

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/339887436>

2020 COVID-19 Coronavirus Ultraviolet Susceptibility

Technical Report · March 2020

DOI: 10.13140/RG.2.2.22803.22566

CITATIONS

4

READS

63,454

3 authors:



[Wladyslaw J. Kowalski](#)

PurpleSun

70 PUBLICATIONS 963 CITATIONS

[SEE PROFILE](#)



[Thomas J Walsh](#)

Weill Cornell Medicine of Cornell University and New York Presbyterian Hospital

1,027 PUBLICATIONS 76,844 CITATIONS

[SEE PROFILE](#)



[Vidmantas Petraitis](#)

Weill Cornell Medicine of Cornell University

116 PUBLICATIONS 3,501 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



pharmacokinetic/pharmacodynamic (PK/PD) model simulating human pharmacokinetics to study the effects of antibiotics, antifungals, antiparasitics and anti-cancer drugs

[View project](#)



Biological Weapons Defense Technology [View project](#)

2020 COVID-19 Coronavirus Ultraviolet Susceptibility

Memo from the Authors

The current global Coronavirus pandemic is of urgent concern with its high transmission rate and rapid spread throughout the world. The current reported death rate is 2-3% and there currently is no antiviral drugs or vaccine available to the public. Structurally, this virus is not unique and is similar to other coronaviruses such as Severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS), and can be addressed with existing disinfection methods such as chemicals and new technologies such as Focused Multivector Ultraviolet (FMUV) from PurpleSun.

Answers to Frequently Asked Questions

1. How long does COVID-19 Live on Surfaces?

6 hours - 9 days on surfaces

2. What is the difference between a virus and bacteria?

Bacteria are self-contained, have cell walls, and can survive and replicate on their own. Viruses are DNA molecules that may be naked or encapsulated and require a host to replicate. They cannot be treated with antibiotics and require a vaccine

3. What is the biggest issue with this COVID-19 virus?

High secondary infection rate, Rapid spread (more rapid than SARS or MERS), Fatality rate (2-3%)

4. Is ultraviolet light effective against COVID-19?

Ultraviolet light destroys DNA of viruses, bacteria, and fung

5. What is the appropriate Personal Protective Equipment (PPE) for healthcare staff?

<https://www.cdc.gov/coronavirus/2019-ncov/downloads/COVID-19-PPE.pdf>

General Explanation of the Disease

COVID-19 is the 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 well, 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.

Confirmation That Ultraviolet is Effective

Ultraviolet light can be an effective measure for decontaminating surfaces that may be contaminated by the SARS-CoV-2 virus by inducing photodimers in the genomes of microorganisms. Ultraviolet light has been demonstrated to be capable of destroying viruses, bacteria and fungi in hundreds of laboratory studies (Kowalski 2009). The SARS-CoV-2 virus has not yet been specifically tested for its ultraviolet susceptibility but many other tests on related coronaviruses, including the SARS coronavirus, have concluded that they are highly susceptible to ultraviolet inactivation. This report reviews these studies and provides an estimate of the ultraviolet susceptibility.

It is estimated that the SARS-CoV-2 virus can survive on surfaces for up to 9 days, based on its similarity to SARS and MERS. Standard disinfectants are effective against SARS-CoV-2 but as an extra level of



protection, and to shield against errors in the manual disinfection process, ultraviolet light can be used to disinfect surfaces and equipment after the manual chemical disinfection process is completed. ASHRAE recommends ultraviolet germicidal irradiation as one strategy to address COVID-19 disease transmission (ASHRAE 2020).

COVID-19 is highly contagious and so any residual contamination, no matter how small, can pose a threat to healthcare workers and patients. The PurpleSun E300 Focused Multivector Ultraviolet (FMUV) system with Shadowless Delivery™ (see Figure 1) is an automated system that has proven to reduce surface contamination by 96% and can address contamination left behind by current manual chemical cleaning which was shown to only reduce contamination by 36% (Armellino 2020).

The PurpleSun E300 system has demonstrated elimination of 99%-99.99% of bacteria and fungi as listed in Table 2 in laboratory tests within 90 seconds (Petraitis 2017). Similar reductions could be expected against the COVID-19 coronavirus in 90 seconds as well.

Scientific 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 7-241 J/m² the mean of which is 67 J/m², should adequately represent the ultraviolet susceptibility of the SARS-CoV-2 (COVID-19) virus.

