Anti-Coronavirus Performance of Air Filtration System Components

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Introduction

As part of the growing concern of hospital- acquired infections, in August 2019, Aura Smart Air performed a trial in collaboration with The Department of General and Oncological Surgery at The Chaim Sheba Medical Center in the installation of air purifiers for the purpose of disinfecting and purifying the air from various pollutants.

Initial results showed a remarkable ability of the purification device to disinfect various bacteria. With the outbreak of the COVID-19 pandemic, in Wuhan, China, focus of the global medical community has changed from preventing hospital-acquired bacterial infections into preventing viral spread of SARS-CoV-2.

Previous experimental results obtained in collaboration with Aura Smart Air demonstrate the devices ability to filter a series of high-risk pathogens including various viruses, such as Influenza H1N1 and Influenza H5N1. We were able to obtain a Coronavirus and build a model to test devices for their ability to filter or eliminate the virus. In May 2020, the company began a clinical experiment to test the effectiveness of Aura Air's disinfection capabilities on the Coronavirus as part of our strategic, long-term, collaboration. The aim of the trial was to quantify the properties of the Aura Smart Air device to purify air contaminated by a Coronavirus similar in size with the SARS-CoV 2.

Methods

Aura Air Disinfection Technology

Pre-filter

The pre-filter is a filter that removes large unwanted contaminants from the air. In HVAC systems and air purifiers, it is usually a washable mesh made from polymers like polypropylene. The pre-filter catches large particles of dust, pollen, insects and animal hair. The pre-filter also has a role in the extension of the life of the more sensitive filters that come after the pre-filter such as the HEPA filter.

HEPA filter

HEPA stands for high-efficiency particulate air and it is an efficiency standard for air filters. The efficiency is measured in the ability of the filter to retain particles larger than 0.3 μm. These filters are used in environments that require contamination control such as food and pharmaceutical industries, hospitals and semiconductors.

The structure of those filters consists of randomly arranged fibers, typically from fiberglass. The diameter of the fiber ranges between 0.5-2 μm. The efficiency of the filter is determined by the fiber diameter, filter thickness, and the face velocity (which is the air speed in the inlet of the filter).

Carbon Filter

Carbon filtering is a method that uses a bed of activated carbon to remove contaminants using a process called adsorption. In this process, the molecules of the pollutant are trapped inside the porous structure of the carbon. This is a very effective method in the treatment of air, and it effectively removes volatile organic compounds (VOC's) and bad odors from air.

Smart Copper Fabric

The Smart Copper Fabric is made from cotton impregnated with copper oxide. Copper is a powerful anti-bacterial agent that also has the ability to neutralize viruses, fungus, and mold. This is a patented and EPA-approved technology. The Smart Copper Fabric is integrated into The Ray filter™ to enhance the ability of the filter to successfully deal with these pollutants. Copper has potent virucidal properties, and neutralization of infectious bronchitis virus, poliovirus, human immunodeficiency virus type 1 (HIV-1), and other enveloped or nonenveloped single- or double-stranded DNA or RNA virus have been reported.

Sterionizer

The Sterionizer is based on the technology of bipolar ionization. The process of ionization uses UV light and electric currents to transform molecules of oxygen (O_2) into two atoms (O). In this process, one of the atoms has an electron attached to it and as a result, it has a negative charge (O-) and the other atom lacks an electron and is positively charged (O+). These atoms are very chemically active and when they attack molecules of water that are present in the air- there are two types of molecules formed: OH- and H2O2. These molecules attack and neutralize different pollutants – viruses, bacteria, fungus, and mold. This technology has another advantage - unlike unipolar ionization that produces high amounts of ozone (O3) (which is a dangerous substance), the Sterionizer emits very low concentrations of ozone that cause no health damage.

UVC LEDs

Ultraviolet germicidal irradiation (UVGI) is a disinfection technique that uses short-wavelength ultraviolet (ultraviolet C or UV-C) light to destroy microorganisms by destroying nucleic acids and disrupting their DNA, resulting in their inability to perform vital cellular functions.

