# Reduction of Bacterial Air Burden During Routine Patient Care by a Novel Mobile Air Purification System (PhotoxAir)

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## Abstract

**Background:** Airborne transmission of pathogens such as *Mycobacterium tuberculosis* can result in the rapid spread of disease. This project assessed the ability of PhotoxAir, a novel mobile air purification system (MAPS) based on photocatalytic oxidation, to minimize the bacterial air burden during routine patient care in an emergency department (ED).

**Methods:** Fifty patients admitted to the ED underwent air sampling in their respective rooms during routine care activities. One six-stage Andersen Air Sampler each was placed at the head and foot of a patient's bed and at the exit/entrance doorway. The MAPS was positioned near the foot of the bed. All samples were collected on blood agar plates. Baseline air burden was assessed for 20 minutes without MAPS activated, followed by a wash-out phase with MAPS activated (eight total air exchanges per room), and a 20 minute air sampling with MAPS activated. Colony-forming units (CFUs) were counted and summed for each location. Significance was assessed using the signed Wilcoxon rank-sum test.

**Results:** A significant reduction in bacterial CFUs was observed from baseline to MAPS use. The greatest decrease was seen at the head of the bed (-7 CFUs; -54%; p≤0.001) followed by the foot of the bed (-4.5 CFUs; -47%; p≤0.001) and the exit (-3.5 CFUs; -27%; p≤0.001). The room total (sum across all sampling locations) also showed a significant reduction (-15 CFUs; -46%; p≤0.001) under MAPS use.

**Conclusions:** The MAPS significantly reduced the bacterial load observed under routine care in an ED setting. The foot of the bed and the exit showed smaller decreases probably affected by higher traffic/activity patterns in these areas as compared to the head of the bed. Application of this new, mobile technology promises to reduce the airborne pathogen burden, and decrease exposure risk providing a safer environment for patient care.

## Introduction

Airborne transmission of pathogens can result in the rapid spread of disease. 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 (1). However, data on how to protect against the spread of these pathogens is sparse (2-5). Masks, respirators, and eye protection are commonly used barriers to block transmission to the individual. Environmental controls focus on air exchanges and air filtration systems diluting and removing airborne pathogens therefore reducing the pathogen burden within a physical space.

**This study assesses the efficacy of the Photox air filtration system in broadly eliminating the amount of bacterial contaminants in the air in a real-life clinical (emergency department) setting.**

## Mobile Air Purification System (MAPS)

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.

**Impact of PhotoxAir MAPS on Bacterial Air Burden**

| | Baseline # of Colonies | MAPS run # of Colonies | Difference (Post – Baseline) | p-value | Percentage Difference (Post-Baseline) | N (Base > 0) |
|---|---|---|---|---|---|---|
| **Head (Bed)** | 14 (7 to 24) | 5.5 (3 to 12) | -7 (17.75 to 0) | ≤0.001 | -54.17% (-70.0% to -5.36%) | 48 |
| **Food (Bed)** | 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/Entrance** | 9.5 (4.25 to 22) | 7 (3.25 to 13.75) | -3.5 (-10.75 to 1.75) | 0.002 | -26.67% (-75.0% to 15.79%) | 49 |
| **Total** | 38.5 (21 to 68.75) | 20 (13.25 to 37.75) | -15 (-36.75 to -1) | ≤0.001 | -46.0% (-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 x ((Post-Baseline) / Baseline) for Baseline counts > 0

## Methods

**Baseline Air Sampling**:
Sampling was 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.

**Photox Instrument Air Sampling (MAPS run)**
After completion of the baseline air sampling the MAPS system was placed at the foot of the bed and run for a total of eight air exchanges (wash-out phase - adjusted by room size). At the end of the wash-out phase, air sampling was performed for 20 minutes as described above while the Photox instrument was left on.

**Colony Forming Unit (CFU) Quantification**
Once the air samples were completed, the plates were placed in a 37ºC incubator. After incubating for 48 hours, the number of colonies congruent with bacterial growth was counted on all plates and recorded.

**PhotoxAir MAPS (center of picture) in a clinical setting.**

## 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. Table 1 shows the bacterial counts in CFU by location at baseline and under MAPS use. The following observations were made:

- MAPS did not interfere with routine care and was well tolerated by staff.
- The highest baseline bacterial CFUs were found close to the patient head.
- A significant reduction in bacterial CFUs was observed from baseline to MAPS use at all locations (-15 CFUs; -46%; p≤0.001) .
- The greatest decrease was seen at the head of the bed (-7 CFUs; -54%; p≤0.001) followed by the foot of the bed (-4.5 CFUs; -47%; p≤0.001) and the exit (-3.5 CFUs; -27%; p≤0.001).

## Conclusions

MAPS 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. The device was well tolerated by the ED staff. In conclusion, use of the PhotoxAir 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

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