REDUCTION OF MRSA POPULATIONS AND AEROALLERGENS ON USING AHPCO® AND PLASMA NANOTECHNOLOGY FOR AIR PURIFICATION

[1]NABARUN GHOSH, [2]AUBREY HOWARD, [3]NELOFAR SHERALI, [4]CHANDINI REVANNA, [5]CYNTHIA PRATT, [6]CONSTANTINE SAADEH, [7]JON BENNERT, [8]JEFF BENNERT, [9]KATY MULLAN, [10]JIM ROGERS

[1,2,3,5,10]Center of Advanced Study in Aerobiology, Department of Life, Earth and Environmental Sciences, West Texas A&M University, Canyon, Texas
[4]Department of Environmental Health & Safety, Texas Tech University, Lubbock, Texas
[6]Allergy A.R.T.S., Amarillo, Texas, [8]R&D, Air Oasis, Amarillo, Texas

Abstract - Methicillin-resistant Staphylococcus aureus, MRSA has become a serious public health issue. We implemented an air purification system using a hybrid AHPCO® and Plasma Nanotechnology that reduced the indoor particulate matters including all forms of aeroallergen.In this study, the efficiency of Air Oasis air purifiers such as the Xtreme 3000 air purifier, Wall-Mount and the InductACT air purifiers were evaluated in the Microbiology and Mycologylaboratories of the Baptist Saint Anthony's Hospital (BSA) in Amarillo, Texas. This department processes around 85,000 bacterial and fungal cultures per calendar year, and the staff also performs various types of serological testing for bacterial pathogens and routine parasitological examinations on various types of clinical specimens. We evaluated the efficiency of the net reduction of bacteria in a negative pressure laboratory and the specific effect on isolates identified as Methicillin-resistant Staphylococcus aureus (MRSA). The air purification system with novel AHPCO®and Plasma nanotechnology reduced the concentration of MRSA, Fungi and the other indoor particulate matters gradually with varied time intervals.

Index Terms - Air Purifiers, AHPCO®, Plasma Nanotechnology,MRSA, Staphylococcus aureus.

I. INTRODUCTION

Eradication of multi-resistant superbugs is one of the clinical challenges of the 21st century [1]. As the rate of the development of new antibiotics continues to decrease, there is a consistent rise in number of antibiotic resistant microbes. Methicillin-resistantStaphylococcus aureus (MRSA) is a form of contagious bacterial infection that is resistant to numerous antibiotics including Methicillin, Amoxicillin, Penicillin, and Oxacillin, and has become commonplace in the healthcare setting [2]. This resistance makes it challenging to treat because it canincrease treatment time and healthcare cost, as well as decrease the efficacy of the prescribed antibiotic therapy. MRSA infection may begin as a skin sore, pimple, or boil, before becoming serious, potentially harmful, and sometimes fatal. Airborne pollen and fungal spores are causative factors in respiratory allergy, asthma and other allergic diseases [3]. Mold allergens are risk factors for bronchial asthma in patients suffering from allergic rhinitis [4]. A collaborative research between the West Texas A&M University and Air Oasis developed the Advanced Hydrated Photo Catalytic Oxidation (AHPCO®) Nanotechnology and Plasma Nanotechnology [2,3,6]. AHPCO® was applied to develop an air purification system to reduce the indoor aeroallergen, thereby improving the air quality. The Plasma Nanotechnology was initially applied for a better food preservation and reducing the microflora in the ice machines. Later, it was applied to sterilize the ice makers. Air Oasis air purifiers utilize a new generation of AHPCO® Nanotechnology that simply produces a blanket of redundant oxidizers that not only cleans the surrounding air, but targets the particulate matters in the air as well as on the surface, sanitizing the air eventually. Our investigation at the BSA Hospital and at the West Texas A&M University laboratories with AHPCO® Nanotechnology proved to be efficient for net reduction of microbes, fungal spores,and VOCs with the specific effect on Methicillin-resistantStaphylococcus aureus, MRSA.

