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Case report

UNINTENDED ULTRAVIOLET-C EXPOSURE DURING HOSPITALIZATION IN A DOG

Jiyoung YANG[1], Yujin KIM[1], Min JANG[2], Sungin LEE[1*]

[1]Chungbuk National University, College of Veterinary Medicine, Department of Veterinary Surgery, Cheongju, Korea; [2]Kyungpook National University, College of Veterinary Medicine, Department of Veterinary Surgery, Daegu, Korea.

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A 12-year-old castrated male Maltese dog was referred for a liver mass and underwent complete liver lobectomy. On postoperative day 3, generalized skin erythema and ocular irritation were observed. Investigation revealed accidental activation of a ceiling-mounted UV-C germicidal lamp (253.7 nm, 2.5 W) located 30 cm above the patient, resulting in an estimated exposure of 15,000 J/m² approximately over 4 hours. Clinical signs included hyperthermia, tachycardia, and diffuse erythema. The site from which a continuous glucose monitoring device had been removed showed deeper skin injury, suggesting enhanced UV-C penetration through compromised stratum corneum and epidermis. Ocular symptoms were mild and resolved rapidly. Supportive care included cooling therapy, topical aloe vera, and prophylactic ophthalmic medication. Dermatological symptoms progressed to partial-thickness skin injury but resolved completely within 1 month, with full hair regrowth and no abnormalities observed at a 6-month follow-up. This case identifies UV-C disinfection systems as a potentially underrecognized source of iatrogenic injury in veterinary hospitals. Prolonged confinement and the inability to escape the irradiated area likely contributed to lesion severity. The case emphasizes the importance of staff education regarding the safe use of UV-C equipment to prevent similar incidents in clinical practice.

Keywords: Canine, Erythema, Irradiation, Skin injury, Ultraviolet Rays

INTRODUCTION

Ultraviolet radiation, primarily originating from solar radiation, comprises wavelengths ranging from 100 to 400 nm and is conventionally subdivided into three categories based on wavelength: UV-A (315–400 nm), UV-B (280–315 nm), and UV-C (100–280 nm) [1]. Of these, UV-C is largely absorbed by the Earth's ozone layer and does not naturally reach the surface. As a result, it has historically received limited attention as an environmental hazard [2].

*Corresponding author: e-mail: sunginlee@cbnu.ac.kr

The increasing use of artificial UV-C sources, particularly germicidal lamps designed for microbial control, has shifted the relevance of UV-C exposure from a largely theoretical concern to a tangible occupational risk [3,4]. The germicidal mechanism of UV-C involves the induction of DNA and RNA damage in microorganisms. Absorption of UV-C photons by nucleic acid bases leads to the formation of pyrimidine dimers, particularly cyclobutane pyrimidine dimers, which interfere with replication and transcription and ultimately result in microbial inactivation [5,6]. UV-C germicidal lamps are now employed across various domains, including human and veterinary clinical facilities, for the disinfection of air, water, and surface [4,7]. Their use has gained prominence in response to the growing threat of antimicrobial resistance and the emergence of novel infectious diseases [8].

Despite their benefits, the expanded application of UV-C disinfection systems has raised safety concerns related to inadvertent exposure [3]. In human medicine, several reports have documented accidental UV-C irradiation due to improper handling or unintended activation of disinfection lamps, resulting in dermatologic and ophthalmic injuries [9-11]. While the adverse effects of UV-C exposure are relatively well characterized in human healthcare environments, to date, there are no published reports of UV-C-induced injury in veterinary patients.

This report describes a case of acute skin injury in a dog following inadvertent UV-C exposure during hospitalization. By outlining the clinical progression and therapeutic response, this case highlights the potential hazards associated with UV-C disinfection systems in veterinary settings and underscores the importance of implementing safety protocols to prevent such incidents.

CASE PRESENTATION

A 12-year-old castrated male Maltese dog weighing 5.1 kg was presented to a local veterinary hospital for a health examination. Abdominal ultrasonography revealed a liver mass, and the patient was referred to Chungbuk National University Veterinary Teaching Hospital for further evaluation. A complete liver lobectomy was performed, and the patient was hospitalized for postoperative care.

