

Don't Let Ultraviolet Hurt Your Eyes During SARS-CoV-2 Disinfection: A Retrospective Observational Study

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Abstract

Purpose: A retrospective observational study was carried on to investigate whether UV lamp will increase the risk of eye damage by comparing the exposure factors leading to ultraviolet keratitis (UVK) during the epidemic of COVID-19 and the control group in 2019.

Methods: Data on UVK patients with clear exposure histories and typical symptoms were gathered. The date acquisition refers to the most crucial period in fighting the COVID-19 pandemic (24 January to 29 February in 2020, crucial period for short) in China, while the equivalent control 37- day period in 2019 refers to the period from 4 February to 12 March (control group for short). The detailed information of UVK cases were gathered through questionnaire survey, including injury photosources, ultraviolet applications, onset locations.

Results: This retrospective observational study of 81 patients revealed that the number of UVK cases during crucial period 1 was threefold higher (n=61 patients) than control group (n=20 patients). All cases who recorded injury photosources were injury by UV lamps during crucial period, while by UV lamps (61.54%) or welding (38.46%) during control group. There were more than 70% of UVK cases injured at home by household UV lamps during crucial period, while were 15.38% during control group. They are significant differences in UVK photosource and exposure location between 2 groups ($P < 0.001$).

Conclusion: Household UV lamp users should be informed about possible UVK risk and of relevant preventive measures. Government and media should guide people use household disinfection items rationally and safely.

Highlight

1. Ultraviolet lamp and welding are the main photosources leading to the ultraviolet keratitis.
2. The ratio of ultraviolet keratitis caused by improper use of household ultraviolet lamp were increased during the COVID-19 crucial period in 2020 in Guangzhou.
3. Improper use of ultraviolet lamps for air disinfection increase the risk of ultraviolet keratitis.
4. People should be informed the keratitis risk of the ultraviolet lamps and the relevant preventive measures.

Introduction

Coronavirus disease 2019 (COVID-19) is a severe acute respiratory syndrome that has spread across the globe. The causative pathogen SARS-CoV-2 mainly spreads through respiratory droplets or contact with contaminated surfaces[1]. Be different from SARS-CoV, SARS-CoV-2 has higher infectivity, greater occult infection (and thus greater risk of transmission by asymptomatic carriers)[2, 3], and slower clearance rate[4, 5]. Moreover, SARS-CoV-2 may even stay in the air for a longer period by combining with other airborne particles.

A report issued by the Centers for Disease Control (CDC) in China demonstrated that SARS-CoV-2 is sensitive to ultraviolet radiation (UVR), 56°C for 30 minutes, 75% ethanol, and to chlorine-containing disinfectants with an effective chlorine concentration of 500 mg/L[6]. Consumer-grade ultraviolet disinfection lamps (UV lamps) are chosen for SARS-CoV-2 eradication because of easy installing and using. However, incorrect use of UV exposure can cause keratitis (UVK). To assess if the application of household UV lamps is a significant risk for UVK, we compared UVK injury conditions, ultraviolet application, place, and continuous contact time between two 37-day periods encompassing the Chinese Spring Festival, 4 February 2019 to 12 March 2019 (control group) and 24 January 2020 to 29 February 2020 (crucial period), using data collected by Zhongshan Ophthalmic Center (ZOC). The results suggest that the public must be aware of the potential hazards associated with UV lamp disinfection and provided alternatives for enhanced safety during home quarantine.

Methods

1. Data acquisition

Data on UVK patients gathered from emergency department of the Zhongshan Ophthalmic Center (ZOC) were included which with a clear exposure history of ultraviolet or strong light, symptoms such as photophobia, tearing, and foreign body sensations, and signs of blepharospasm, and (or) diffusive superficial punctate keratopathy or patches of corneal epithelial defects. The date acquisition refers to the period from 24 January to 29 February in 2020 (37 days), which is the most crucial period in fighting the COVID-19 pandemic in China, while the equivalent control 37-day period (control group) in 2019 refers to the period from 4 February to 12 March. Both of them includes a 7-day legal holiday of Chinese Spring Festival and the following month. Patients' subsequent visiting data were excluded to avoid duplicate cases. The detailed information of UVK cases were gathered through questionnaire survey, including injury conditions, ultraviolet application, place, and continuous contact time.

The ZOC is one of the top ophthalmic hospitals in China. And It is the only ophthalmic hospital do business during the Spring Festival or the COVID-19 in Guangzhou. It means these data should be representative of the general population in Guangzhou.

2. Data analyses

Injury photosources were compared between groups by Fisher exact test and onset locations by Chi square test. STATA statistics software was used for all analyses. A $P < 0.05$ (two-tailed) was considered significant for all tests.

