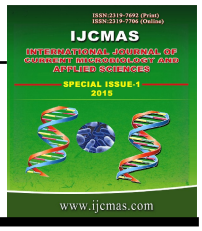
Int.J.Curr.Microbiol.App.Sci (2015) Special Issue-1: 281-285

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-1 (2015) pp. 281-285**
http://www.ijcmas.com



Original Research Article

Microgen and Airocide® Technology as a Method for Sterilization in ICU: A Comparative Study

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A B S T R A C T

In hospitals, especially in ICU it is important to keep in mind that there is a high population of immuno-compromised patients. Therefore, an effective sterilization method has to be employed to prevent cross contamination. Microgen, a third generation quaternary ammonium compound whereas AiroCide® is a unique airborne pathogen killing technology that was developed and used by NASA. We aimed to evaluate and quantify the effectiveness of Microgen and the AiroCide® device as sterilization method in the ICU of JNMCH, a tertiary care centre. Culture samples from various locations of the ICU were incubated both before and after Microgen fumigation and pre and post installation of AiroCide®. The total CFUs were counted and compared. It was found that there was no significant reduction in bacterial load with the use of Microgen whereas with AiroCide® the number of CFUs was reduced dramatically. It was concluded that the AiroCide® system provides a better level of effectiveness and reduces cross contamination between health staff and patients.

K e y w o r d s

Microgen, AiroCide, effectiveness, sterilization, ICU

Introduction

Hospital-associated infections are an important cause of patient morbidity and death (Sandle, 2006). Cross infection in ICU is a common problem which needs special attention. In hospitals, especially in ICU it is important to keep in mind that there is a high population of immuno-compromised patients. These infection susceptible patients include AIDS patients, geriatrics, neonatal patients, recent surgery patients (especially organ transplant recipients), tuberculosed patients, and chemotherapy and radiation therapy patients. For these individuals, even low levels of pathogenic spores can be potentially fatal. Therefore, an effective sterilization method has to be employed to prevent cross contamination. Sterilization is defined as a process that effectively kills or eliminates almost all microorganisms including bacteria, viruses, fungi and spores.

In the ICU of Jawaharlal Nehru Medical College, Aligarh the existing method of sterilization is Chemical sterilization. A

chemical called Microgen, which is a quaternary ammonium compound consisting of alkyl dimethyl benzyl ammonium chloride, alkyl dimethyl ethylbenzyl ammonium chloride and inert ingredients is being used in the ICU. These compounds although are better than the previous compounds the toxicity issue still persist (Prem *et al.,* 2013). In view of this, newer technologies and methods of sterilization are being developed and studied. AiroCide® is a unique airborne pathogen killing technology that was developed and used by NASA.

Our study was undertaken to evaluate and compare the efficacy of Airocide® technology over Microgen in the ICU setup.

Materials and Methods

The study was conducted in a tertiary care hospital, Jawaharlal Nehru Medical College, Aligarh, Uttar Pradesh between the period of January 2014 and February 2014. The study site was the 10 bedded ICU of this hospital. The samples were collected from the indoor air of the Intensive Care Unit.

Sampling pre and post Microgen fogging

The samples were collected from the sites by open plate sampling method. In the open plate method 5% defibrinated sheep blood agar plates were placed about one meter above the ground near the designated locations for 15 minutes. The plates were then removed from the locations in a sterile manner and were appropriately labeled. The open plates were then incubated at 37^{o}C for 24 hours.

Sampling pre and post AiroCide® installation

The Anderson air Sampler was used to draw air. It is a single stage microbial bioaerosol impaction sampler designed to test for viable fungi and bacteria. The unit consists of an inlet-cone, a jet classification stage and base plate. The impactor stage contains 400 precision-cut holes. When air is drawn through the sampler, multiple jets of air direct airborne particles toward the surface of the agar collection media (Tryptic Soy Agar with 5% Sheep Blood).