At 9:00 a.m. on postoperative day 3, routine monitoring of vital signs and medical care revealed generalized skin erythema and ocular irritation. It was identified that the UV-C lamp installed in the cage for disinfection had been inadvertently turned on. At the facility, inpatient vital signs are monitored every 4 hours. The UV-C lamp was confirmed to be off during the 1:00 a.m. round, but was presumably activated during the 5:00 a.m. monitoring, indicating an estimated UV-C exposure duration of approximately 4 hours. The germicidal UV-C lamp (G8T5 8W, Sankyo Denki Co., Ltd., Tokyo, Japan) with an emission wavelength of 253.7 nm, lamp power of 8 W, and ultraviolet output of 2.5 W (as per manufacturer specifications), was installed on the ceiling of the cage, approximately 30 cm above the patient. Given the patient was

housed in a 65 cm (length) × 65 cm (width) × 45 cm (height) cage, was able to move freely, and had an approximate body height of 10 cm, the patient was presumed to have remained in a sternal recumbent position during most of the exposure period.

On day 0, at the time of detection, the patient exhibited hyperthermia (40.7°C) and tachycardia (200 beats per minute). Diffuse erythema and increased skin temperature were noted on the dorsal and flank regions. More severe erythema was observed at the site where a continuous glucose monitoring device (CGMD, Freestyle Libre 2, Abbott, Abbott Park, IL, USA) had been attached and removed. Ocular irritation was also present. Cutaneous lesions were distributed bilaterally, with no clinically relevant difference in severity between the left and right sides. Cooling therapy was initiated immediately. Ice packs and 0.05% chlorhexidine were applied every hour, and aloe vera (DMSO gel with aloe vera, TriMedica Inc., Salt Lake City, UT, USA) was administered every 4 hours. Owing to suspected UV-C-induced photokeratitis and ocular irritation, prophylactic ofloxacin eye drops (Ocuflox® eye drops, Samil Pharmaceutical Co., Ltd., Seoul, Republic of Korea) were applied every 8 hours, and lubricating eye gel (Liposic eye gel, Dr. Gerhard Mann Chemisch-Pharmazeutische Fabrik GmbH, Berlin, Germany) was used every 3 hours. Ocular symptoms improved within 6 hours. Body temperature was monitored hourly, and intensive cooling was continued. After 6 hours, body temperature normalized to 38.6°C. On day 1, erythema persisted but had improved compared to the previous day. Hyperpigmentation was also observed (Figure 1). No ocular symptoms were noted, and vital signs remained stable. The patient was discharged with instructions to continue topical aloe vera application.

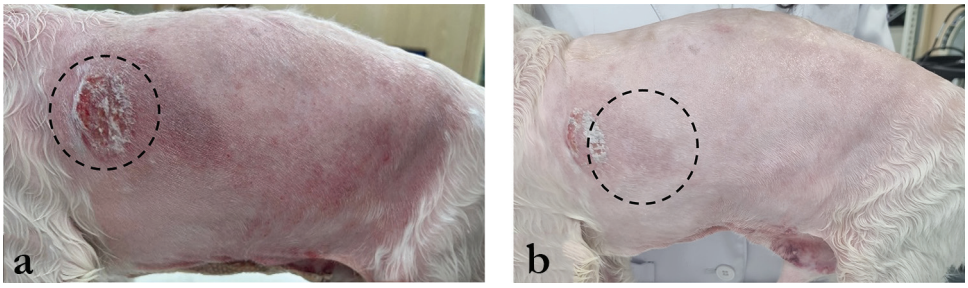

Figure 1. Progression of skin lesions following UV-C exposure in a dog. The dotted circle marks the site where a continuous glucose monitoring device (CGMD) had been attached and subsequently removed. **(a)** Day 0 (the day of exposure): generalized erythema was observed, with more pronounced erythema at the CGMD attachment site. **(b)** Day 1, overall erythema showed slight improvement compared to day 0 but remained evident.

On day 3, generalized erythema and hyperpigmentation persisted. Skin condition had deteriorated compared to the time of discharge, with mild residual heat sensation. The region previously damaged by the CGMD still showed severe erosion but had improved compared to earlier observations. The patient returned to the hospital on day 6 due to worsening skin condition. Erythema remained similar, while localized blistering had developed, consistent with progression to deep dermal injury. Pruritus was noted for the first time. The CGMD site continued to show more pronounced

erythema and hyperpigmentation than other areas (Figure 2). Aloe vera treatment was continued, and a protective cloth covering was prescribed to prevent self-trauma from scratching.

