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Black ceiling tiles reduce occupational UV exposure for staff in clinical area containing phototherapy cabinets

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Ethics statement: Not applicable.

Learning Points

- White surfaces reflect stray ultraviolet radiation from phototherapy cabinets into the clinical environment.
- Staff and patient exposure to ultraviolet (UV) radiation must be carefully controlled and monitored.
- Exposure Limit Values (ELV) can be as little as 30 minutes in clinical scenarios.
- Replacement of white surfaces such as ceiling tiles with black alternatives reduce reflections by up to 90%.
- ELV can be increased to hours with nearly 10x the time required before ELV is reached.

Abstract

Phototherapy clinics administer UV light to patients via phototherapy cabinets. The UV radiation from these cabinets reflects on the white ceiling tiles of the clinic and is directed towards both staff and patients in the area. This is particularly problematic for clinical technologists who must undertake dosimetry in these areas and have a particular time (often as low as 30 minutes) before they reach their maximum exposure limit. By replacing the white tiles with black alternatives which absorb the stray radiation, we have been able to reduce these reflections by almost 90%, prolonging the time to maximum exposure by nearly 10 times. We therefore present these findings to encourage similar clinics to undertake the simple protocols outlined which will significantly improve staff and patient safety.

Ultraviolet (UV) light in the UV-A and UV-B bands is used to treat a range of skin conditions, including psoriasis, eczema, cutaneous T-cell lymphoma, vitiligo, fibrosing skin diseases such as localized morphoea among others[1-3]. To this end, phototherapy cabinets are used, whereby a patient is positioned inside whilst a precise light dose is administered by the surrounding UV lamps. Phototherapy cabinets are typically open at the top to allow for heat dissipation, which in turn allows stray UV-radiation to reflect from the white ceiling tiles (CTs), presenting an exposure risk to staff working in the area. For this reason, the area around a cabinet is often demarcated or shielded to mitigate this risk. Working practices and Local Rules help ensure staff time within the shielded area is minimised to achieve occupational exposure that is as low as reasonably practicable (ALARP), as required by the Control of Artificial Optical Radiation at Work Regulations 2010 (CAORWR2010) Section 4[4].

However, staff may need to spend prolonged periods of time inside the demarcated area, for example when undertaking dosimetry measurements. In such circumstances, staff rely upon Personal Protective Equipment (PPE) as an important control measure. Previous Risk Assessment (RA) at the Phototherapy Unit in Ninewells Hospital, Dundee, has highlighted that the legal exposure limit value (ELV) of UV within the demarcated area could be as low as half an hour.

White CTs are commonplace in phototherapy units and the hospital environment. Previous studies have demonstrated the varying reflectance of ceiling tiles is of interest in the context of ultraviolet germicidal irradiation, but it has not, to our knowledge, been explored in

phototherapy[5,6,7]. We therefore present a practical and cost-effective measure for reducing stray UV-radiation by replacing white CTs with black alternatives, whose light-absorbing surface will aid in cutting down reflected UV light.

First, we tested black CTs (AMF Thermatex Alpha Black – 600mm Square Edge) under laboratory conditions and compared with our existing white CTs of the same style. Each CT was suspended facing a UV light source; both broadband fluorescent UV-A and narrow-band (NB) UV-B lamps. A detector was placed between the lamp and the CT, facing towards the CT. Distance-varied measurements revealed that when the white CT was replaced with a black CT, the reflected light received by the detector was reduced by approximately 80% in UV-A and 75% in UV-B. This significant reduction in reflected UV radiation provided our justification in replacing all white CTs above our phototherapy cabinets with black CTs.

Our phototherapy area consists of four phototherapy cabinets (1-4), which are: 1) *UVA Waldmann-UV5040AL*, 2) NB-*UVB Waldmann-5000* 3) NB-*UVB Daavlin Neolux* and 4) *UVA1 Waldmann*-7001 *(see Fig-1A).* We measured the maximum irradiance at a height of 163 cm within the demarcated area with both white and black CTs and compared results. Time to reach the ELV for UVA to the eye (H_{UVA} = 10,000 mJcm^{-2}) and for actinic UV (H_{eff} = 3 mJcm^{-2}) were then calculated.