Samples were taken from the selected locations in the range of 36" and 72" above the floor. Readjustment of the tripod was not done during air sampling. The air sampler was directed upwards for ALL air samples.

After cleaning the hands throwaway gloves which were worn the flexible tubing was connected to the male connector of the air sampler and the pump was turned on. An agar plate was placed on the base of the sampler so that the plate rests on the three raised metal pins. The pump is turned on for 3 mins. Air is drawn into the sampler. The clamps are unhooked and the agar plate is removed and appropriately labeled. The cultures are then incubated for 48 hours to facilitate microbial colony formation.

In the first month of the study period the ICU was sterilized by 3rd generation quaternary ammonium compound Microgen which consists of alkyl dimethyl benzyl ammonium chloride (2.37%) and alkyl dimethyl ethylbenzyl ammonium chloride (2.37%) and inert ingredients (95.26%) in one liter solution. Fogging was carried out using 15 ml of D-125 concentrate [Microgen] with one liter of tap water and for every 1000 cubic feet.

During the second month of the study the ICU was sterilized using AiroCide® technology which is based on the principle of photo catalytic oxidation. AiroCide® is a unique airborne pathogen killing technology

that was funded, developed and used by NASA. It uses a patented combination of ultraviolet light and a proprietary titanium based photo catalyst that is capable of killing a wide range of airborne pathogens including bacteria, viruses, and molds, and is adept at promoting the breakdown of volatile organic compounds (VOC's). This system is completely filter less and does not produce any ozone.

Result and Discussion

A total of 8 samples were taken prior to fogging with Microgen in the first month of the study. The concentration of airborne bacteria was expressed as colony forming units per cubic meter cube (cfu/m^3).

Table 1 shows that the total number of CFU's prior to Microgen Fogging was 1290. The pathogens included *Staphylococcus aureus, Bacillus, Citrobacter*, *E. col*i and *Klebsiella sp.*

Table 2 depicts that the total number of CFU's post Microgen fogging was 756. The pathogens included *Staphylococcus aureus, Bacillus, Pseudomonas, Klebsiella* and *E. coli.*

During the second month of the study 8 samples were collected from various locations pre and post installation of Airocide®.

Table 3 shows that the total number of CFUs prior to installation of Airocide® was 1410. The pathogens included *Staphylococcus aureus, Bacillus, Citrobacter sp, Pseudomonas, Klebsiella* and *E. coli.*

Table 4 depicts that the total CFU count was 90 after AiroCide® installation. The pathogens included *Staphylococcus aureus, Bacillus, Citrobacter sp, Pseudomonas, Klebsiella* and *E. coli*.

By comparing the above findings, we found that the CFU count post Airocide® installation was significantly lower as compared to the CFU count post Microgen fumigation (p value = 0.0001).

Microbial contamination of the hospital environment, especially the intensive care units has led to continued increased prevalence of nosocomial infection (Bonten, 1996; Boyce, 1997). Therefore, environmental cleaning is an important aspect in terms of prevention of nosocomial infection. In most of the heath care settings the most common form of sterilization is the chemical method. In the present study, we evaluated and compared the efficacy of Airocide® over Microgen.

During the present study, we collected and incubated 8 samples from various locations both before and after Microgen fogging and AiroCide® installation. The CFU count in the ICU before Microgen Fumigation was 1290 which came down to 756 after Microgen Fumigation whereas the CFU count prior to AiroCide® installation was 1410 which was reduced to 90 post AiroCide® installation and this difference was significant statistically. We found a persistent high bacterial load after Microgen Fumigation as indicated by the high CFU count. Our finding was consistent with the findings of Singh (2013) and his study also revealed high bacterial contamination in air samples with Chemical sterilization.

The study also had some limitations. We did not compare the effectiveness of these methods against fungi, *Mycobacteria* and viruses. Although Airocide® technology has a better effectiveness in providing a superior indoor air quality it is not suitable for surface sterilization which can be achieved with Microgen, so, we could not compare these two methods in terms of surface sterilization.

