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Title page

Title: Improper use of germicidal range ultraviolet lamp for household disinfection leading to phototoxicity in COVID-19 suspects

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Abstract

Purpose:

To report germicidal range ultraviolet (UV) irradiation-induced phototoxicity due to unprotected exposure to UV lamps for presumed household disinfection of SARS-CoV-2 in a domestic setting.

Methods:

We report on a family of three adults who experienced photophobia, intense eye pain, epiphora, blurred vision, and burning sensation over the face and neck area after a short period of unprotected exposure to UV germicidal lamps.

Results:

Initial examination revealed erythema and tenderness over the face and neck area, reduced visual acuity of 6/12, and conjunctival injections bilaterally in all three patients. Further assessment at the ophthalmology department three days later revealed gradual improvement of visual acuity to 6/6 bilaterally. Slit-lamp examinations revealed few punctate epithelial erosions. Fundal examinations were normal without evidence of solar retinopathy. The patients were diagnosed with germicidal-range UV irradiation-induced photokeratitis and epidermal phototoxicity. Lubricants and emollients were prescribed for symptom relief, and the patients were warned against using a UV germicidal lamp for disinfection purposes without appropriate protection.

Conclusions:

Although SARS-CoV-2 is structurally akin to SARS-CoV-1 and MERS-CoV, and previous

49 studies demonstrated high levels of inactivation of beta-coronavirus with germicidal-range UV,  
50 evidence for its efficacy to inactivate SARS-CoV-2 is lacking. This case report serves to  
51 emphasize the potential consequences of phototoxicity from improper use of UV germicidal  
52 lamps for household disinfection as well as to highlight the fact that UV germicidal lamps  
53 currently have no established role in household disinfection of SARS-CoV-2.

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## Introduction

The novel coronavirus (SARS-CoV-2) that causes coronavirus disease 2019 (COVID-19) pandemic has resulted in significant morbidity and mortality around the world<sup>1</sup>. Persons with suspected or confirmed COVID-19 who are residing at home or in self-isolation are advised to practice thorough household cleansing and disinfection as recommended by the Centers for Disease Control and Prevention (CDC)<sup>2</sup>. Ultraviolet (UV) irradiation, specifically in germicidal ranges between 200-280 nm (UV-C), is a disinfection method with proven efficacy against beta-coronavirus (e.g., SARS-CoV-1, MERS-CoV) and is utilized as part of a multibarrier approach for disinfection in the healthcare setting<sup>3,4</sup>. Current evidence for UV-C inactivation of the SARS-CoV-2 virus is lacking and the World Health Organization (WHO) has discouraged its use for disinfection<sup>5</sup>. Nevertheless, misleading reports and claims regarding the effects of UV-C on SARS-CoV-2 are prevalent on social media and public utilization of UV-C lamps for household disinfection has increased. We report a family of three adults who used UV-C light at home for presumed household disinfection of SARS-CoV-2 that developed photokeratitis and epidermal phototoxicity after exposure to unprotected UV light.

## Case report

A 17-year-old girl was quarantined at home after recently travelled to a high-risk SARS-CoV-2 outbreak region. She exhibited no symptoms or signs of respiratory syndrome. Results of reverse transcription polymerase chain reaction testing for SARS-CoV-2 ribonucleic acid on a throat saliva specimen were negative. She resided in a flat with her mother and father who were both asymptomatic and self-isolated in 1 of the rooms. Household disinfection was carried out thoroughly following CDC guidance on high-touch domestic surfaces together with hand

hygiene. All three adults enjoyed good health and declared no history of ophthalmic disease.

A germicidal device was purchased on the internet for additional presumed domestic SARS-CoV-2 disinfection. The purchased UV germicidal lamp was intended for stand-alone purification and deactivation of bacteria, viruses, and other microorganisms in households. The UV lamp, measuring 120 x 120 x 428 mm, had a power output of 38 W with an effective illumination area of 40 m<sup>2</sup>. Photometric data revealed irradiation of short-wave UV radiation with a peak at 253.7 nm (UV-C). Instructions from the manufacturer recommended strict avoidance of directly contacting and gazing at the lamp 30 min before and after using the UV lamp, and that the lamp be used in a closed environment. The UV lamp was placed in the corner of a room measuring 8 m<sup>2</sup> to avoid shadowing effects.