Ultraviolet pressure lamps have been used for decades for the disinfection of air. They are effective in neutralizing bacteria, viruses, and parasites by hurting the proteins on the cell membrane. In the past several years, UVC LEDs showed the potential to replace those traditional lamps. These UVC LEDs that work in the range of 267-310 nm were tested for disinfection and the wavelength of 275 nm was found to be the most efficient and suitable replacement for the traditional lamps.

Coronavirus detection

1. Virus propagation

Virus propagation was performed in embryonated chicken eggs. The allantoic fluid was harvested 48 h post-inoculation (PI) and stored at −80 ◦C, until used for RNA extraction.

2. Virus Detection: Real-time RT-PCR assay

A conserved region of 336 b located at nucleotide position 741–1077 of the H120 strain N gene sequence (GenBank accession no. AM260960) was used to design primers and probe for the real-time RT-PCR assay. Amplification plots were recorded, analyzed, and the threshold cycle (Ct) determined with the StepOne software, version 2 (Applied Biosystems).

1. **Test Description:**

Tested materials and pretesting preparation:

Elements of the filtration system (see description above) were tested separately to define antiviral properties of each component (Reference) 04/01-01/04:

- HEPA filter was cut to squares of 0.5 X 0.5 cm.
- Smart Copper Fabric (SCF) has been turned into four-layer squares measuring 0.5 x 0.5 cm.
- Sterionizer ™ (High and Low power) were placed at a distance of 30 cm from viral suspension when the ion flow was directed to the suspension using an additional fan.
- UVC LEDs were allocated at a distance of 1 cm from the suspension.

Performance: The tests were done at The Surgical Oncology Laboratory, Department of Surgery, The Chaim Sheba Medical Center.

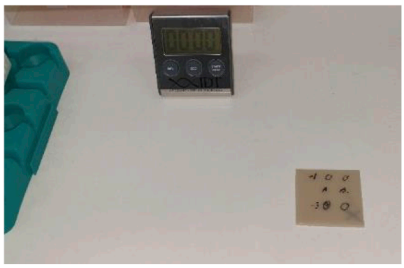
Viral suspension: Corona RNA retrovirus was cultivated in chicken eggs, extracted, and resuspended in dPBS for samples contamination. This initial suspension was diluted 1:100 in dPBS and used for the sample's contamination.

Testing process:

HEPA filters and Smart Copper Fabric has been contaminated by wetting of viral suspension (10 µl per each piece) and exposed for 10 min. Within exposure, we extracted virus residuals from the samples by rinsing of the samples with 0.1 ml of dPBS.

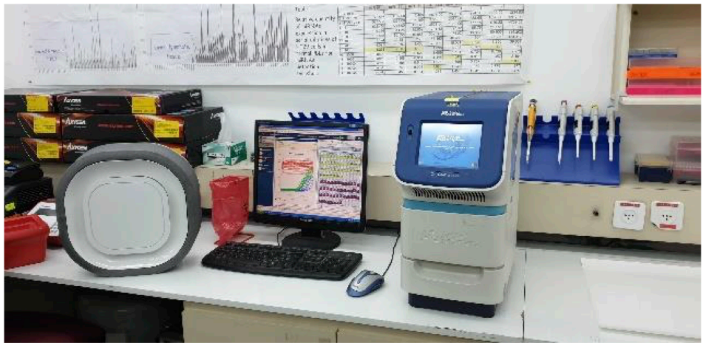
To test the Sterionizer ™ and UVC LED 10µl of suspension was dropped onto the surface of neutral polycarbonate (See fig.1) and located as described above. After 10 min. of exposure, the drops were transferred to 90 µl of dPBS and tested.

Fig. 1

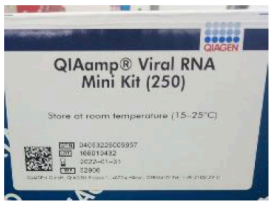


Materials and equipment:

a) PCR machine: Step One pus RT-PCR System, A&B applied Bio-Systems.



b) *Reagents:*



Virus detection: Presence of the virus in exposed suspension was checked by RT-PCR technique using relevant reagents.