For UVA cabinets (1 and 4) the highest irradiance values E_{UVA} were 1) 208.2 µW/cm^2 and 4) 255.5 µW/cm^2. Referring to ICNIRP guidelines[8], the time to maximum exposure t_{ME} was then calculated as $t_{ME} = H_{UVA}/E_{UVA}$ giving 1) 80 minutes and 4) 65 minutes. Similarly, for UVB cabinets (2 and 3) the highest effective irradiance values E_{eff} were 2) 1.43 µW/cm^2 and 3) 1.29 µW/cm^2. The time to maximum exposure was 2) 35 minutes and 3) 39 minutes.

After replacing white CTs with black CTs (*see Fig-1B*) the new time to maximum exposure for cabinets 1-4 were calculated as 1) 10.9 hours, 2) 5.6 hours, 3) 5.8 hours, and 4) 5.4 hours, *see Fig-1C*. These were calculated due to reductions in reflected irradiance of 1) 87.7%, 2) 89.6% 3) 88.9% and 4) 81.2%, giving an average reduction of 87% ± 3.3 per phototherapy cabinet, *see Fig-1D*. We attribute the minor variations between cabinets to slight differences in the physical surroundings providing variations in reflective surfaces.

Given ceiling tiles in hospital areas are subject to replacement due to wear and tear, there were already protocols in place for doing so, meaning the entire process of changing to black

tiles was completed by our estates team within an afternoon, and was scheduled for minimal disruption to our clinic. Though it was not possible to execute any blinding in our experiments, we are satisfied with the demonstrable cut-down in UV-exposure.

Black ceiling tiles have been shown to be a very effective engineering control measure that exemplifies the ALARP principle, increases compliance with CAORWR 2010 and reduces the reliance on PPE. We recommend that other clinics with similar stray-radiation issues adopt this simple, low-cost, and effective strategy of ceiling-tile replacement to protect both staff and patients from unwanted UV-exposure.

Acknowledgements:

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Figure legends

Figure 1. a) Our phototherapy cabinets (1 - 4) with white ceiling tiles, and b) with black ceiling tiles. c) Shows the number of hours to reach the ELV for white and black tiles. d) shows the percentage reduction of reflected stray UV light from black tiles after replacing the white tiles.

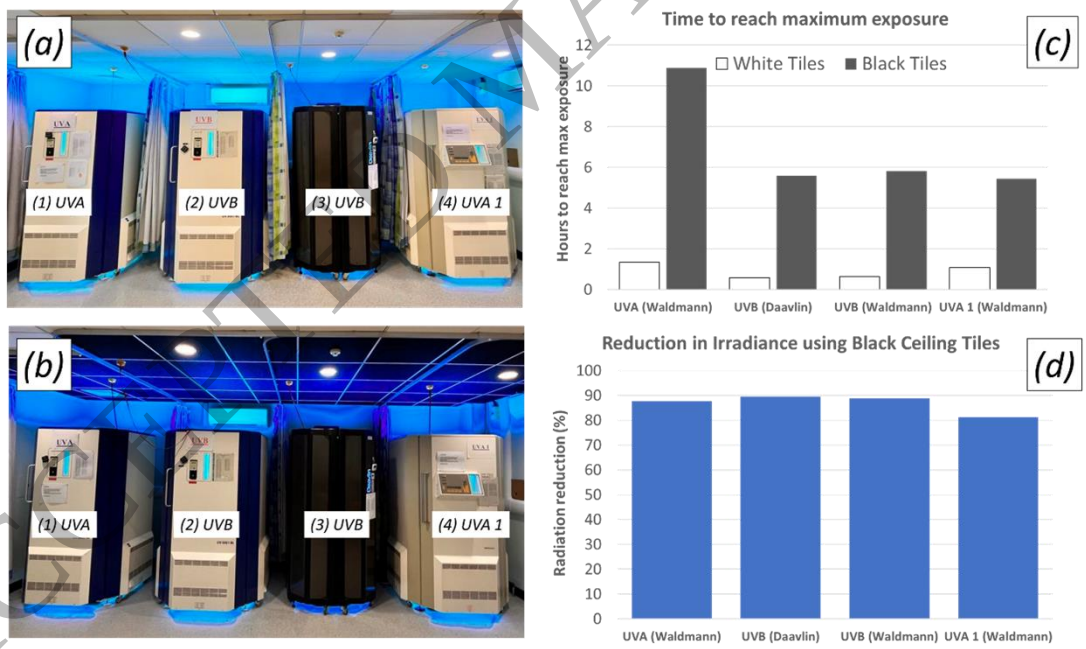

Figure 1
145x85 mm (DPI)