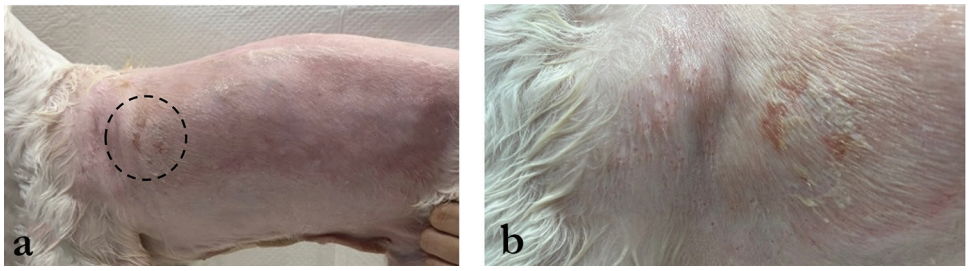

Figure 2. (a) Day 6: persistent generalized erythema with blister formation. **(b)** Day 6: close-up view of blistered lesions.

By day 9, no heat sensation was detectable. Erythema had diminished overall, but widespread crusting was present. The superficial crusting extended from the dorsal to ventral abdominal region. No new blisters were observed. After 1 month of treatment, complete resolution of erythema and crusting was confirmed. Hair regrowth was evident, and treatment was discontinued. At a follow-up health check 6 months after UV-C exposure, the overall skin condition was normal, with no signs of pruritus, erythema, elevated skin temperature, or scaling (Figure 3, Table 1).

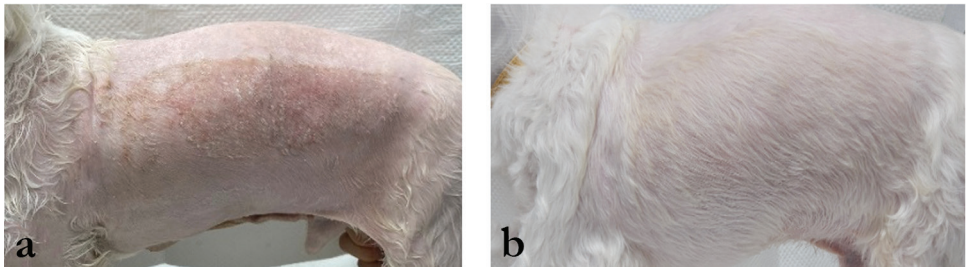

Figure 3. (a) Day 9: widespread crusting. **(b)** At 1-month follow-up: complete resolution of lesions with hair regrowth.

Table 1. Time of onset and duration of clinical signs following UV-C exposure.

Adverse effects after the exposure	0h–6h	6h–12h	Day 1	Day 3	Day 6	Day 9	1 month
Hyperthermia	*						
Skin erythema	*	*	*	*	*		
Heat sensation	*	*	*	*	*		
Hyperpigmentation			*	*			
Ocular irritation	*						
Blisters					*		
Crust						*	
Pruritus					*		

Clinical signs including hyperthermia, erythema, heat sensation, hyperpigmentation, ocular irritation, blister formation, crust formation, and pruritus were recorded at multiple time points after UV-C exposure. An asterisk (*) indicates the onset and persistence of each clinical sign.

DISCUSSION

Due to the retrospective nature of the event, direct irradiance measurements were unavailable at the time of exposure. Therefore, the UV-C dose was estimated based on lamp specifications and guideline-based calculation models, using worst-case assumptions. The effective irradiance (E_{eff}) of the UV-C source was calculated using the following formula [12], where E_{λ} is the spectral irradiance at the center wavelength of 254 nm, **S(λ)** is the relative spectral effectiveness at this wavelength, and **Δλ** is the bandwidth around the center wavelength:

$$E_{eff} = E_{\lambda} \times S(\lambda) \times \Delta\lambda \ (\mathrm{W/m^2})$$

According to the 2019 guidelines of the American Conference of Governmental Industrial Hygienists, the relative spectral efficiency at 254 nm was used, and Δλ was set at 1 nm [12]. The UV-C dose was calculated by multiplying the effective irradiance by the exposure duration [13], as follows:

$$Dose = E_{eff} \times time \ (\mathrm{J/m^2})$$

Mathematical evaluation indicated that the absorbed UV-C energy in this case was approximately 15,000 J/m². There are currently no established threshold limits for UV exposure in animals. In humans, however, the American Conference of Governmental Industrial Hygienists and International Commission on Non-Ionizing Radiation Protection guidelines define a threshold limit for UV-C exposure. The maximum permissible exposure for humans is 60 J/m² over an 8-hour period at 254 nm [12,13]. The exposure in the present case exceeded this limit by more than 250 times [12,13], and was over twice the dose reported in documented human cases [9].

