Reducing airborne contamination in hospital environments with an in-room non-thermal Plasma air-treatment unit

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Abstract

Objective: Evaluate in critical hospital environments the performance of a new mobile air treatment unit, for lowering the airborne bio-burden and reducing the risk of nosocomial infection from opportunistic airborne pathogens such as *Aspergillus fumigatus*.

Design: Three Phase testing Strategy:
Phase 1. Laboratory bench testing of the technology,
Phase 2. Device Testing under simulated conditions in the Hospital,
Phase 3. Device Testing in occupied patient rooms of an haematology/onocolgy ward.

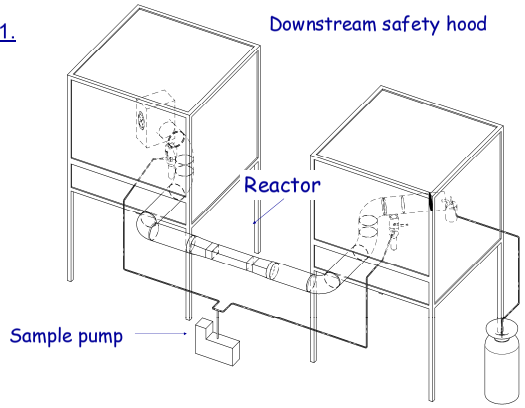
Monitor airborne contamination (*i.e.* particles > 0.5 μm) removal rates and overall lowering of the airborne bio-burden (*i.e.* cfu/m^3 of total mesophilic flora (TMF) and fungal levels). In patient rooms, opportunistic and non-pathogenic airborne fungal levels are determined with an air-treatment unit and compared to those of a control room.

Results:
Phase 1. At 1.5 m/s, >99 % single-pass performance of the technology for a wide range of airborne pathogens.
Phase 2. In a 118 m3 OR, the time required to lower the ≥ 0.5 micron airborne particle counts by 90% is decreased from twelve to less than two minutes, with a two-log decrease in their steady-state levels, p< 0.01. Concurrently, airborne TMF concentrations dropped by a factor of two and fungal species were reduced to undetectable levels, p<0.01.

Phase 3. For 12 day test period in the haematology ward a significant reduction in airborne fungal levels, p<0.01, with average reductions of 75% and 82% for opportunistic and non-pathogenic species respectively.

Conclusion: Our data indicate that the mobile non-thermal plasma air-treatment unit tested in this study can rapidly reduce levels of airborne particles and significantly lower the airborne bio-burden in hospital high-risk environments.

Phase 1.



Single-pass laboratory testing facility. Biological aerosols generated with a 6-jet collision nebulizer and before and after the reactor samples retrieved with AGI-30 glass impingers.

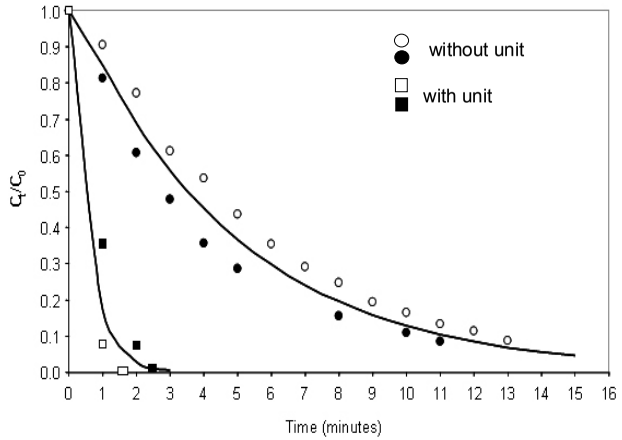
Single-pass results @ 1.5 m/s (e.g. 625 CFM)

Species	% Reduction
Brevundimonas diminuta	> 99.99
Bacillus subtilis	> 99.95
Staphylococcus sp.	99.9
Serratia marcescens	>99.9
Aspergillus sp.	>99.9
MS-2 coliphage	>99.995
Avian Flu virus H5N2	>99.995

A broad spectrum of microorganisms including viruses are destroyed by the Plasma reactors

Phase 2.

Decontamination Kinetics in an OR



Plot of the reduction of particles ≥0.5 μm as a function of time with and without the mobile recycle unit operating.

Airborne contamination peaks are abated ten times faster when the recycle unit is in operation.

Phase 3

Lower Airborne Bio-burden in patients room

Statistic	Opportunistic species		Non-pathogenic species	
	Test Room	Reference Room	Test Room	Reference Room
Average (CFU/m^3)	0.6	2.4	7.3	41
Std. Deviation	0.8	2	6.7	21.3
Percent reduction	**75%**		**82%**	
Significance test	p< 0.01		p< 0.01	

Table summarizing results from airborne viable fungal levels in an occupied patient room hosued in a haematology/oncology ward.

Significant lowering of the airborne fungal levels in the patients room is witnessed.