3. Ethics approval

The study was approved by the Ethics Committee of the Zhongshan Ophthalmic Center, Sun Yat-Sen University, Guangzhou, Guangdong (2020KYPJ030). The study conformed to the tenets of the Declaration of Helsinki.

Results

1. Photosources and exposure locations for UVK

During the 37-day study period in 2020 (COVID-19 crucial period), 61 UVK cases were diagnosed, of which 46 (75.4%) were clearly induced by UV disinfection lamps (253.7nm, Chinese national standard), while there were no cases due to welding arc exposure. Of these 61 cases, 15 (24.6%) failed to follow-up by telephone because of unsuccessful calls. 31 of 61 cases (50.8%) occurred at home, while 13 (21.3%) occurred in the workplace. Two cases did not provide detailed information on exposure location. Due to the outbreak, no hospital-related UVK occurred. Among these 44 patients (at home and in workplace) tracked by telephone, 27 (61.4%) stated that they did not know to avoid UV lamp radiation, 10 (22.7%) inadvertently turned on the UV lamp or did not know that the UV lamp was turned on, and 7 patients (15.9%) knew to avoid eye exposure while using the UV lamp, but forgot that the UV lamp was turned on.

The control group in 2019 included 20 UVK cases, of which 8 (40%) were clearly induced by UV disinfection lamps and 5 (25.0%) by welding arc exposure. 7 cases (35.0%) failed to follow-up by telephone. 2 of 20 cases (10.0%) occurred at home, and 11 cases (55.0%) occurred in the workplace or during hospital-visiting. Among these 13 patients tracked by telephone, 1 (7.7%) did not know that eye exposure to UV lamp radiation should be avoided, 5 (38.5%) did not know that eye exposure to welding arc light and glare should be avoided, while 6 (46.1%) turned on the UV lamp inadvertently or did not know that the UV lamp was turned on, and 1 (7.7%) knew the safety rules but forgot that the UV lamp was turned on (Tables 1 and 2).

Table 1
Comparisons of photosource and exposure location between 2019 and 2020 UV keratitis cases.

	2020	2019	Value/
	N (%)	N (%)	<i>P</i>
Photosource			
UV Lamp	46 (100%)	8 (61.5%)	17.0719/
Welding	0	5 (38.5%)	< 0.001*
Total	46 (100%)	13 (100%)	
Onset location			
Household	31 (70.5%)	2 (15.4%)	10.5238/
Workplace	13 (29.5%)	11 (84.6%)	< 0.001**
Total	44 [!] (100%)	13 (100%)	
*Fisher exact test. **Chi square test			
! ² in 46 cases were reluctant to describe how they were exposed to UV			

Table 2
Reasons for UV exposure from lamps.

	2020	2019	
	UV Lamp	UV Lamp	Welding
	N (%)	N (%)	N (%)
Forgot the lamp was turned on	7 (15.9%)	1 (7.7%)	0
Did not know it was turned on	10 (22.7%)	6 (46.1%)	0
Do not know UV exposure was dangerous	27 (61.4 %)	1 (7.7%)	5 (38.5%)
Count	44 (100%)	8 (61.5%)	5 (38.5%)
Total	44 (100%)	13 (100%)	

2. Comparison between 2019 and 2020

The injury photosource and exposure location of UVK cases by telephone followed-up differed significantly between COVID-19 crucial period in 2020 and the control group in 2019. The value of Fisher

exact test for injury photosource is 17.0719, $P < 0.001$. And the value of pearson chi-square for the exposure location between 2 compared periods is 10.5238, $P = 0.001$.

Discussion

This retrospective observational study of 81 patients revealed that the cases confirmed UVK during the 37-days COVID-19 crucial period in 2020 in Guangzhou was threefold higher ($n = 61$ patients) than the number during the control group in 2019 ($n = 20$ patients). All of the UVK cases who recorded injury photosources were injury by UV lamps during the crucial period in 2020, while by UV lamps (61.54%) or welding (38.46%) in the control group. There were more than 70% of UVK cases injured at home by household UV lamps during the crucial period in 2020, while were 15.38% in control group. They are significant differences in UVK photosource and exposure location between periods in 2019 and 2020 ($P < 0.001$).

Even the number of UVK cases increased so much during 2020 period, we found no cases related to welding arc or hospital-visiting UV lamp exposed, while misuse of household UV disinfection lamps account for all recorded injury photosource cases. In contrast, greater proportions of cases in 2019 were related to welding arc and medical UV disinfection lamp exposure. We suspect that the COVID-19 has had a serious impact on people's daily habits. With much of the industry shut down, people grounding themselves at homes, and taking more emphasis placed on home disinfection than ever. Consumer-grade ultraviolet (UV) disinfection lamps are chosen for SARS-CoV-2 eradication because of easy installing and using. As a result, it increased household UV lamp related UVK cases.