Table.1 Culture report from plates before Microgen fumigation

SITE	MICROORGANISM	CFU	%
ICU entrance	*Staphylococcus aureus, Bacillus*	180	13.95%
Near bed 2 and 3	*Citrobacter sp, Bacillus sp.*	200	15.50%
Near bed 3 and 4	*Citrobacter sp.*	150	11.62%
Near bed 4 and 5	*E. coli, Klebsiella sp., Bacillus*	140	10.85%
Midpoint of ICU	*E. coli, Klebsiella sp*	156	12.00%
Near bed 6 and 7	*E. coli, Klebsiella sp.*	160	12.40%
Near bed 8 and 9	*Citrobacter sp., E. coli*	138	10.69%
ICU endpoint	*Citrobacter sp., Klebsiella sp.*	166	12.86%
TOTAL		1290	100.00%

Table.2 Culture report from plates after Microgen fumigation

SITE	**MICROORGANISM**	**CFU**	**%**
ICU entrance	*Staph aureus, Bacillus*	100	13.22%
Near bed 2 and 3	*Staph Aureus, Bacillus*	90	11.90%
Near bed 3 and 4	*Pseudomonas, Staphylococcus species*	86	11.37%
Near bed 4 and 5	*Klebsiella spp*	100	13.22%
Midpoint of ICU	*Staphylococcus aureus, E. Coli*	112	14.81%
Near bed 6 and 7	*Staphylococcus aureus, Bacillus*	90	11.90%
Near bed 8 and 9	*Klebsiella Sp., E. coli*	86	11.37%
ICU endpoint	*Klebsiella, Bacillus*	92	12.16%
TOTAL		756	100.00%

Table.3 Culture report of the plates prior to installation of AiroCide®

SITE	**MICROORGANISMS**	**CFU**	**%**
ICU entrance	*Staphylococcus aureus, Bacillus*	180	12.76%
Near bed 2 and 3	*Citrobacter sp, Bacillus sp.*	170	12.05%
Near bed 3 and 4	*Citrobacter sp.*	190	13.47%
Near bed 4 and 5	*Pseudomonas, Staphylococcus species*	180	12.76%
Midpoint of ICU	*Klebsiella spp*	200	14.18%
Near bed 6 and 7	*Staphylococcus aureus, E. coli*	160	11.34%
Near bed 8 and 9	*Citrobacter sp., Klebsiella sp.*	170	12.05%
ICU endpoint	*Klebsiella spp*	160	11.34%
TOTAL		1410	100.00%

Table.4 Culture report of the plates after installation of Airocide®

SITE	MICROORGANISMS	CFU	%
ICU entrance	*Staphylococcus aureus, E. Coli*	10	11.11%
Near bed 2 and 3	*Staphylococcus aureus, Bacillus*	20	22.22%
Near bed 3 and 4	*Klebsiella Sp., E. Coli*	12	13.33
Near bed 4 and 5	*Klebsiella, Bacillus*	16	17.77%
Midpoint of ICU	*Staphylococcus aureus*	8	8.88%
Near bed 6 and 7	*E. coli, Klebsiella sp., Bacillus*	10	11.11%
Near bed 8 and 9	*E. coli, Klebsiella sp*	6	6.66%
ICU endpoint	*E. coli, Klebsiella sp.*	8	8.88%
TOTAL		90	100.00%

From the above study we can conclude that AiroCide® technology is a better choice as compared to Microgen in terms of controlling microbial contamination and providing better indoor air quality and hence, reduces cross contamination between patients and health staff. However, further studies are required to compare the efficacy of this equipment against other pathogenic microorganisms.

Acknowledgements

The AiroCide® device was provided to the ICU of this Hospital by Brissk Innovations on a trial basis.

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