II.MATERIALS AND METHODS

We have evaluated the efficiency of the Air Oasis air purification units, Xtreme 3000, Wall-Mount and the InductACT air purifiers. The Air Oasis air purifier is designed to sanitize air, as well as kill surface mold, bacteria, and viruses in areas up to 6,000 square feet. It has been proven to reduce colony growth in petri-dishes in one, two, four, eight and sixteen foot distances [3], [6]. At first the effectiveness of the air purifiers was evaluated in the mycology room which is approximately 80 square feet. In this experimental study the re-evaluation of the square footage of the Microbiology room and the layout of the air ducts were taken into consideration. The four InductACT units were evaluated in the Microbiology room which is 960 square feet. These units use an Advanced Hydrated Photocatalytic Oxidation nanotechnology that is placed directly into the air circulation system via a hole cut into the ventilation system.

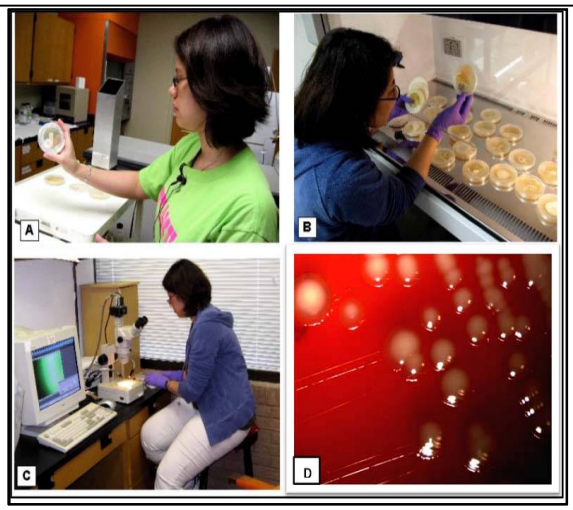

Fig 1. A. set up the air purifier. B. Working with petri-plates under Laminar Hood. C. Capturing images with an SZ-40 stereo microscope. D. Stereo micrograph of the MRSA colonies.

The BSA Microbiologydepartment processesa large number of bacterial cultures. The peak hours of activity of culture evaluation and clinical specimen setup in the Microbiology department were from 06:00 to 16:30 daily. The BSA Microbiology department handles a variety of clinical specimens from the inpatient cases, emergency room, two urgent care centers, a dozen long term care facilities, and many of the area physician offices.We plated the MRSA strains from the stock culture after dilution 10^{-4} to investigate the effect of the air purifiers on the production of number of colonies of the Methicillin-resistantStaphylococcus aureus. In order to establish growth patterns in both rooms, tryptic soy agar (TSA) plates with 5% sheep blood were placed out in the Microbiology and Mycology rooms at 15, 30, 60, 120, 180, 240, 300, 360, 420, and 480 minutes of exposure to room air during peak times of activity. The plates were evaluated for the total number of bacterial and fungal colonies observed at 24 and 48 hours of incubation at 35^{o}C in a CO_2 incubator (Figs. 1A-D).

The experimental plates were collected while operating both air purifiers on consecutive days. To identify the Staphylococcus aureus isolates, colonies were analyzed as follows: we captured the images of bacterial colonies using a using a SZ-40 stereo-scope attached to a DVC digital camera and gooseneck fiber optics light sources; we evaluated the bacterial micro-morphology by observing the Gram-stained slides under a BX-40 Olympus Microscope attached to a DP-70 digital camera with Image Pro 6.0 software. We also followed beta hemolysis on TSA agar with 5% sheep blood and detected the presence of coagulase by latex agglutination testing. The data were then grouped and compared by the days of collections respectively to account for the difference in workload during the work week. The data for the control and experimental setups are summarized in the graphs as follows.

III. RESULT AND DISCUSSION

We counted the microbial and fungal colonies formed on the Petri plates on exposure to the air at fixed intervals in the Microbiology and Mycology rooms of the BSA Hospital.The data for the control and experimental setups are summarized in the graphs as follows.

