Airborne bacteria in the operating room can be reduced by HEPA/Ultraviolet air recirculation system (HUAIRS)

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The Healthcare Environment Institute is a nonprofit corporation dedicated to improving healthcare outcomes by improving the environments in which healthcare is provided. HEI enacts its vision through partnerships with leading clinicians, industry and healthcare stakeholders.
Surgical site infections (SSI) are a major cause of morbidity and mortality in US hospitals. Airborne bacteria in operating rooms may contribute to SSI. In Europe but not the US, regulations exist to limit the airborne bacterial levels in the operating theater. In the 1st part of a multi-part study, we sought to determine whether airborne bacterial levels can be reduced by the HUAIRS system.

A newly commercialized HUAIRS from Aerobiotix, Inc. (Dayton, OH) was evaluated as to its efficacy in reducing airborne bacteria present in a plastic surgery operating room at an outpatient surgery center. The reactor system of the HUAIRS utilizes C-band ultraviolet light focused on a reaction chamber filled with a multitude of clear cylindrical silicate quartz crystals to decrease bacteria from the air. An air sampling impactor and agar media plates were placed in multiple locations in the operating room and used to measure the number of colony forming units (CFU) per cubic meter of bacteria in the air before and after the utilization of the HUAIRS.

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
- Experimental measurement of the operating room during use of Aerobiotix system

Additionally, bacterial air samples were taken using vacuum impactors and agar plates to obtain the number of airborne colony forming units (CFU) in each test modality using the USP 797 standard. Sample plates were placed in various locations within the operating suite during aesthetic procedures. Twenty four samples were utilized in the analysis. The agar plates were incubated by an independent microbiological laboratory.

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 HUAIRS in-room decontamination-recirculation unit (Figs. 1 and 2) utilizes a hybrid of biological and physical systems to remove bacteria, fungi and viruses from the air. Its key biocidal technology is a solid-state germicidal irradiation system which provides simultaneous physical filtration and irradiation of high-volume air flow. The system utilizes C-band ultraviolet light (UVC) at a 254 nm wavelength diffused into a solid media which is gas and radiation permeable. While organisms are slowed or trapped in the solid media, they are inactivated by the internal UVC dosage. This has the effect of increasing the inactivation efficiency over prior UV technologies.
Using a continuous air quality monitor (IC Sentinel, Oberon Technologies) the indoor air quality assessment consisted of the measurement of the following particulate levels:

- 0.5 µM/m³
- 2.5 µM/m³
- 5.0 µM/m³

During the control period, levels of air contamination were obtained for all particulate sizes using automated particle air sampling on a per 2 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. Again, levels of air contamination were obtained for all particulate sizes using automated air sampling on a per-2 minute basis.

Measurements were taken in a fully occupied general operating room, while a mixture of plastic and reconstructive procedures were performed using standard techniques and protocols.
A. Particulate Studies

**Outpatient surgery Baseline vs T1 OR Graphs**

<table>
<thead>
<tr>
<th></th>
<th>Ch1 Data 0.5µ</th>
<th>Ch2 Data 2.5µ</th>
<th>Ch3 Data 5.0µ</th>
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<tr>
<td>CONTROL</td>
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<td>ABX T1</td>
<td>2209157.383</td>
<td>151508.6411</td>
<td>14183.33971</td>
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<td>% reduction</td>
<td>68.08</td>
<td>72.51</td>
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B. Microbial Studies

**AIRBORNE BACTERIAL LEVELS – OUTPATIENT SURGERY**

<table>
<thead>
<tr>
<th>Sample Number</th>
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<th>Sample 2</th>
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<th>Sample 7</th>
<th>Sample 8</th>
<th>Sample 9</th>
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<th>Sample 11</th>
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<tr>
<td>CFU/mm³</td>
<td></td>
<td></td>
<td></td>
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<td>14</td>
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**Discussion and Conclusion**

The collected data demonstrate a marked reduction in air contamination for the particle sizes measured using the T1 device. Reductions ranged from 66.3% to 72.5%, with comparable reductions across all measured particle sizes. In this study, we concentrated on airborne particles in the 0.5 to 5.0 µm size. This particle size range has been most closely identified with pathogenic airborne bacterial populations (Kowalski, 2012). It is important to note that for any given environmental air sample, there will be orders of magnitude higher amounts of particles than culturable bacterial colony forming units. Particles include a broad population of inorganic matter, non-viable organic particles, and prokaryotic and eukaryotic cells.
For the cultured samples obtained, there was a 67.7% reduction in CFU count in twelve paired samples. This reduction is statistically significant (p=.0163) using a paired T-test.

In conclusion, the HUAIRS device significantly decreases the level of airborne bacteria present in the operating room. Further studies will demonstrate whether this reduction will translate into a decrease in SSI in surgical patients.

References


