

Shortening the Pause: Calculating Aerosol Clearance for the Illuvia® System in the Operating Room Environment

Introduction

During the COVID-19 pandemic, the resumption of elective procedures has required increased vigilance in reducing airborne O.R. contamination. Studies have shown that aerosol generating procedures (AGP), such as intubation, can increase the transmission rates of SARS pathogens by a factor of 13.¹ A specific concern is O.R. turnover times and aerosol clearance between procedures. The use of Aerobiotix HEPA/UV-C Air Recirculation Systems (Illuvia®) can have a direct effect on room clearance times, compared to rooms without this technology. Illuvia® systems have been independently tested to achieve 100% single-pass virus elimination.² These systems work in three ways to reduce clearance times:

- Increasing air exchange rates by 25% compared to baseline airflow.
- Reducing baseline contamination levels through continuous O.R. use by 70%.
- Allowing for relocation in close proximity to aerosol generating procedures (AGPs).

Determining baseline clearance rate

Air clearance rates are determined by the formula:

$$T = [\ln (C2 / C1) / (Q / V)] \times 60$$

Where T = time in minutes, C1 = initial concentration of contaminant, C2 = final concentration of contaminant, Q = air flow rate in cubic feet/hour, V = room volume in cubic feet.

At baseline, a typical O.R., with flow rate 100,000 cubic feet/hour, 4750 cubic feet volume, an initial viral concentration of 1000/cubic foot, a final concentration of 1, will have a clearance rate of **19.7 minutes**.



ILLUVIA[®]
HEPA-Ultraviolet Air Recirculation System

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ILLUVIA®: Reduction in initial concentration and increase in flow rate

Published studies³ have found the Illuvia® system reduced airborne contamination levels, defined as aerosol particulates between 0.5 to 10 microns. This particulate size range has been identified as a size range for COVID-19 bioaerosols.⁴ With continuous use in the operative setting, particle contamination was reduced by 70%. Results were achieved with the unit placed 4m from the surgical table, adding an additional 27,000 cubic feet/hour of exchange capacity.

Referring to the clearance formula, addition of the Illuvia® system in the same O.R. increases flow rate to 127,000 cubic feet/hour, and reduces initial concentration to 300, resulting in a clearance rate of **12.8 minutes**.

Moving the ILLUVIA® closer to contamination source will increase performance

A recent technical report⁵ from the European Centre for Disease Prevention and Control indicates that in rooms where aerosol-generating procedures have been performed (including intubation and bag-valve ventilation) the use of a portable HEPA air filtration system placed in close proximity to where the patient was located is advised.

Clearance time using the Illuvia® can be further reduced by placing the unit near the area where AGPs have been performed. Aerosol concentration will be highest in this location and decrease as an inverse square of the distance from the source:

$$\text{Concentration} = 1/\text{distance}^2$$

Placing the unit 1m from the AGP contamination source will capture a much higher proportion of the contamination than at 4m. Temporarily moving the unit from 4m to 1m during intubation and extubation may result in an additional 9X reduction in local aerosol concentration after an AGP is performed. Filtration systems, work more efficiently at levels of higher contamination, where a single pass through the system removes relatively more particulates in the same time period.

Referring again to the clearance formula, addition of the Illuvia® system at 1m from a known contamination source with a specific contamination event reduces initial room concentration to 33, resulting in a clearance rate of **7.8 minutes**, assuming that is the only source of contamination.

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Conclusion

There is significant variability in operating room construction, airflow, workflow and potential sources and concentrations of contamination. No engineering control can provide a guaranteed result with the inherent variability of the system.

Illuvia HUAIRS: Factors for Room Clearance

- Reduces baseline particle levels
- Increases Air exchange rate
- Can be placed at source of contamination

Moving the ILLUVIA® closer to contamination source will increase performance

The use of the Illuvia® unit in a typical operating room environment will result in a potential **reduction in clearance time from 19.7 minutes to 7.8-12.8 minutes**. Variability is based upon room configuration and the source and level of contamination. If the source can be localized, such as with a specific AGP, higher efficiency may be achieved. It must also be noted that any environmental control system does not substitute for appropriate airborne precautions and wearing of PPE, which must be maintained in any setting where diagnosed or suspected COVID-19 patients are located.

References

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