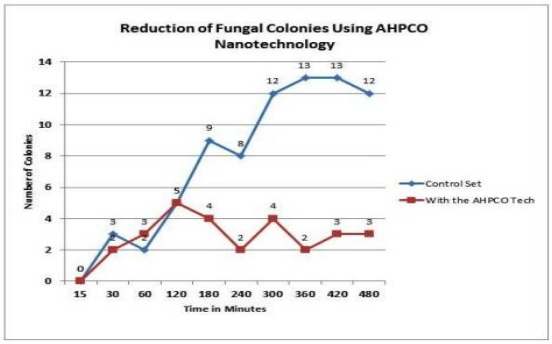

Fig.2 showing the number of fungal colonies growing on the TSA Petri plates for both the “Control Set” (no air purifier) and “With the AHPCO®” (with running the air purification unit) at different intervals. The data analyzed, as presented in the graph, showed a gradual reduction in the formation of fungal colonies when using the AHPCO® Nanotechnology.

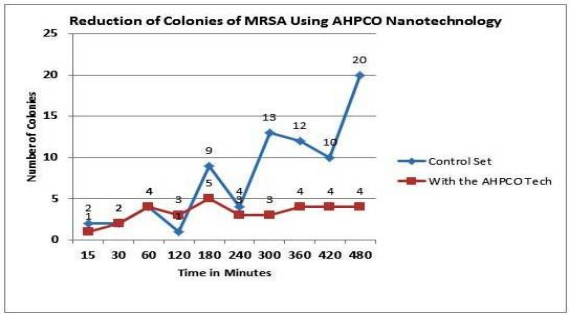

Fig.3. Data analyzed with the above graphical representation displays the gradual reduction of MRSA colonies upon using the AHPCO® Nanotechnology. From Fig. 3, it is clear that after 360, 420 and 480 minutes of exposures with the AHPCO® air purifiers, the MRSA colonies became inactive revealing no further growth, whereas the “Control” set without the InductACT running resulteda peak in the graph thatdepicted a continuous microbial growth.Out of all the air purification units, the InductACT was the most effective one which was able to minimize the number of bacterial colonies. The experimental data showed a net 86% reduction in the number of colonies produced in the inoculated TSA agar plates on using the Inducts. A separate assessment by the EMSL Analytical, the testing company confirmed the reduction of the MRSA population by the AHPCO® and Plasma Nanotechnology to the same multitude.MRSA and various aeroallergens reduce the health quality in

hospitals. The AHPCO® Nanotechnology is proven as an effective way to sanitize surfaces and help manage a growing problem that hospitals all around the world are facing. The AHPCO® and Plasma Nanotechnology provide a viable option to help control and prevent the spread of not only the MRSA, but many other infectious microbial contaminants that are detrimental to human health. The decolonization of microbial organisms and sanitization of the air and surrounding surfaces that AHPCO® Nanotechnology provides should be taken into consideration for daily application and commonplaceusage where the regulation of these microbial contaminants is essential.

REFERENCES

[1] Maisch T, Shimizu T, Li Y-F, Heinlin J, Karrer S, et al. (2012) Decolonisation of MRSA, S. aureus and E. coli by Cold-Atmospheric Plasma Using a Porcine Skin Model In Vitro. PLoS ONE 7(4): e34610. doi:10.1371/journal.pone.0034610

[2] MRSA: Treatment, causes, and prevention. (2017). Medical News Today: Web link: http://www.medicalnewstoday.com/articles/10634.php visited on 4/18/2017

[3] Ghosh,N., Bennert, J., Whiteside, M., Patel, R. Eradication of Indoor Aeroallergen Using a 3000 Xtreme Air Purifier. Abstract Book, Plant Biology 2007, Chicago, 275

[4] Chooniedass, R., Rabbani, R., Liem, J., Becker, A. (2007). The Risk of Asthma in Children Sensitized to Alternaria. J ALLERGY CLIN IMMUNOL, JANUARY 2007. S186

[5] Ghosh, N., G. Estrada, Veloz, M., Bouyi, D., Bennert, J. Bennert, J., Saadeh, C. and Revanna, C. Meteorological and clinical analysis of aeroallergen data: Increase in allergy and asthma cases in Texas Panhandle. ALLERGY AND ALLERGEN IMMUNOTHERAPY: New Mechanisms and Strategies (2017):101-124. Book Chapter, Apple, CRC Press, New York

[6] Air Oasis : Web site: http://www.airoasis.com/

★★★