Memo from the Authors

The COVID-19 virus has impacted the globe for over a year and so far, very little has been achieved in regard to mitigating its dire effects on the economy and society as a whole. Although vaccines have become available, the current scepticism of vaccines in general points to the inability to achieve herd immunity. Covid-19 mutations and vaccine escape by various strains also seem to be a predominant and legitimate concern that will render current vaccines ineffective. The current reported fatality rate is 1.7% in the United States and 8.6% in Mexico which is the highest of all countries studied. Structurally, Covid-19/SARS-CoV-2 is not unique and is similar to other coronaviruses such as Severe Acute Respiratory Syndrome (SARS-CoV-1) or Middle East Respiratory Syndrome (MERS) and can be treated with existing disinfection methods.

General Explanation of the Disease

COVID-19 is a respiratory disease caused by the SARS-CoV-2 virus that has caused outbreaks worldwide. The SARS-CoV-2 is a new variant in the betacoronavirus family (Fisher 2020). It transmits by direct contact or contact with fomites and can be suspended in air, as are the related betacoronaviruses SARS, MERS, and the four known Human coronaviruses – OC43, 229E, NL63, and HKU1. The majority of infection transmissions are believed to be by droplet spray from coughing and sneezing and by direct contact or contact with fomites as of the time of this report. It is also widely believed throughout the medical community that SARS-Cov-2 is aerosolized and is the leading cause of infections, although the Center for Disease and Control has not provided official guidance.

Confirmation That Ultraviolet Is Effective

Ultraviolet light was recognized at the turn of the century and has been implemented throughout water treatment plants, offices, hospitals and medical facilities since the mid 80's. Ultraviolet light has been demonstrated to be capable of destroying viruses, bacteria and fungi thoroughly in laboratory studies (Kowalski 2009). The effects of UV-C exposure to SARS-CoV-2 were studied by Boston University and the National Emerging Infectious Disease Laboratories (NEIDL) recently and confirmed that SARS-CoV-2 was 99% inactivated at 5mJ intensity when exposed to UV-C radiation at 254nm for up to six (6) seconds. ASHRAE also recommends ultraviolet germicidal irradiation as one strategy to address COVID-19 disease transmission (ASHRAE 2020).

Testing Summary

The Uventx Guardian is an upper room UV-C germicidal disinfection system that when manufactured according to the tested sample specifications of 19.3mJ/cm2 output is effective in disrupting the SARS-Cov-2 virus ability to reproduce and transmit disease. The required exposure time is <1.5 seconds due to the increased mJ exposure, multi-vector design and the closer distance of <51mm synergy radius. Although the individual output of the lamps installed are not as effective when compared to the use of a single larger wattage input lamp and a narrower disinfection chamber, when implemented with a three-lamp focused multi-vector (Petraitis V. 2020) format, the design layout has proven to be exceedingly effective against the reproduction of the Coronaviridae viral group in general.

Rationale

Coronaviruses are members of the Coronaviridae group and contain a single-stranded, positive-sense RNA genome surrounded by a corona-like helical envelope (Ryan 1994). Approximately 100 sequences of the SARS-CoV-2 genome have been published and these suggest there are two types, Type I and Type

II, of which the latter came from the Huanan market in China while the Type I strain came from an unknown location (Zhang 2020). The genome consists of 29,751 base pairs (NC_045512.2) and the genome is about 80% homologous with SARS viruses (NCBI 2020, Fisher 2020). Coronaviruses have a size range of 60-140nm, with a mean size of 0.10 microns (Zhu 2020).

Table 1 summarizes the results of studies that have been performed on Coronaviruses under ultraviolet light exposure, with the specific species indicated in each case. The D90 value indicates the ultraviolet dose for 90% inactivation. Although there is a wide range of variation in the D90 values, this is typical of laboratory studies on ultraviolet susceptibility. The range of D90 values for coronaviruses is 7-2410 J/m2 and the average of all studies is 237 J/m2. However, the study by Walker (2007) is an airborne study and is an outlier in this set of water-based studies. Also, the studies by Weiss (1986) and Darnell (2004) are outliers on the low and high ends. Excluding outliers, the mean D90 is 47 J/m2 , and this should adequately represent the ultraviolet susceptibility of the SARS-CoV-2 (COVID-19) virus.

Two recent studies on SARS-CoV-2 have been added to Table 1 (Inagaki 2020, Bianco 2020). The average value of the D90 is 27 J/m2 , which suggests the average value for all coronaviruses reported above (47 J/m2) is conservative. Both of these studies indicate tailing in the survival curve above about 3- 6 logs of reduction, beyond which the D90 value will not be an accurate predictor (Blatchley 2020).

Table 1: Summary of Ultraviolet Studies on Coronaviruses

Microbe	**D_{90} Dose J/m^2**	**UV k m^2/J**	**Base Pairs kB**	**Source**
Coronavirus	6.6	0.35120	30741	Walker 2007[a]
Berne virus (Coronaviridae)	7.2	0.32100	28480	Weiss 1986
SARS-CoV-2 (Italy-INMI1)	12.3	0.18670	29811	Bianco 2020
Murine Coronavirus (MHV)	15.0	0.15351	31335	Hirano 1978
SARS Coronavirus (Frankfurt 1)	16.4	0.14040	29903	Eickmann 2020
Canine Coronavirus (CCV)	28.5	0.08079	29278	Saknimit 1988[b]
Murine Coronavirus (MHV)	28.5	0.08079	31335	Saknimit 1988[b]
SARS Coronavirus (CoV-P9)	40.0	0.05750	29829	Duan 2003[c]
SARS-CoV-2 (SARS-CoV-2/Hu/DP/Kng/19-027	41.7	0.05524	29811	Inagaki 2020
Murine Coronavirus (MHV)	103.0	0.02240	31335	Liu 2003
SARS Coronavirus (Hanoi)	133.9	0.01720	29751	Kariwa 2004[d]
SARS Coronavirus (Urbani)	2410	0.00096	29751	Darnell 2004
Average	**237**	**0.00972**	Including all studies	
Average excluding outliers	**47**	**0.04943**	Excluding Walker, Weiss & Darnell	
Average for SARS- Cov2	**27**	**0.08528**	Two studies, 90% inactivation	

[a] (Jingwen 2020) [b] (estimated) [c] (mean estimate) [d] (at 3 logs)

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Updated on January 6, 2021 by:

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NY 2015: https://www.researchgate.net/publication/284691618_SARS_Coronavirus_UV_Susceptibility

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