works through several mechanisms. Most patients with serious infections typically have some type of imaging procedure performed

during the course of their treatment. Neutral Electrolyzed Oxidizing Water (NEOW) is a biocide with a broad spectrum of activity, with immediate action on the surface leaves no residue. Because of its physical and chemical mode of action is not expected that the micro-organisms have developed resistance. Natural biocide bound electrons of the surroundings and thus destabilize the bacterial wall micro-electrolysis itself is formed and hyper-oxide ions, which are also disinfecting effect, quickly and without delay. Just as the biocide is a not necessary rinse surface [24,25]. Since the device for magnetic resonance imaging routinely fails to disinfect, we were interested in this part, how surface of the device loaded with the presence of microorganisms and what effect NEOW of microorganisms in different acceptable ways of spreading on the surface. The purpose of this study was to determine the reliability of NEOW using two different methods of disinfection on 3.0 T MRI Scanner.

Materials and Methods

The experiment was performed at the University Medical Centre Maribor Slovenia in the Department of Radiology. The disinfection of the 3.0 T MRI GE Signa HDxt Scanner was completed by the procedure indicated by the manufacturer in the technical instructions (sodium hypochlorite solution). Ethical Commission of the Republic of Slovenia approved the study under the serial number 110/05/11. The disinfection was completed by using the sprayer and the method of cold fogging. NEOW with redox potential value of 830-850 mV (Steriplant®N, Obisan Institute, Slovenia) was used as a biocide. The experiment tested the number of colony-forming units on the model of Staphylococcus aureus ATCC 25923.Test colony of *S. aureus* was applied to test surfaces in the concentration of $1,5x10^6$.Cold fogging was performed with the OptiJet CSMD R1 system (Swiss Steriplant AG, Switzerland, and the modification Obisan, Slovenia), using the nozzle model 0/2 with the compressed air flow of 600 l/min. Test surfaces were set vertically, horizontally, and on the ceiling. After 15 minutes the swabs were taken to analyze the total number of colony-forming units in CFU/cm^2 on 20cm^2 of surface. The experiment was conducted in two stages. We disinfected 3.0 T GE Signa MRI HDxt by the procedure of the manufacturer in the technical guidance (sodium hypochlorite).Swabs for determining the total number of micro organisms were taken to 12 cities before and after disinfection. To determine the presence of micro organisms on surfaces, swabs were taken on the surface of 20 cm^2. As a biocide was used NEOW redox potential of 830-850 mV (Steriplant®N, Obisan, Slovenia). Biocide was given by hand sprayer until the surface was visibly wet and waits 5 minutes. Then we took swabs from the surfaces. The second stage of the experiment was carried out by the modified method of testing the model of biocides Staphylococcus aureus ATCC 25923. Test culture *S. aureus* was application on the test surface at a concentration of 1.5 x106 CFU/cm^2. Then the task is a system of cold fogging OptiJet CS MDR 1(Swiss Steriplant AG, Switzerland and modification Obisan, Slovenia). Biocide for application in areas as cold fogging nozzle, we used the model 0/2 at a rate of 600 l/min of compressed air. Test plates were placed vertically, horizontally and ceiling as location areas has an impact on the performance disinfection. After a time of 15 minutes, we took the swabs to test tile and check the count in CFU/cm^2.

Results

On the basis of the results of the experiments we have determined efficiency of neutral electrolyzed oxidizing water Steriplant®N with small amounts of biocide in *in vivo* conditions for manual surface disinfection, and in cold fogging. Based on the results of the experiment we can conclude that with the model of NEOW Steriplant®N in practical terms we can see over 90%reduction of microorganisms (> 1log10 CFU/cm^2) on MRI. The model test microorganism *S. aureus* shows a decrease of 3.32 log102 (P<0.001), which exceeds the required reduction of micro-organisms in the testing of biocides, even in laboratory conditions. For efficient operation we recommend to apply biocide in a significant amount to the surface for efficient operation. It is not necessary to remove the Biocide from the surface after application; you can just wipe it or leave it to dry. NEOW is not corrosive and is effective even when on the surface creates a biofilm. The research has shown that the use of NEOW for the hard surface disinfection can considerably reduce the presence of micro-organisms and consequently the possibility of hospital infections.

Discussion

In the first part of the experiment was determined performance NEOW directly on the surface MRI. Control swabs from surfaces MRI showed a relatively low number of microorganisms, which was also the reason for the observed relatively low reduction. However, after disinfection we found reduction of microorganism NEOW over 90% or more than 1log10 CFU/cm^2.In the second part of the experiment we test the surface with *S. aureus* ATCC 25923 were placed on the surface of the MRI. Test surfaces were exposed to cold fogging disinfection. When we used in a quantity NEOW 8 ml/m^2 we found a reduction in the number of microorganisms by an average of 3.32 log10 CFU/cm^2. The results showed a fairly uniform load of microorganisms. We believe that the reason of an identified microbial presence in the way of forced air ventilation spaces of the entire hospital (central ventilation system with air prior preparation). Recommendations of some authors are that the diagnostic and operational spaces achieve the presence of microorganisms of less than 10 CFU/m^3 air. The use of the biocide aerosol Steriplant®N in practical terms in prepared space in which substantially reduces the burden of microorganisms. We believe that this helps to establish a bio-security between operational and diagnostic interventions. Considering the fact that the biocide aerosolization needs 6-8 ml of biocide solution/1m^{3}can reach very small amounts of disinfectant effects on equipment. Important features of the biocide Steriplant®N hospital environment is a broad spectrum of activity mainly in the form of resistant microorganisms (metycillin resist with *S. aureus*, E. coli) uncorrosivity, security for operators disinfection, medical staff and patients, and that does not remain on the surfaces of the biocide residues (not required disposal of residues). We also wish to highlight the importance of the choice of the methodology air sampling for the presence of microorganisms. We believe that the compulsory cyclone method of air sampling in the liquid medium is appropriate to identify the presence of micro-organisms.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

All authors participated in conception and design, generation, analysis and interpretation of data also revision of manuscript. All authors read and approved the final manuscript.

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