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*SOTYKTU was studied in two global, Phase 3, randomised, multi-arm clinical studies: POETYK PSO-1 and PSO-2. **PASI 75 and sPGA 0/1 vs. placebo at Week 16 were co-primary endpoints.** PASI 75 was defined as ≥75% reduction from baseline in the Psoriasis Area and Severity Index. sPGA was defined as sPGA score of 0 or 1 with ≥2-point improvement from baseline. N numbers: PSO-1: SOTYKTU (n=332); apremilast (n=168), placebo (n=166); PSO-2: SOTYKTU (n=511); apremilast (n=254), placebo (n=255). SOTYKTU delivered superior PASI 75 response rates vs placebo (PSO-1: 58.4% vs. 12.7%, p<0.0001; PSO-2: 53.0% vs. 9.4%, p<0.0001) at Week 16, and superior results achieving clear or almost clear skin (sPGA 0/1) vs. placebo (PSO-1: 53.6% vs. 7.2%, p<0.0001; PSO-2: 49.5% vs. 8.6%, p<0.0001) at Week 16 (co-primary endpoints).[2,3]

†Via enzyme inhibition, enzyme induction, or transporter inhibition.[1]

Abbreviations: AE, adverse event; DDI, drug–drug interaction; PASI, Psoriasis Area and Severity Index; sPGA, static Physician's Global Assessment; TYK2, tyrosine kinase 2.

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Job code: 1787-GB-2300026 Date of preparation: September 2023

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Great Britain

Consult Summary of Product Characteristics (SmPC) before prescribing. **This medicinal product is subject to additional monitoring. This will allow quick identification of new safety information.**

PRESENTATION: Film-coated tablet containing 6 mg of deucravacitinib.

INDICATION: Treatment of moderate to severe plaque psoriasis in adults who are candidates for systemic therapy.

DOSAGE AND ADMINISTRATION: Treatment should be initiated under the guidance and supervision of a physician experienced in the diagnosis and treatment of psoriasis. Posology: 6 mg orally once daily. If a patient shows no evidence of therapeutic benefit after 24 weeks, treatment discontinuation should be considered. The patient's response to treatment should be evaluated on a regular basis. Special populations: *Elderly:* No dose adjustment is required in elderly patients aged 65 years and older. Clinical experience in patients ≥ 75 years is very limited and deucravacitinib should be used with caution in this group of patients. *Renal Impairment:* No dose adjustment is required in patients with renal impairment, including end stage renal disease (ESRD) patients on dialysis. *Hepatic impairment:* No dose adjustment is required in patients with mild or moderate hepatic impairment. Deucravacitinib is not recommended to be used in patients with severe hepatic impairment. *Paediatric population:* The safety and efficacy of deucravacitinib in children and adolescents below the age of 18 years have not yet been established. No data are available. Method of administration: For oral use. Tablets can be taken with or without food. Tablets should be swallowed whole and should not be crushed, cut, or chewed.

CONTRAINDICATIONS: Hypersensitivity to the active substance or to any of the excipients (see SmPC). Clinically important active infections (e.g. active tuberculosis).