The UV germicidal lamp was turned on for the designated effect, but protective measures were not practiced. The family was exposed to the UV-C irradiation for 60 min, 20 min, and 15 min respectively. Symptoms of photophobia, intense eye pain, epiphora, blurred vision, and a burning sensation over the face and neck area were reported 60 to 90 min later. The family later self-referred to the emergency department. Initial physical examination of the 3 adults revealed grade 1 thermal injury over the face and neck areas. Ophthalmic examination revealed reduced visual acuity of 6/12 bilaterally in all three patients. Bilateral conjunctival injections were noted with no signs of epithelial defects or uptake of fluorescein stain. Lubricating eye drops and emollients were prescribed, and all three patients were referred to the ophthalmology department.

Further assessment at the ophthalmology department three days later revealed gradual

improvement of the blurred vision, photophobia, and epiphora, although the sensation of grittiness persisted. Mild erythema was also observed over the face, periorbital, and neck areas. Visual acuity improved to from 6/6 bilaterally in all patients. Slit-lamp examinations revealed few punctate epithelial erosions and minimal conjunctival injections. Fundus examinations were normal and solar retinopathy was not detected. All 3 adults were diagnosed with UV radiation-induced photokeratitis and epidermal phototoxicity. Additional courses of lubricants and emollients were prescribed for symptom relief, and the patients were warned against using a UV germicidal lamp for disinfection purposes without appropriate protection.

## Discussion

Short-wave length UV or UV-C exerts germicidal properties by inducing DNA lesions such as pyrimidine dimers in microorganisms, which causes genome mutations and apoptosis<sup>6</sup>. The phototoxicity of UV-C is also responsible for the unwanted side effects of photokeratitis, photoconjunctivitis, and epidermal phototoxicity. The shallow penetration depth and high level of absorption of UV-C at the corneal epithelium and dermal stratum corneum accounts for the superficial nature of overexposure injuries<sup>7</sup>. UV-C phototoxicity as a result of damaged UV germicidal lights, overexposure to nightclub lighting, and misinstallation of UV-C lamps has been described in the literature. Fortunately, damaged superficial cells are normally sloughed off and re-epithelialized within 24-72 h, and patients generally have a good visual prognosis. Treatments are usually supportive.

Although SARS-CoV-2 is structurally similar to SARS-CoV-1 and MERS-CoV, and previous studies have demonstrated high levels of inactivation of beta-coronavirus with UV-C, evidence

for the efficacy of UV-C to inactivate SARS-CoV-2 is lacking. The WHO has discouraged the use of UV light as a disinfection method for SARS-CoV-2 due to the potential risk of phototoxicity<sup>5</sup>. Current guidance from the CDC and WHO for patients with suspected or confirmed COVID-19 who are residing at home or in self-isolation includes cleaning and disinfecting high- touch surfaces with Environmental Protection Agency- approved solutions, 0.1% sodium hypochlorite (equivalent to 1000 ppm) or alcohol-based wipes and sprays that contain at least 70% alcohol<sup>2,8</sup>. More importantly, practicing good hand hygiene is key for preventing the household transmission of SARS-CoV-2.

Misleading and false claims disseminated on social media often lead to confusion in the public and could further complicate conditions for healthcare workers in times of outbreaks and crisis<sup>9</sup>. Reports of the misinterpreted effects of UV germicidal lamps for the inactivation SARS-CoV-2 are currently prevailing on social media. This is an alarming issue as there is currently no evidence for UV-induced inactivation of SARS-CoV-2, and UV-C induced phototoxicity is avoidable. Furthermore, increased general use of UV germicidal lamps in households for disinfection of other microorganisms may also increase the risk for UV-C induced phototoxicity due to misuse, overexposure, and under-protection. It is important to educate the public on the judicious use of UV germicidal lamps, and to debunk myths about the effects of UV-C on SARS-CoV-2 until further evidence is available.

This case report serves to emphasize the potential consequences of UV-C–induced phototoxicity from improper use of UV germicidal lamps as well as to highlight the fact that UV germicidal lamps currently have no established role in household disinfection of SARS-CoV-2.

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