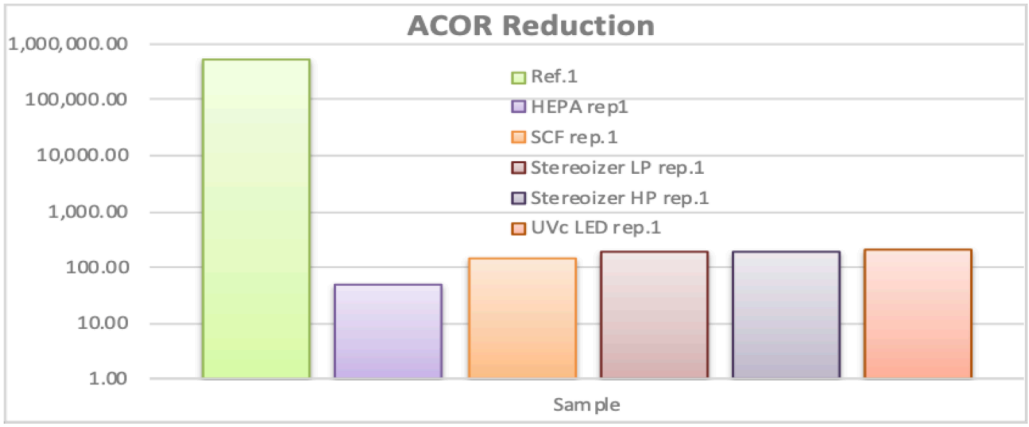
2. Testing Results:

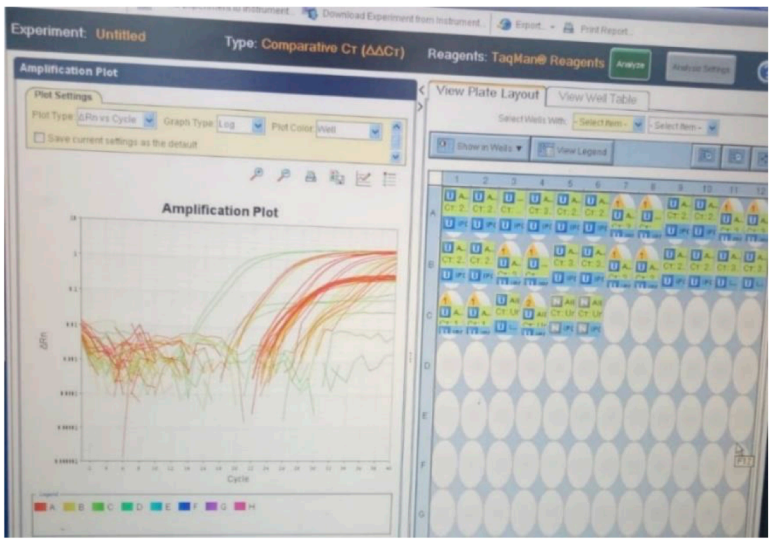
Results processing: The data measured by the RT-PCR system at # 32 was used to evaluate the results of the experiment. This have been defined as the last point in which measurements of control samples do not show saturation of detector and prevent misunderstanding of the results.

Results:

Sample	Coronvirus Reduction Ratio [%]
Ref.1	
HEPA rep1	**99.7243**
SCF rep.1 Smart Copper Fabric	**99.9744**
Sterionizer ™ LP rep.1 Low Power	**99.9651**
Sterionizer ™ HP rep.1 High Power	**99.9429**
UVC LED rep.1	**99.9631**

Following table and plot present results of Coronavirus quantitation.





Conclusions:

1. Each of the tested components of the Aura Air Device was able to significantly reduce the viral load as measured by PCR.
2. This early, however promising result, is the basis of more advanced experiments studying the performance of the Aura Air device in closed spaces.

Details on the Coronavirus strain used for testing:

"The etiologic agent used in these tests is an infectious bronchitis virus (IBV), from the coronavirus family. It is an enveloped, positive-sense, single-stranded RNA virus.

The comparison of genome structures of SARS-CoV-2 and other coronaviruses shows that SARS-CoV-2 and IBV share the same genome structure and diameter. We chose to use the IBV virus because it allows testing of a similar virus without endangering the medical staff at the hospital during the trial process"

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