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Editorial

Antimicrobial Photodynamic Therapy as a Potential Treatment Against COVID-19: A Case for Blue Light

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Respiratory viruses account for more deaths than any other infectious disease. As evidenced by Coronavirus Disease-2019 (COVID-19) and other respiratory disease pandemics, such as the 1918 H1N1 ''Spanish Influenza,'' the 1957 H2N2 ''Asian Influenza,'' the H3N2 ''Hong Kong Influenza'' of 1968, severe acute respiratory syndrome (SARS) of 2002, and the 2012 Middle East respiratory syndrome, they are of global concern given their rapid spread and their capacity to cause devastating socioeconomic consequences.[1,2] Innovations and advances in health care will be required to lessen the devastating effects of such pandemics.

Phototherapy (i.e., photobiomodulation) was one of the treatments used to minimize the impact of the 1918 viral pandemic.[3,4] Consequently, a major purpose of this editorial is to briefly consider the important role photobiomodulation has played in a past viral disease pandemic and to stimulate research and clinical exploration of photobiomodulation as a potential treatment in the early stages of COVID-19. Therapeutic intervention in the early stages of COVID-19 is of great importance to avoid progression toward multi-organ end-stage disease and eventual death.

Similar to the 1918 influenza, most of those succumbing to COVID-19 today die from disease-related complications, such as pulmonary inflammation/edema, pneumonia, and acute respiratory distress syndrome. Accounts of the 1918 pandemic[3,4] indicate that sunlight was effective in reducing mortality. For example, although lacking demographic information and primary data, one editorial noted that the Massachusetts Health Department found open air sunlight therapy to be ''the most valuable factor in reducing mortality.''[4] Accordingly sunlight therapy decreased fatality of hospitalized patients from 40% to 13%, boosting flu immunity among physicians and nurses, and overall, besting the outcome of the vaccines of those days.[4] Since then, photobiomodulation treatment with sunlight has been used as part of the protocol for treating tuberculosis, psoriasis, acne vulgaris, rickettsia, depression, jaundice, and a host of other diseases.[5]

Notably, 25 years before the 1918 pandemic, Finsen in 1893 developed a light source used to cure 83% of 804 patients with mycobacterium skin tuberculosis (lupus vulgaris) and other diseases, and was awarded the Nobel Prize in Medicine in 1903 for successfully treating diseases with light.[6] Although Finsen used light to treat diseases from 1882 to 1903, the earliest record of light as medical treatment dates back to the time of Egyptian Pharaohs—5000 BCE.[7] Historical records and artifacts further show that ancient Mesopotamians, Chaldeans, Greeks, and Romans used light to treat various diseases,[7] as did the Indians[8] and the Chinese.[9]

The discovery of ultraviolet (UV) in 1801 transformed heliotherapy (treatment with light) into clinical photobiomodulation as lamps generating narrower wavelengths of light from quartz, mercury vapor, and other sources were successfully used to treat a wide range of diseases.[6] Subsequent development of lasers in the late 1950s and the evolution of light-emitting diodes—emitting narrow spectra of monochromatic light—transformed photobiomodulation. This development now enables precision in providing treatment, using the beneficial effects of specific wavelengths, light intensities (irradiances), doses (radiant energies), and pulse frequencies. For example, light in the 400–470 nm range has been shown to inactivate several Gram-positive and Gram-negative bacteria,[10–12] and the mechanisms involved are well documented.[11,12] Moreover, the same mechanisms are now known to account for Finsen's successful treatment of tuberculosis.[13]

Most of the antimicrobial rays reaching the earth from the sun are in the blue light spectrum due to the filtering effect of atmospheric ozone, which absorbs harmful UV

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radiation.[14] Sunlight is known to be bactericidal and viricidal,[14] as such, it follows that some of the bacterial and antiviral effect of the sun may be due to blue light. This is further supported because the peak transmission of sunlight at the surface of the earth is in the blue region, and together with violet light, is 10 times greater than the amount of UV reaching the surface of the earth.[14] Since it has been shown that many microbes—bacterial or viral—are inactivated by blue light,[11,15] it seems reasonable to attribute a proportion of the sun's antimicrobial power to the blue spectrum of radiation. Indeed, a recent study of broad-spectrum light—mimicking sunlight—showed that simulated sunlight alone inactivated aerosolized influenza virus.[16]

The successful photoinactivation of viruses as cited earlier[15,16] and the emerging use of blue light as a disinfectant to reduce hospital infections[17] suggest that blue light is not only an antibacterial but also as a promising antiviral. This presents an important rationale to continue to study the antiviral potential of blue light, particularly since pulsed blue light has been specifically shown to be 40–100 times more potent than the commonly available continuous wave blue light in its effect on bacteria.[10] Further, the antiviral potential of blue light provides an opportunity to develop a new generation of medical devices for treatment and disinfection, and more importantly to determine (1) if RNA viruses with a lipid capsid such as SARS-Coronavirus-2 (SARS-CoV-2) can be inactivated, and (2) the specific mechanism of inactivation of this virus especially since it is causing a devastating pandemic.

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