Evaluation of operating room air contamination levels

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Study acceptance

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This study was designed to evaluate the effectiveness of the Aerobiotix HEPA/Ultraviolet air recirculation system to reduce airborne particle levels in operating room air at [CONFIDENTIAL], a [CONFIDENTIAL]-bed tertiary care facility located in Cleveland, Ohio, USA.

Air quality was monitored before and after use of the Aerobiotix system by using a continuous air particle measurement system, with readings taken every 2 minutes for the test period.

- Control measurement of the operating room before use of Aerobiotix system for 5 days
- Measurement of the operating room before use of Aerobiotix system for 5 days

Airborne pathogen levels in healthcare settings are a significant, yet under-appreciated cause of hospital acquired infections and surgical site infections. Infections acquired at hospitals are the number four cause of death in the United States, exceeding the combined mortality of breast cancer, AIDS and traffic accidents at an annual cost estimated at $40 billion (McCaughey, 2008; Mitka 2008). Increasingly, the microorganisms causing these infections have mutated into antibiotic resistant strains, making the resulting morbidity/mortality of a healthcare associated infection greater than ever. Surprisingly, there is no minimum U.S. standard for the number of bacteria, viruses, or fungi in hospital air, including critical areas of surgery suites, immunocompromised patient areas, or intensive care units.

The ABX T1 (Aerobiotix, Dayton, OH) is a novel in-room air decontamination-recirculation unit. (Fig. 1) It utilizes a hybrid of biological and physical systems to remove bacteria, fungi and viruses from the air. Its key biocidal technology is a reactor system which provides simultaneous physical filtration and irradiation of high-volume air flow with minimal resistance. The reactor system utilizes C-band ultraviolet light (UVC) focused on a reaction chamber filled with a multitude of clear cylindrical silicate quartz crystals. Silicate quartz transmits UVC radiation with minimal loss of power. Additionally, quartz itself is impervious to UV irradiation, and will not discolor or degrade under long-term high-energy exposure. The cylindrical design allows for maximal air-flow and surface area. While organisms are slowed or trapped in the quartz matrix, they are inactivated by the penetrating UVC dosage. This has the effect of increasing the inactivation efficiency over prior UV technologies.

**Figure 1:** Mechanism of Action for Aerobiotix T1 Air Decontamination unit.
The indoor air quality assessment consisted of the measurement of the following particulate levels:

- 0.5 µM/m³
- 1.0 µM/m³
- 5.0 µM/m³
- 10.0 µM/m³

The Oberon IC Sentinel® (ICS) network-enabled real-time particulate monitoring system was placed in the operating room. During the control period, levels of air contamination were obtained for all particulate sizes using automated air sampling on a per-minute basis. For the Aerobiotix test period, the particle measurements were taken along with an Aerobiotix T1 unit running at a 450 CFM air treatment rate. Baseline levels of air contamination were obtained for all particulate sizes using automated air sampling on a per-minute basis. The T1 unit was then switched on, running at 450 CFM while regular readings continued to be taken.

Measurements were taken in a fully occupied general operating room, with a mixture of general and orthopedic procedures. In hospitals, the ICS system can be used to verify efficacy of mechanical air ventilation systems designed to minimize occurrences of airborne infectious disease. ICS can be used to measure nominal or baseline IAQ parameters such as particle count. The ICS can detect changes in airborne particle count due to mold and fungus disruption, degraded air filtration, or activities (such as construction or renovation) from which patients are not adequately protected.
Results

St. OR Baseline vs T1 Particulates per M³

Baseline 7AM-5PM: May 21, 22, 23, 27, 28

- 0.5µ per M³ Baseline
- 49.3% reduction

- 1.0µ per M³ Baseline
- 50.0% reduction

- 5.0µ per M³ Baseline
- 47.4% reduction

- 10.0µ per M³ Baseline
- 43.1% reduction

T1 7AM-5PM: May 29, 30, June 2, 3, 4

- 0.5µ per M³ with T1

- 1.0µ per M³ with T1

- 5.0µ per M³ with T1

- 10.0µ per M³ with T1

Average 60,988 1.0µ particulates per sample

Samples taken every 2 minutes
The collected data demonstrate a marked reduction in air contamination for the particle sizes measured using the T1 device. Reductions ranged from 49.25% to 51.95%, with no trend of greater reduction of certain sized particles. In this study, we concentrated on airborne particles in the 0.5 to 10.0 µm size. This particle size range has been most closely identified with pathogenic airborne bacterial populations (Kowalski, 2012).

There are no regulated standards for airborne particulate levels in most health care settings in the United States. However, international literature recommends the use of ISO 14644-1 cleanroom standards, with ISO 8 and ISO 7 levels published as operating room reference levels, depending on procedural requirements. (Scaltriti 2007, Wan 2011, Charkoska 2008). The ISO 8 level has been promulgated under ISO 14644-1 to describe the minimal standard for cleanroom air, with air exchange and enclosure requirements.

For the standardized particle sizes measured, the ABX unit improved mean airborne particulate levels from ISO 9 (green box above) into ISO 8 levels (red box above), specifically with 47.4% reduction in 5.0 µM/m3 particle concentrations.
In conclusion, the ABX technology successfully reduced airborne contamination under the test parameters and environment described. The addition of ABX supplemental air decontamination to this facility should be considered, as part of a comprehensive environmental management plan.

References