Marked hyperthermia (40.7°C) was documented at recognition and normalized within several hours with active cooling (Table 1). Acute UV-C irradiation can trigger keratinocyte-derived pro-inflammatory cytokines (e.g., IL-1, TNF-α), producing a transient, regulated febrile response rather than direct thermal heating of tissue [12,13]. Similar events have been described after inadvertent high-dose UV-C exposure in occupational settings [14]. In the present case, the tight temporal association with UV-C activation, concurrent widespread erythema irritation, and rapid defervescence with supportive care made alternative postoperative causes of temperature elevation less likely. Reduced heat dissipation in the enclosed cage may have additionally contributed to the observed body temperature rise.

Differential diagnoses for the observed erythema and hyperthermia included thermal injury associated with intraoperative warming devices, drug-related reactions, postoperative inflammatory changes, and infection. A forced-air warming system (3M™ Bair Hugger™ Warming Unit, Model 7752, Solventum, St. Paul, MN, USA) was used intraoperatively. The cutaneous lesions were predominantly confined to the

flank rather than all areas covered by the warming blanket and were first recognized three days after surgery, making warming-related thermal injury an unlikely cause. No new medications were administered during hospitalization, and the lesions were distributed away from the ventral midline surgical site, with gradual resolution following supportive topical care without antimicrobial therapy.

Previously reported human cases of UV-C exposure have involved the face, scalp, and neck, with symptoms including erythema, burn, irritation, and pain. Ocular signs have included burning sensation, tearing, pain, blurred vision, difficulty opening the eyes, conjunctival hyperemia, and eyelid swelling [9-11]. In the current case, similar cutaneous signs such as erythema and heat sensation were observed, but skin damage progressed more severely than in human reports, with the development of small blisters and pruritus, followed by desquamation (Figure 2). The presence of blistering, together with the subsequent spontaneous epithelial recovery without surgical intervention, was considered consistent with a superficial partial-thickness dermal injury [15].

The greater extent of exposure in this dog patient compared to human cases may be attributed to differences in environmental constraints. In humans, reported cases of UV-C exposure have mostly occurred in school or workplace settings [9-11,14]. In other words, individuals were exposed to the environment only for a set period, without continuous exposure. In contrast, the canine patient was confined to a restricted space in the hospitalization ward throughout the exposure period. Due to his proximity to the UV-C source and inability to leave the enclosed environment, he experienced excessive and sustained exposure.

Given the high UV-C dose in this case, involvement of deeper skin layers was possible. UV exposure often occurs during occupational or educational settings, increasing the likelihood of direct ocular irradiation [9-11,14]. In contrast, exposure in this case likely occurred while the patient was asleep, with eyelids closed. If so, because of the limited penetration capacity of UV-C, irradiation of corneal and intraocular structures would have been minimal, resulting in a substantially reduced ocular dose and milder symptoms [16]. While ocular signs were not clinically significant here, potential adverse ocular effects should be considered when using UV-C in future veterinary clinical contexts.

The penetration depth of ultraviolet radiation increases with wavelength. As the shortest wavelength band in the UV spectrum, UV-C is primarily absorbed by the outermost skin layer — the stratum corneum — and only a minimal fraction penetrates deeper [16]. Consequently, UV-C carries a lower carcinogenic risk than UV-B and rarely causes injury to deeper skin layers. Histologically, the stratum corneum is most affected in UV-C-induced skin damage [17,18]. In this case, the overall skin lesion pattern was relatively uniform. However, the lesion on the left shoulder, where the CGMD had been attached and later removed, showed more intense and prolonged erythema with early exudation. This suggests that although UV-C was predominantly absorbed within the stratum corneum elsewhere, preexisting disruption of the stratum corneum

and partial epidermis under the sensor patch allowed deeper UV-C penetration and more direct epidermal injury, resulting in a more severe localized reaction.

