Photodiagnosis and Photodynamic Therapy 31 (2020) 101890

Contents lists available at ScienceDirect

Photodiagnosis and Photodynamic Therapy

journal homepage: www.elsevier.com/locate/pdpdt

Letter to the editor

Ultraviolet-based biophotonic technologies for control and prevention of COVID-19, SARS and related disorders

The coronavirus disease 2019 (COVID-19) and similar pandemics lead to shortage of personal protective equipment (PPE), hospital beds, isolation rooms and other resources to contain its progression. Thus, immediate technological adaptation has been required to support the healthcare and safety of the population worldwide. While coronavirus vaccines to prevent respiratory infections in humans have not been licensed [1], regulatory mechanisms to speed up development and approval of technologies and medicines against COVID-19 have been issued [2,3]. The flexibility of regulatory approvals accelerates the development of research and clinical testing of approaches to diagnose, control, prevent, and treat COVID-19. With this in mind, this letter focuses on encouraging researchers and companies to develop safe and reliable ultraviolet (UV) light technology to be used for decontamination of PPE as well as environmental surface disinfection, food safety, possible production vaccines based on ultraviolet-inactivated SARS-CoV-2 (the cause of COVID-19) and SARS-CoV. Practical aspects of designing novel UV technology are discussed along with the context of the technological need of each application.

As the incidence of COVID-19 increases exponentially worldwide, healthcare-provider demand for PPE is currently outpacing supply. SARS-CoV-2 can be transmitted by direct routes including cough, sneeze, and droplet inhalation as well as contact routes such as contact with nasal, oral, and eye mucous membranes. Therefore, the World Health Organization (WHO) issued guidance on infection prevention and control (IPC) strategies [4], including the implementation of precautions against droplet, contact and airborne transmission, aerosol-generating procedures, and support treatments of COVID-19. In order to ensure the safety of healthcare workers and contain the virus spreading, strategies have been developed to extend the lifespan of medical equipment as well as disinfect environmental surfaces. These strategies include using ultraviolet (UV) light-based innovations to decontaminate N95 and SN95 respirators, robot-controlled UV surface disinfection in hospital rooms, and microbial inactivation on food safety applications. However, the implementation of these strategies by using existing devices has not been successful in every institution.

In terms of respirator decontamination, UV germicidal irradiation (UVGI) is used as potential alternative instead of vapor of hydrogen peroxide and ethylene oxide, which were proven to be more effective in a limited number respirator models. Novel UVGI technology should avoid combination with methods that can cause damage to the mask, toxicity, or loss of filtration efficiency. According to the WHO guidelines, these methods include washing, steam sterilization at 134 °C, disinfection with bleach/sodium hypochlorite or alcohol, or microwave oven irradiation and, thus, should be avoided [4]. In addition, the use of UV−C (typically at the wavelength of 254 nm) may affect the electrostatic charges of polypropylene masks and compromise N95 respirator integrity. In this case, reusing UV−C equipment such as biosafety cabinets and disinfection lamps would not be recommended to achieve user safety. Academic departments and dermatology offices using narrow-band UV−B phototherapy instruments for psoriasis treatment may investigate UV−B decontamination protocols of PPE as an alternative to UV−C applications [5]. Recommended light dose and application times should lead to total microbial inactivation. Since many hospitals do not have the UVGI equipment, the initiative for scalable production of UV light-emitting diodes (LEDs) should be encouraged for attending the global demand and decreasing the price per device unit. Innovations should aim for compact equipment and strategies to address the lack of space in hospitals by placing disinfection apparatus in several locations and ensuring proper transportation of reusable respirators. Reliability and safety of such innovations should be validated on studies aiming to standardize the disinfection parameters and protocols. Implications of practical considerations must include the feasibility of the control of all indicated parameters. Comparison between studies will dictate the best approaches for reprocessing of masks and respirators.

Healthcare institutions often have issues with the disinfection of rooms where COVID-19 patients are located. The containment of the COVID-19 transmission is managed by monitoring patients from safe distances. However, cleaning hospital rooms is inevitable and coronaviruses can persist on inanimate surfaces for long periods of time. Contamination from these surfaces can be reduced by including UVGI technology into the existing cleaning robots. The implementation of UVGI in cleaning robots can reduce the risk of transmission among employees of medical institutions, food producers and the pharmaceutical industry, which play a critical role in the containment the pandemic, especially on countries where lockdown approaches were adopted. UVGI innovation may also benefit cleaners, drivers, and caregivers, who need to be in contact with potentially contaminated surfaces and diseased people. Food safety applications should focus on optimizing parameters for decontamination after food processing and handling. In these applications, decontamination may be enhanced by using natural photosensitizers for antimicrobial photodynamic therapy (aPDT) and photodynamic microbial inactivation (PDI). Although similar antimicrobial effects as those for SARS-CoV are expected on the inactivation of SARS-CoV-2, validation studies are necessary to standardize the UVGI parameters. Finally, COVID-19 vaccine alternatives may use UV-inactivated SARS-Cov-2 [1]. If these alternatives are feasible, UV device industry must be prepared to supply stable equipment for repeatable and reproducible production of COVID-19 vaccines.

With the discussed clinical and safety needs in mind, UV-based optical and biophotonic technologies can significantly help overcoming the COVID-19 pandemic as well as prove its safe use in research and industry. Opportunities range from improving the healthcare worldwide to increasing sales volume for UV-related products and technology. As reliable technology is produced, medical institutions can benefit from acquiring decontamination equipment for short and long-

https://doi.org/10.1016/j.pdpdt.2020.101890
Received 30 May 2020
Available online 22 June 2020
1572-1000/

term use, and industries in general can have resources to mitigate risk or decrease losses in unexpected pandemic circumstances. UV light technology has potential to make the future brighter to everyone.

Ethical approval

Not required.

Funding sources

No funding was received to conduct the research shown in the manuscript. Marcelo Saito Nogueira receives a scholarship from Science Foundation Ireland for his PhD candidate position at Tyndall National Institute/University College Cork.

Declaration of Competing Interest

No conflicts of interest to declare.

References

[1] L.J. Saif, Vaccines for COVID-19: perspectives, prospects, and challenges based on candidate SARS, MERS, and animal coronavirus vaccines, Euro Med J. (2020).

[2] J. Lenzer, Covid-19: US Gives Emergency Approval to Hydroxychloroquine Despite Lack of Evidence, British Medical Journal Publishing Group, 2020.

[3] E.M. Agency, Guidance for Medicine Developers and Companies on COVID-19 [Internet], [cited Apr 21]. Available from: (2020) https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/coronavirus-disease-covid-19/guidance-medicine-developers-companies-covid-19.

[4] World Health Organization, Rational Use of Personal Protective Equipment for Coronavirus Disease (COVID-19) and Considerations During Severe Shortages: Interim Guidance 6 (2020) April 2020.

[5] S.N. Marcelo, Biophotonics for Pandemic Control: Large-area Infection Monitoring and Microbial Inactivation of COVID-19. Photodiagnosis Photodyn Ther, Elsevier, 2020.

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