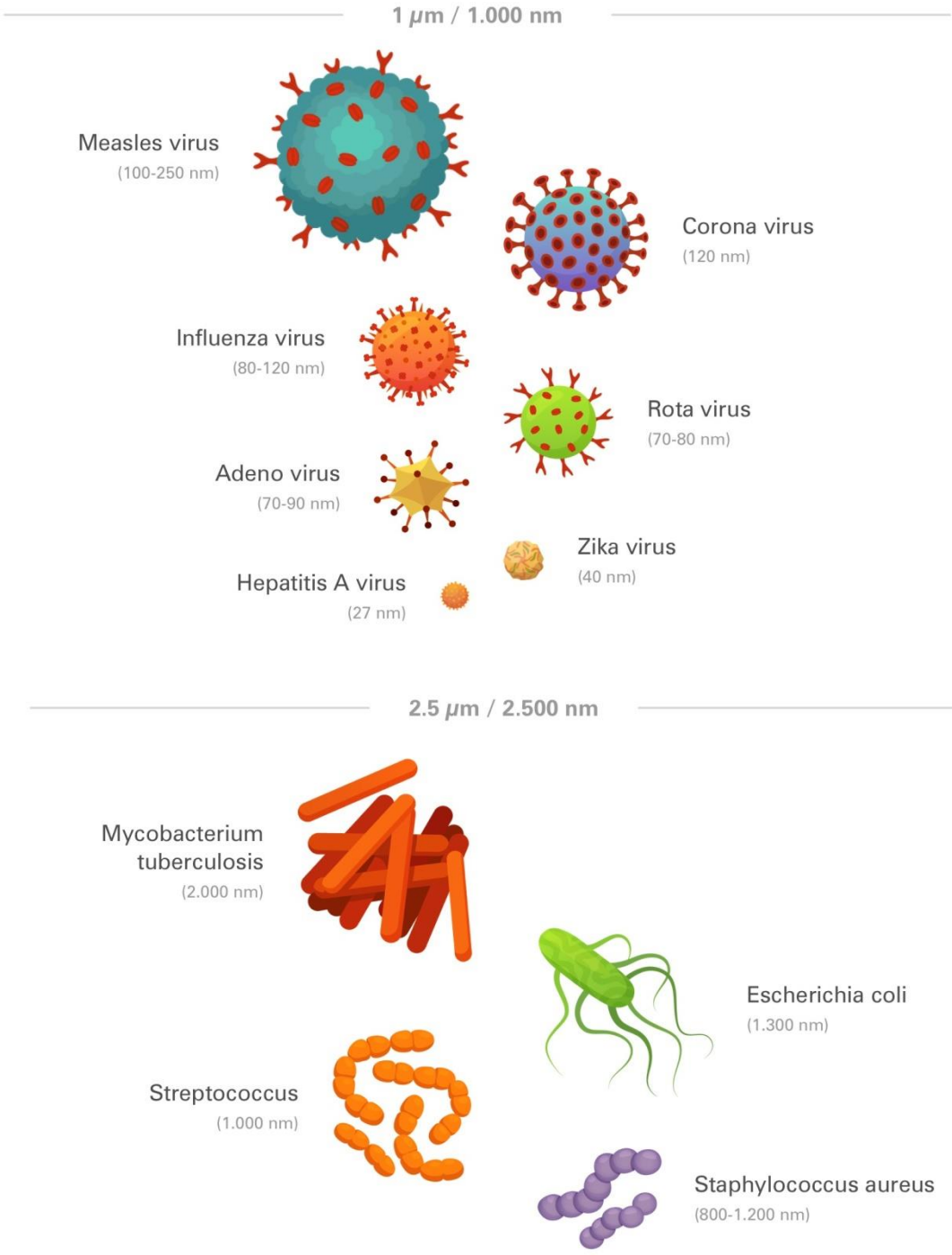
TEST REPORT ON THE EFFICACY OF THE MIDTHERM UVC AIR SANITISER

The attached report was produced by Dr Daniel O'Toole, School of Medicine, National University of Ireland Galway, in cooperation with Dr Ronan MacLoughlin CSO of Aerogen.