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	7	0.35120	30741	Walker 2007 ^a
Berne virus (Coronaviridae)	7	0.32100	28480	Weiss 1986
Murine Coronavirus (MHV)	15	0.15351	31335	Hirano 1978
Canine Coronavirus (CCV)	29	0.08079	29278	Saknimit 1988 ^b
Murine Coronavirus (MHV)	29	0.08079	31335	Saknimit 1988 ^b
SARS Coronavirus CoV-P9	40	0.05750	29829	Duan 2003 ^c
Murine Coronavirus (MHV)	103	0.02240	31335	Liu 2003
SARS Coronavirus (Hanoi)	134	0.01720	29751	Kariwa 2004 ^d
SARS Coronavirus (Urbani)	241	0.00955	29751	Darnell 2004
Average	67	0.03433		

^a (Jingwen 2020)

^b (estimated)

^c (mean estimate)

^d (at 3 logs)

Table 2: Performance of the FMUV System against Bacteria and Vegetative Fungi

Bacteria (Yellow) or Vegetative Fungi (Green)	D90 J/m ²	Survival (CFU) at Exposure Time, seconds						
		0	5	15	30	60	90	120
Multidrug-resistant <i>Pseudomonas aeruginosa</i>	26	1500	400	0				
Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	40	8200	1900	0				
ESBL-producing <i>Escherichia coli</i>	26	18000	1000	10	0			
<i>Candida parapsilopsis</i>	98	2300	300	11	0			
Vancomycin-resistant <i>Enterococcus faecium</i> (VRE)*	120	1800	800	100	0			
<i>Fusarium solani</i>	313	1700	1100	300	0			
Carbapenemase-resistant <i>Klebsiella pneumoniae</i> (KPC)	52	7200	2100	28	4	0		
<i>Acinetobacter baumannii</i>	18	4200	1900	38	10	0		
<i>Candida albicans</i>	374	3000	2800	700	32	0		
<i>Clostridioides</i> (<i>Clostridium</i>) <i>difficile</i>	38	2800	2600	1000	20	0		
<i>Aspergillus fumigatus</i>	560	2700	2700	2200	1200	100	10	0

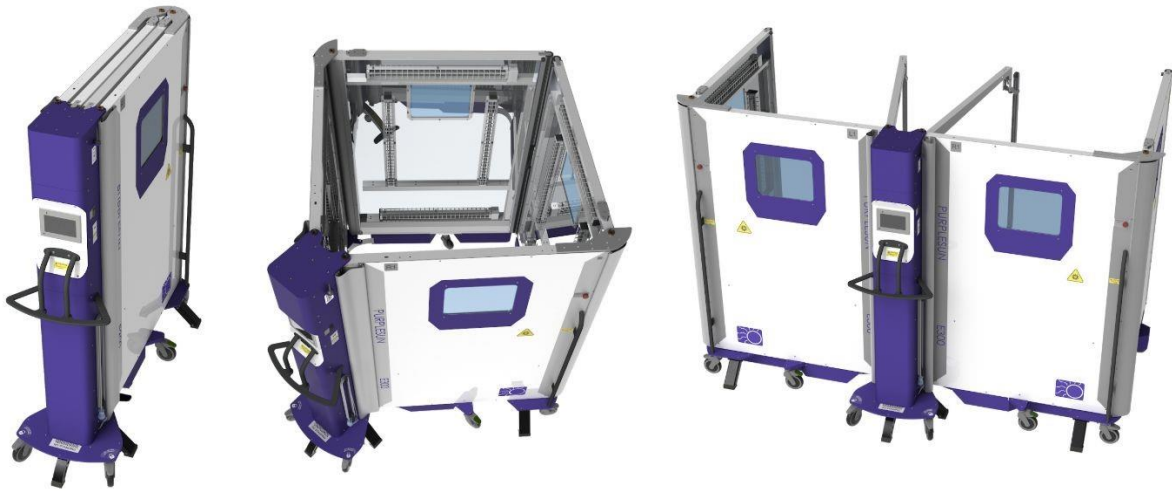


Figure 1: The PurpleSun E300 FMUV system in PACT configuration for transport or storage (Left), CUBE configuration for surrounding smaller equipment (Center), and RECTAN mode for surrounding larger equipment (Right).

