Wake Forest®
School of Medicine

Department of Internal Medicine
Section on Infectious Diseases

Medical Center Boulevard
Winston-Salem, NC 27157
p 336.716.4584
f 336.716.3825

Kevin P. High MD, MS
Professor
Section Chief

Laura Bachmann MD
Associate Professor

Luis Barroso MD
Assistant Professor

Werner Bischoff MD, PhD, MS
Associate Professor

Charles de Comarmond MD
Assistant Professor

Ricardo M. La Hoz MD, FACP
Assistant Professor

Vera Luther MD
Assistant Professor

Charles McCall MD
Professor

Marina Nunez MD, PhD
Associate Professor

Christopher Ohl MD
Professor

James Peacock MD
Professor

Katherine R. Schafer MD
Assistant Professor

Aimee M. Wilkin MD, MPH
Associate Professor

Affiliated Faculty
James Johnson PharmD
John Williamson PharmD
Scott Rhodes PhD, MPH

Professors Emeriti
Joseph O'Flaherty MD
P. Samuel Pegram MD
Robert Sheretz MD

Werner E. Bischoff, MD PhD
Health System Epidemiologist
Infection Prevention & Health System Epidemiology
Associate Professor
Internal Medicine, Section on Infectious Diseases
Wake Forest University School of Medicine

03/25/2014

To Whom It May Concern:

Please find attached the final report examining the effect of the Photox air filtration system on eliminating airborne bacteria in a real world, clinical setting (emergency department). All locations tested displayed a highly significant reduction in airborne bacterial load after treatment with Photox. We look forward to further testing of the air filtration system in other clinical settings.

Sincerely,

Werner E. Bischoff

Evaluation of Photox for Bacteria Clearance in a Clinical (Emergency Department: ED) Setting

Introduction

Airborne transmission of pathogens, including flu virus, can result in the rapid spread of disease. For example, influenza has been responsible for three pandemics in the last century alone, with an overall death toll reaching tens of millions, and continues to cause annual epidemics of varying severity worldwide (1)**.** The current understanding of aerosol transmission assumes that a number of human pathogens are spread by respiratory secretions and/or infect by way of the respiratory tract (2). However, data on how to protect against the spread of these pathogens is sparse (3, 4). Masks, respirators, and HEPA filtration systems are commonly used barrier and decontamination methods for preventing and/or reducing airborne transmission. The current project is designed to study the ability of the Photox air purification system to serve as a broad pathogen decontamination system. Current air decontamination systems tend to revolve around HEPA filtration systems which require frequent costly filter replacements resulting in increased biohazard waste and decreased efficiency over time if not properly maintained. There are even some discussions regarding the HEPA filters ability to grow mold if they are not treated with an antimicrobial preservative, again adding to the biohazard waste conundrum in the effort to reduce airborne pathogens (5). Under the requirements of the ongoing healthcare reform, it is critical to reduce healthcare associated infections in order to create a safe environment for the care of patients.

Hospitals and medical clinics are continually looking for better ways of controlling airborne microbial loads leading to hospital-associated infections. **This study provides data to determine the effectiveness of the Photox filtration system in broadly eliminating the amount of bacterial contaminants in the air.** This improves our understanding of the effectiveness of the Photox air filtration system in a clinical setting as it relates to bacteria.

The Photox air filtration system is an innovative photocatalytic oxidation (PCO) system that effectively cleans the air of volatile organic compounds (VOCs) and has ancillary evidence supporting elimination of broad classes of pathogens. It is different from many of the current PCO systems on the market because it maximizes the number of air treatment cycles in a room and optimizes the PCO reaction process through the use of novel catalyst reaction materials. Together this provides superior clearance of VOCs and is expected to reduce or eliminate a broad range of airborne pathogens. This project is innovative since it examines how effective the Photox system is in eliminating bacteria in a real-life, clinical (emergency department) setting rather than a controlled lab environment.

Methods

Baseline Air Sampling

The samplings were performed in emergency department (ED) rooms with door access. Rooms were selected based on availability and likelihood of the patient being present in the room for 90 minutes or more. Three 6-stage Andersen Samplers were used to sample the air and placed at the head and foot of a patient's bed along with one sampler at the exit/entrance doorway. All samples were collected on blood agar plates. The air was sampled for 20 minutes with no restrictions on care activities for the patient. If the patient had to leave the room for any reason during the air samplings, the sample was excluded from analysis. To assess the baseline bacterial load in the room air sampling was performed before the use of the Photox instrument.