The purpose of the testing was to demonstrate the air sanitiser's efficacy in denaturing (killing) airborne pathogens within a single pass through the unit. The 3 different specific bacteria used were deliberately chosen because of their known ability to cause serious infectious respiratory diseases. In addition to this, the amount of UVC irradiation required to give a 2 log reduction, i.e. 99%, in these bacteria is similar to those required to denature corona type viruses, around 6.6mJ/cm^2. *K. pneumoniae* requires slightly more, 7.2mJ/cm^2. See below for relative sizes.

The results from the testing demonstrate conclusively the ability of the Midtherm MT 250 air sanitiser to destroy 99% of common airborne pathogens very effectively in a single pass. This holds true for a wide range of pathogens that cause diseases within the environment, such as: TB, measles, Norovirus, diphtheria, influenza, SARS-Cov, MRSA, Legionella, etc.


1 µm / 1.000 nm
Measles virus
(100-250 nm)
Corona virus
(120 nm)
Influenza virus
(80-120 nm)
Rota virus
(70-80 nm)
Adeno virus
(70-90 nm)
Zika virus
(40 nm)
Hepatitis A virus
(27 nm)
2.5 µm / 2.500 nm
Mycobacterium tuberculosis
(2.000 nm)
Escherichia coli
(1.300 nm)
Streptococcus
(1.000 nm)
Staphylococcus aureus
(800-1.200 nm)
1 µm / 1.000 nm

REPORT ON THE UTILITY OF THE MIDTHERM UVC SANITISING DEVICE AND PATHOGENIC BACTERIA.

Date: 16/05/21

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Introduction

The Midtherm unit is an air processing device that exposes air to powerful ultraviolet C radiation to destroy or otherwise render unviable microorganisms. It is relatively easy to dismantle and consists of an inlet fan, a chamber where exposure to UV bulbs occurs, and an outlet vent. A controller PCB is located near the inlet fan with an on/off switch and fan speed controller.

Our objective was to determine the efficacy of the device in rendering unviable a spray of live bacterial culture which would be far beyond the device's likely working requirement. These bacteria would be clinically relevant, particularly for infectious respiratory diseases.

Methods

The Midtherm device was located in a fume hood and the main protective, non-functional, external housing sheet removed. This makes access to the inlet fan and outlet easier. The device was used at maximum speed setting at all times, which is 250m^3/h.

The previous day, cryopreserved beads of clinically isolated bacteria were added to 2mL of Luria Bertani broth and incubated in an orbital shaker at 220RPM for 16 hours at 37C. Serial dilution and plating to agar was used to quantify the CFU/mL at the end of incubation.

Bacteria	Source + Notes	Gram test	CFU/mL culture
Escehichia coli	ATCC. Manassas, VA, USA. Cat #25932	Negative	$5x10^9$
Klebsiella pneumoniae	Tullamore General Hospital. Tullamore, Ireland Gentamicin and aztreonam resistant. Meropenem sensitive.	Negative	$5x10^9$
Staphylococcus aureus	ATCC. Manassas, VA, USA Cat #2119	Positive	$1x10^9$

1mL of culture was diluted to 40mL with PBS. The protocol for application to the device was as follows:

1. The UV exposure box was opened and the UV bulbs removed.
2. A TSA petri dish was placed open side down on the air outlet. A small weight was placed on top to prevent the plate being moved by the airflow.
3. The Midtherm device was turned on set to full speed and allowed to reach full speed for 10 seconds.

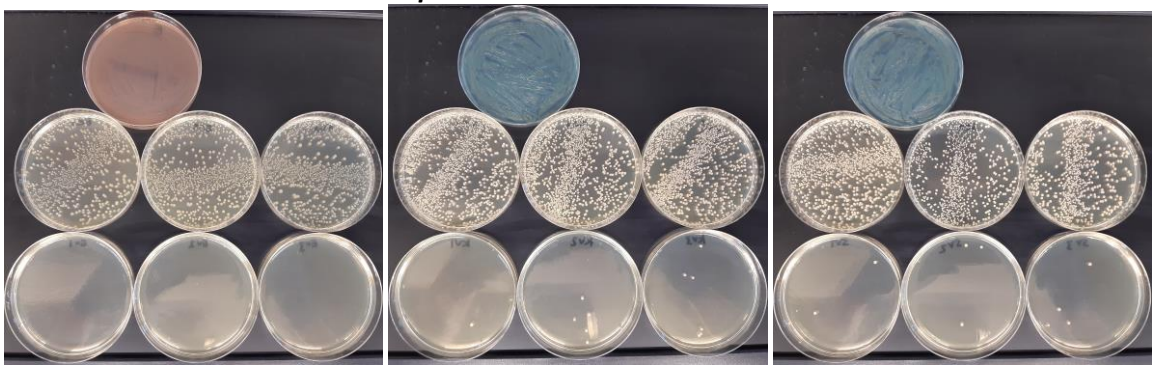
4. 5mL of diluted culture were drawn into a 10mL pipette and a 10uL pipette tip attached. The culture was applied directly to the fan area as a stream of small droplets over the course of c. 1 minute..
5. The device was allowed to run for a further 1 minute.
6. The device was turned off and allowed to power down for 1 minute.
7. The lid was placed on the TSA petri dish and incubated overnight at 37C.
8. Steps 2 to 7 were repeated in triplicate.
9. The UV exposure box was opened, the UV bulbs reinstalled and steps 2 to 8 were repeated.