WARNINGS AND PRECAUTIONS: Infections: Treatment should not be initiated in patients with any clinically important active infection until the infection resolves or is adequately treated. Caution should be exercised when considering the use in patients with a chronic infection or a history of recurrent infection. Patients treated with deucravacitinib should be instructed to seek medical advice if signs or symptoms suggestive of an infection occur. If a patient develops a clinically important infection or is not responding to standard therapy, monitor carefully and deucravacitinib should not be given until the infection resolves. Pre-treatment evaluation for tuberculosis (TB): Prior to initiating treatment with deucravacitinib, patients should be evaluated for TB infection. Deucravacitinib should not be given to patients with active TB. Treatment of latent TB should be initiated prior to administering deucravacitinib. Anti-TB therapy should be considered prior to initiation of deucravacitinib in patients with a past history of latent or active TB in whom an adequate course of treatment cannot be confirmed. Patients receiving deucravacitinib should be monitored for signs and symptoms of active TB. Malignancies*: Malignancies, including lymphomas and non-melanoma skin cancer (NMSC), were observed in clinical studies with deucravacitinib. Limited clinical data are available to assess the potential relationship of exposure to deucravacitinib and the development of malignancies. Long-term safety evaluations are ongoing. The risks and benefits of deucravacitinib treatment should be considered prior to initiating patients**. Major adverse cardiovascular events (MACE), deep venous thrombosis (DVT) and pulmonary embolism (PE)*: An increased risk was not observed in clinical trials with deucravacitinib. Long-term safety evaluations are ongoing. The risks and benefits of deucravacitinib treatment should be considered prior to initiating patients**. Immunisations: Consider completion of all age-appropriate immunisations according to current immunisation guidelines prior to initiating therapy. Use of live vaccines in patients being treated with deucravacitinib should be avoided. Excipients: Contains lactose. Patients with rare hereditary problems of galactose intolerance, total lactase deficiency or glucose galactose malabsorption should not take this medicinal product. Contains less than 1 mmol of sodium (23 mg) per tablet, essentially 'sodium-free.' *serious. **It is not known whether tyrosine kinase 2 (TYK2) inhibition may be associated with the adverse reactions of Janus Kinase (JAK) inhibition. In a large randomised active-controlled study of a JAK inhibitor in rheumatoid arthritis (RA) patients 50 years and older with at least one additional cardiovascular risk factor, a higher rate of malignancies (particularly lung cancer, lymphoma and NMSC), a higher rate of MACE (defined as cardiovascular death, non-fatal myocardial infarction and non-fatal stroke), and a dose dependent higher rate of venous thromboembolism (including DVT and PE) were observed with a JAK inhibitor compared to TNF inhibitors.

INTERACTIONS: Deucravacitinib does not have any known clinically relevant drug interactions. Refer to SmPC for full details.

PREGNANCY AND LACTATION: Pregnancy: There is a limited amount of data on the use of deucravacitinib in pregnant women. As a precautionary measure, it is preferable to avoid the use of deucravacitinib during pregnancy. Breast-feeding: It is unknown whether deucravacitinib/metabolites are excreted in human milk. A risk to the newborns/infants by breast-feeding cannot be excluded. A decision must be made whether to discontinue breast-feeding or to discontinue/abstain from deucravacitinib therapy taking into account the benefit of breast feeding for the child and the benefit of therapy for the woman. Fertility: The effect of deucravacitinib on human fertility has not been evaluated.

UNDESIRABLE EFFECTS: The most commonly reported adverse reaction is upper respiratory infections (18.9%), most frequently nasopharyngitis. The longer-term safety profile of deucravacitinib was similar and consistent with previous experience. Very common (≥ 1/10): Upper respiratory infections*** (including nasopharyngitis, upper respiratory tract infection, viral upper respiratory tract infection, pharyngitis, sinusitis, acute sinusitis, rhinitis, tonsillitis, peritonsillar abscess, laryngitis, tracheitis, and rhinotracheitis). Common (≥ 1/100 to < 1/10): Herpes simplex infections*** (including oral herpes, herpes simplex, genital herpes, and herpes viral infection), Oral ulcers (including aphthous ulcer, mouth ulceration, tongue ulceration, and stomatitis), Acneiform rash (including acne, dermatitis acneiform, rash, rosacea, pustule, rash pustular, and papule), Folliculitis and Blood creatine phosphokinase increased. Uncommon (≥ 1/1,000 to < 1/100): Herpes zoster***. Refer to SmPC for full details on adverse reactions.

***serious adverse drug reaction

LEGAL CATEGORY: POM

MARKETING AUTHORISATION NUMBER and BASIC NHS PRICE: PLGB 15105/0179: Carton of 28 film-coated tablets 6 mg NHS price: £690.00; Carton of 84 film-coated tablets 6 mg NHS price: £2070.00.

MARKETING AUTHORISATION HOLDER: Bristol-Myers Squibb Pharma EEIG, Plaza 254, Blanchardstown Corporate Park 2, Dublin 15, D15 T867, Ireland.

FOR FURTHER INFORMATION CONTACT:

medical.information@bms.com or 0800 731 1736 (Great Britain).

DATE OF PREPARATION: May 2023

ADDITIONAL INFORMATION AVAILABLE ON REQUEST

Approval code: 1787-GB-2300080

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DATE OF PREPARATION: June 2023

ADDITIONAL INFORMATION AVAILABLE ON REQUEST

Approval code: 1787-IE-2300001

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