Updated on March 12, 2020 by:

Dr. Wladyslaw J. Kowalski, PhD, Chief Scientist and World UV Expert, PurpleSun Inc

Research@purplesun.com

Dr. Thomas J. Walsh, MD, PhD, Infectious Diseases Translational Research Laboratory, Weill Cornell Medicine of Cornell University, New York City, NY

Dr. Vidmantas Petraitis, MD, Infectious Diseases Translational Research Laboratory, Weill Cornell Medicine of Cornell University, New York City, NY

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

REFERENCES

1. Armellino D, Walsh TJ, Petraitis V, Kowalski W. (2019). Assessment of focused multivector ultraviolet disinfection with shadowless delivery using 5-point multisided sampling of patient care equipment without manual-chemical disinfection. *Am J Infect Control* 47,409-414.
2. Armellino D GK, Thomas L, Walsh T, Petraitis V. (2020). Comparative evaluation of operating room terminal cleaning by two methods: Focused multivector ultraviolet (FMUV) versus manual-chemical disinfection *Am J Infect Contr* (Accepted).
3. ASHRAE. (2020). ASHRAE Resources Available to Address COVID-19 Concerns. (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA).
4. Darnell MER, Subbarao K, Feinstone SM, Taylor DR. (2004). Inactivation of the coronavirus that induces severe acute respiratory syndrome, SARS-CoV. *J Virol Meth* 121,85-91.
5. Duan SM, Zhao XS, Wen RF, Huang JJ, Pi GH, Zhang SX, Han J, Bi SL, Ruan L, Dong XP. (2003). Stability of SARS Coronavirus in Human Specimens and Environment and its Sensitivity to Heating and Environment and UV Irradiation. *Biomed Environ Sci* 16,246-255.
6. Fisher D, Heymann D. (2020). Q&A: The novel coronavirus outbreak causing COVID-19. *BMC Med* 18,57.
7. Hirano N, Hino S, Fujiwara K. (1978). Physico-chemical properties of mouse hepatitis virus (MHV-2) grown on DBT cell culture. *Microbiol Immunol* 22,377-90.
8. Jingwen C, Li L, Hao W. (2020). Review of UVC-LED Deep Ultraviolet Killing New NCP Coronavirus Dose. In *Technology Sharing*. (Hubei Shenzi Technology Co., Ltd).
9. Kariwa H, Fujii N, Takashima I. (2004). Inactivation of SARS coronavirus by means of povidone-iodine, physical conditions, and chemical reagents. *Jpn J Vet Res* 52,105-112.
10. Kowalski W, Bahnfleth W, Raguse M, Moeller R. (2019). The Cluster Model of Ultraviolet Disinfection Explains Tailing Kinetics. *J Appl Microbiol* 128,1003-1014.
11. Kowalski WJ. (2009). *Ultraviolet Germicidal Irradiation Handbook: UVGI for Air and Surface Disinfection*. (Springer, New York).
12. Liu Y, Cai Y, Zhang X. (2003). Induction of caspase-dependent apoptosis in cultured rat oligodendrocytes by murine coronavirus is mediated during cell entry and does not require virus replication. *J Virol* 77,11952-63.
13. NCBI. (2020). Genome Database <https://www.ncbi.nlm.nih.gov/>. (
14. Petraitis V PR, Schuetz AN, K. Kennedy-Norris K, Powers JH, Dalton SL, Petraityte E, Hussain KA, Kyaw ML, Walsh TJ. . (2014). Eradication of medically important multidrug resistant bacteria and fungi using PurpleSun Inc. multivector UV technology. . In *IDWeek*. (IDWeek, Philadelphia, PA).
15. Ryan KJ. (1994). *Sherris Medical Microbiology*. (Appleton & Lange, Norwalk).
16. Saknimit M, Inatsuki I, Sugiyama Y, Yagami K. (1988). Virucidal efficacy of physico-chemical treatments against coronaviruses and parvoviruses of laboratory animals. *Jikken Dobutsu* 37,341-345.
17. Walker CM, Ko G. (2007). Effect of ultraviolet germicidal irradiation on viral aerosols. *Environ Sci Technol* 41,5460-5465.
18. Weiss M, Horzinek MC. (1986). Resistance of Berne virus to physical and chemical treatment. *Vet Microbiol* 11,41-49.
19. Zhang L, Yang Y-R, Zhang Z, Lin Z. (2020). Genomic variations of COVID-19 suggest multiple outbreak sources of transmission. *medRxiv* (preprint).
20. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, Zhao X, Huang B, Shi W, Lu R and others. (2020). A Novel Coronavirus from Patients with Pneumonia in China, 2019. *N Engl J Med* 382,727-733.