Photox Instrument Air Sampling

After completion of the baseline air sampling the Photox system was placed at the foot of the bed and run to allow the room air to circulate a total of eight times. This was adjusted by room size (wash-out phase). At the end of the wash-out phase, air sampling was performed for 20 minutes as described above while the Photox instrument was left running.

Colony Quantification

Once the air samples were completed, the plates were placed in a 37^{o}C incubator. After incubating for 48 hours, the number of colonies was counted on all plates and recorded.

Results

A total of 70 participants were consented and enrolled in the study. Out of the 70 participants, 20 participants were excluded due to leaving the ED room before completion of sampling (n =16) or withdrawing (n = 4). Samples of the remaining 50 participants were analyzed.

The bacteria counts (colony-forming units [CFU]) are summarized as medians and interquartile ranges (25th to 75th) for each sampling location as well as the total (sum of all sampling locations) (see table 1). Summary values are presented in the table for the baseline sampling phase and the Photox sampling phase. The change between the baseline and the Photox sampling phases was evaluated using signed Wilcoxon rank-sum tests. For each location, the colony count was summed across the 6 stages of the Andersen sampler.

As shown in the table below, all locations show a highly significant reduction in CFU from baseline to Photox phase. The greatest reduction is seen at the head of the bed followed by the foot of the bed and the exit. The room total (sum across all sampling locations) also shows a highly significant reduction in the bacterial count after treatment with the Photox instrument. The percent reduction ranges from 26.7% to 54.2% based on the sampling location. The originally expected percent reduction of 20% was met at all locations and for the total room.

	Baseline	Post	Difference (Post - Baseline)	p-value	Percentage Difference (Post - Baseline)	N (Base > 0)
Head	14 (7 to 24)	5.5 (3 to 12)	-7 (-17.75 to 0)	≤0.001	-54.17% (-70.00% to -5.36%)	48
Foot	11.5 (6 to 24.25)	7 (4 to 13.75)	-4.5 (-12.5 to 3)	≤0.001	-46.9% (-66.67% to 31.41%)	48
Exit	9.5 (4.25 to 22)	7 (3.25 to 13.75)	-3.5 (-10.75 to 1.75)	0.002	-26.67% (-75.00% to 15.79%)	49
Total	38.5 (21 to 68.75)	20 (13.25 to 37.75)	-15 (-36.75 to -1)	≤0.001	-46.00% (-66.86% to -15.73%)	49

Total N=50 unless otherwise indicated for percentage difference calculations due to baseline needing to be greater than 0

Values are median (interquartile range, 25th to 75th percentile)

p-value based on signed Wilcoxon rank-sum test

Percentage Difference = 100*((Post - Baseline) / Baseline) for Baseline counts > 0

Discussion

The Photox instrument significantly reduced the bacterial load under routine care in an ED setting by a range of 26.7% (exit location) to 54.2% (head location). The foot of the bed and the exit locations showed overall smaller decreases probably affected by higher traffic/activity patterns in these areas as compared to the head of the bed. In conclusion, use of the Photox instrument in an ED setting leads to a significant reduction of the airborne bacterial load. Applications of this new technology promise to reduce the pathogen load, reduce exposure, and provide a safe environment for patient care.

References:

1. Miller MA, Viboud C, Balinska M, Simonsen L. The signature features of influenza pandemics--implications for policy. N Engl J Med. 2009;360:2595-8.
2. Gwaltney JM, Hendley JO. Respiratory transmission. In: Epidemiologic methods for the study of infectious diseases. (p.213-227) Thomas JC, Weber DJ (eds). Oxford University Press, 2001, New York, New York.
3. Institute of Medicine: Preventing Transmission of Pandemic Influenza and Other Viral Respiratory Diseases - Personal Protective Equipment for Healthcare Personnel Update 2010. Available at http://iom.edu/~/media/Files/Report%20Files/2011/Preventing-Transmission-of-Pandemic-Influenzaand-Other-Viral-Respiratory-Diseases/Pandemic%20Influenza%202010%20Report%20Brief.pdf. Accessed January 28, 2011.
4. Brankston G, Gitterman L, Hirji Z, et al. Transmission of influenza A in human beings. Lancet Infect Dis 2007;7:257–65.
5. Price DL, Simmons RB, Crow SA Jr, Ahearn DG. Mold colonization during use of preservative-treated and untreated air filters, including HEPA filters from hospitals and commercial locations over an 8-year period (1996-2003). J Ind Microbiol Biotechnol 2005;32:319-321.