This protocol was repeated for each pathogen tested. 100uL of each culture was also plated directly to TSA.

Results

TSA plates were photographed:

E. coli ***K. pneumoniae*** ***S. aureus***

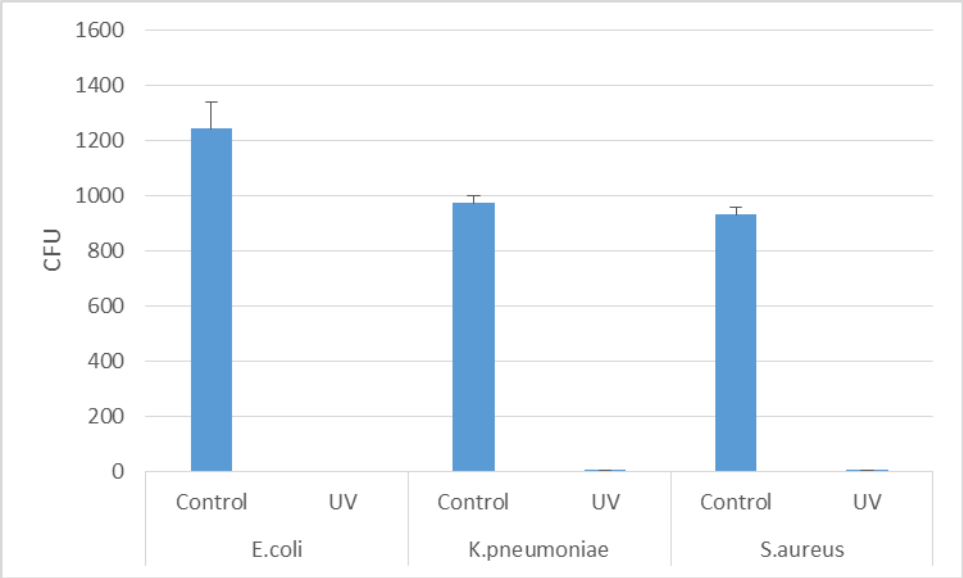


These are (top to bottom): 1) Culture plated directly, 2) collected from device without UB bulb, 3) collected from device with UV bulb.
These images were analysed with OpenCFU v.3.9.0 using the defined areas as illustrated below:

E. coli ***K. pneumoniae*** ***S. aureus***

Automatically determined CFU counts were entered to Excel and analysis performed:

	E.coli		K.pneumoniae		S.aureus	
	Control	UV	Control	UV	Control	UV
CFU	1143	0	980	1	905	2
	1328	0	996	5	958	3
	1261	0	946	6	929	4
Mean	1244	0	974	4	930.6667	3
SD	93.66429	0	25.53429	2.645751	26.53928	1
% alive	**100**	**0**	**100**	**0.410678**	**100**	**0.32235**
% SD	7.529284	#DIV/0!	2.62159	0.271638	2.851642	0.10745
ttest	1	2.12E-05	1	3.27E-07	1	4.47E-07



Conclusions

This principal objective of this experimental design was no to interfere in any way with the flow rate of the device, therefore it was accepted that the vast majority of device output would either not adhere to the agar plate or bypass the plate completely. A percentage difference in viability was more important.

As expected, we observed a 2 log reduction (within error margin) in CFU for each clinical isolate, including *K. pneumoniae* which is assumed to be more resistant to UV damage due to its thicker bacterial cell wall.

Dr. Daniel O'Toole