Clinical signs of UV-C exposure closely resemble those of sunburn [11]. Sunburn is characterized as acute cutaneous photodamage from excessive UV radiation. Evidence-based management of sunburn includes symptomatic care with bland emollients and cool compresses, along with adequate pain control [19]. Spontaneous symptom resolution without intervention has been documented [9,11], although topical corticosteroids, calamine lotion, and antihistamines have also been used [10]. In the present case, blister formation indicated dermal involvement; hence, aloe vera gel was applied [19,20]. Additionally, an ice pack was used to alleviate the heat sensation. At 1-month follow-up, no residual dermatologic signs were observed.

This case represents the first documented instance of acute UV-C-induced skin injury in a dog during hospitalization. Although UV-C germicidal lamps are widely used for disinfection in both human and veterinary settings, their risks have been underrecognized in veterinary practice. The current case highlights UV-C disinfection systems as a potential nosocomial hazard in veterinary hospitals and underscores the importance of preventive strategies to minimize iatrogenic injury. The clinical course, treatment response, and outcome offer valuable insights for managing similar cases. Moreover, this case emphasizes the need for staff education on the safe use and timing of UV-C devices to prevent unintended exposure and ensure patient safety.

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Authors' Contributions

YJ conceived and designed the study, collected and curated the clinical data, performed image processing and visualization, and drafted the original manuscript. KY assisted with data organization, visualization and contributed to manuscript review and editing. JM supervised the clinical management, provided validation and critical feedback, and participated in manuscript revision. SL supervised the entire project, contributed to study conceptualization and funding acquisition, and provided critical revisions as the corresponding author. All authors have read and approved the final version of the manuscript.

Declaration of conflicting interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Statement of informed consent

The owner understood the procedure and agreed that results related to investigation or treatment of their companion animals, could be published in Acta Veterinaria-Beograd.

ORCID iDs

Jiyoung Yang https://orcid.org/0009-0004-7392-7971
Yujin Kim https://orcid.org/0009-0003-1427-8900
Min Jang https://orcid.org/0000-0002-2188-1906
Sungin Lee https://orcid.org/0009-0009-0663-1114

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NENAMERNO IZLAGANJE ULTRALJUBIČASTOM C ZRAČENJU TOKOM HOSPITALIZACIJE PSA

Jiyoung YANG, Yujin KIM, Min JANG, Sungin LEE

Dvanaestogodišnji kastrirani mužjak maltezera upućen je na operaciju zbog mase na jetri i podvrgnut je kompletnoj lobektomiji jetre. Trećeg dana nakon operacije primećeni su generalizovani eritem kože i iritacija oka. Istraga je otkrila slučajno aktiviranje UV-C germicidne lampe (253,7 nm, 2,5 W) postavljene na plafonu, koja se nalazila 30 cm iznad pacijenta, što je rezultiralo procenjenom izloženošću od 15.000 J/m² približno tokom 4 sata. Klinički znaci su uključivali hipertermiju, tahikardiju i difuzni eritem. Mesto sa kog je uklonjen uređaj za kontinuirano praćenje glukoze pokazalo je dublju povredu kože, što ukazuje na pojačano prodiranje UV-C zračenja kroz ugroženi stratum korneum i epidermis. Očni simptomi su bili blagi i brzo su se povukli. Podporna nega je uključivala terapiju hlađenjem, lokalnu primenu aloe vere i profilaktičke oftalmološke lekove. Dermatološki simptomi su napredovali do delimične povrede kože, ali su se potpuno povukli u roku od 1 meseca, sa potpunim ponovnim rastom dlake i bez primećenih abnormalnosti tokom šestomesečnog praćenja. Ovaj slučaj identifikuje UV-C dezinfekcione sisteme kao potencijalno nedovoljno prepoznat izvor jatrogenih povreda u veterinarskim bolnicama. Dugotrajno zatvaranje i nemogućnost bekstva iz ozračenog područja verovatno su doprineli težini lezija. Slučaj naglašava važnost edukacije osoblja o bezbednoj upotrebi UV-C opreme kako bi se sprečili slični incidenti u kliničkoj praksi.