COVID-19 has spread across the globe, and while there are intensive efforts to reduce spread and identify treatments. Home disinfection may help prevent spread within families, but there are no guidelines on the most suitable disinfection agents and their use[7]. A large number of Chinese citizens purchased UV lamps[8] through the internet for daily household disinfection during the early stages of the pandemic. However, lack of relevant knowledge regarding safe use and suitable eye protection can lead to UVK. A similar phenomenon was also reported during the 2003 SARS pandemic, as GH Zhou et al [9]found that exposure to household UV disinfection lamps accounted for 91% of all UVK cases. Ultraviolet light exposure is a major environmental danger. Natural sunlight in mountainous, snowy, or water environments is considered a major source of acute UV radiation, while major artificial sources include medical air disinfectors, tanning beds, welding arcs, photo floodlights, electrical sparks, and halogen desk lamps[10, 11]. In contrast, household disinfection lamps are not considered a major contributor. However, the risk has increased markedly in China due to the more frequent use of UV disinfection lamps.

The reasons for increased UV exposure from disinfection lamps and resulting UVK incidence can be summarized as follows. First, many users are unaware that direct eye exposure should be avoided as they have not read the safety instructions carefully. Further, most large e-commerce websites that sell household UV lamps present these warnings inconspicuously. Second, many users did not know that the UV lamp was turned on even when aware of the safety precautions, so a conspicuous warning signaling

that the instrument is on should be placed on the device. We suggest that clinicians initiate public information campaigns on the dangers of UV lamp exposure.

Ultraviolet irradiation at 207 nm induces little cellular damage when used for air disinfection[12], while longer wavelengths can induce DNA damage[13], UVK, radiation cataract, dermatitis, skin cancer, and mucosal or choroidal melanoma among other diseases[14]. However, the wavelength standard of UV disinfection lamps is 254 nm[15], so improper use may lead to these aforementioned complications depending on exposure level.

There are currently no consensus guidelines on household cleaning for SARS-CoV-2. A recent study[16] in Wuhan, China, found that SARS-CoV-2 was widely distributed in the air and on object surfaces in both the intensive care unit (ICU) and a general ward (GW) during the epidemic. Since some ICU patients require airway opening, the exposure risk is even greater than in the GW, even if there is a ventilation system. These findings indicate that virus-laden aerosols concentrate near and downstream from the patient and that SARS-CoV-2 may transmit up to 4 m. A recent study[17] in Italy also found that SARS-CoV-2 RNA can attach to outdoor particulate matter in pandemic areas, thus enhancing the persistence of SARS-CoV-2 in the atmosphere.

Otherwise, a recent study[5] in Singapore did not detect viral RNA in air samples from isolation wards with mild COVID-19 cases before disinfection, but did detect viral RNA in vents, on floors, window sills, light switches, stethoscopes, tables, and chairs, and both inside and outside sinks. In wards with patients showing intermediate levels of infection, no viral RNA could be detected in air samples and surface swabs after wiping with chlorine-containing disinfectants, even in the absence of UV lamp disinfection. This state may be attributed to the following conditions of isolation wards: ☒ Patients have non-open airways by tracheal intubation, ☒ There are effective ventilation systems, ☒ Patients are isolated in individual rooms and wear medical masks. Therefore, to avoid viruses being transmitted from droplets and close contact, more attention should be shifted to surface disinfection and hand hygiene (hand washing) rather than UV air disinfection. Moreover, if there are no potential risks of respiratory infection at home, UV disinfection may be unnecessary. In addition, the presence of virus in toilet and sink swabs[5] suggests the possibility of fecal–oral transmission, against underscoring the value of hand hygiene for personal protection. During home quarantine, correct hand washing is still the most important measure rather than whether the hand sanitizer/soap is antibacterial[18, 19].

As indicated above, people should avoid exposure of eyes and skin to UV rays while using inexpensive and effective UV disinfection lamps in pandemic regions. We hope that these results and recommendations will encourage public health organizations to establish effective and safe disinfection protocols and promote the use of suitable personal protection during home quarantine.

Conclusion

Household surface disinfection and hand washing are crucial for preventing COVID-19. Therefore, governments and media should inform the public of the most effective methods and of potential

dangers, including of household UV disinfection lamps. Public health organizations should encourage research on better and safer disinfection strategies for coping with public health emergencies.

Declarations

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Conflict of Interest Disclosures:

The authors have no potential competing interests to declare.

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None

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics approval:

The study was approved by the Ethics Committee of the Zhongshan Ophthalmic Center, Sun Yat-Sen University, Guangzhou, Guangdong (2020KYPJ030).

Consent for publication:

Written informed consent for publication was obtained from all participants.

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