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Skin cancer and welding

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Summary

Many workers in several different occupations can be exposed to ultraviolet radiation (UVR), which may increase their risk of developing skin cancer. Welding, an occupation employing an estimated 11 million people worldwide, is one such occupation. Welders are known to be exposed to the full spectrum of UVR from the welding arc and often experience burns and localized cutaneous erythema. In 2017, UVR from welding was classified as carcinogenic to humans based on sufficient evidence of ocular melanoma in humans. It has been hypothesized that exposure to UVR from the welding arc also may increase the risk of skin cancer among workers in this occupation. This review summarizes the current literature on skin cancer risk in welders.

Ultraviolet radiation exposure in welding

Ultraviolet (UV) radiation (UVR) is a known risk factor for the development of skin cancer. Both squamous cell carcinoma (SCC) and basal cell carcinoma (BCC), which are the nonmelanoma skin cancers (NMSC), classically arise in sun-damaged areas of skin.[1] The International Agency for Research on Cancer (IARC) classified UVR as Group 1 or 'carcinogenic to humans' in 2012 and specifically classified UVR from arc welding as Group 1 in 2017.[2,3] There are three types of UVR: UVA (400–315 nm), UVB (315–280 nm) and UVC (280–100 nm). While UVA represents the majority of UVR to which humans are exposed, it penetrates deeper into the skin than other forms, which may make it less likely to lead to skin cancer. UVA, however, is known to cause skin ageing.[4–6] By contrast, although UVB is thought to account for only 2% of human solar UVR exposure, this type of UVR is considered more damaging to DNA and cells than UVA, and UVB exposure leads to skin erythema and skin cancer.[6] UVC may be the most dangerous form of UVR, although it is prevented from reaching the Earth's surface.[1,7] However, humans can be exposed to UVC from artificial and occupational sources such as welding.[8,9]

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It is estimated that more than 110 million workers across the world are subject to some form of welding-related exposure, whether they are full-time welders or employed in other industries such as construction, farming, ship-building or vehicle servicing.[3,10] Welders are exposed to a number of direct hazards including high heat and radiation, as well as respiratory, cardiovascular and reproductive hazards through inhalation of carcinogenic welding fumes. Dermal toxicity from welding-associated UVR is also a concern. While the association between welding and the development of skin cancer has been infrequently studied, ocular melanoma is a well-known risk of UVR exposure from weld- ing.[3] It is known that welders are exposed to the full UV spectrum, including UVA, UVB and UVC radiation, artificially from the welding arc.[8,9] Notably, the UVR from the welding arc can result in erythema of unprotected areas of the welder's skin, particularly in the head and neck region,[10] and many welders also experience burns from radiation or flying sparks and hot metal.[11] The severity of such erythema or burns depends on factors such as distance from the source, susceptibility of the host, use of protective clothing, exposure time and wavelength. The type of welding performed also effects how much UVR is produced. Gas metal arc welding is believed to produce the most UV, whereas plasma arc welding produces the least, and more UV is produced when argon rather than carbon dioxide or helium is used as a shielding gas.[10–13] The presence of metals such as chromium, nickel, zinc, cobalt, cadmium, molybdenum and tungsten in welding fumes can sensitize the skin to UVR. UVR can also reflect off painted walls and ceilings and be harmful to welders even with protective devices in place to block the welding light. Workplaces should use paints with high concentrations of titanium dioxide and low concentrations of metallic particles, as these cause less UV reflection. Many welders also work outdoors, which may increase their exposure to solar UV.[14] Despite the potential increased exposure to UVR, whether welders are at increased risks of skin cancer is debatable.

Skin cancer risk in welders

We performed a literature search in October 2017 using the PubMed database. The key terms used for the search included 'welding', 'skin cancer', 'melanoma', 'basal cell', 'squamous cell', 'actinic keratosis', 'ultraviolet' and 'radiation'. All relevant articles printed in English were considered for this review.

Eight case reports were found in relation to skin cancer in welders (Table 1), all of which concerned NMSC in welders. We did not find any reports regarding nonocular melanoma in welders. Not all of the eight case reports provided details on welder skin type or duration of exposure. However, in reports where this information was provided, all welders had Fitzpatrick I, II, or III skin type and had spent at least 10 years working as a welder. Their ages ranged from 44 to 80 years, with a mean age of 60 years. Four case reports indicated that the welder or an assistant had not worn proper protective clothing such as shields and gloves.[15-18]

In addition, five case-control studies have been published concerning the potential link between welding and skin cancer (Table 2).[9,19-22] Four of the five studies did not find an increased prevalence of skin cancer in welders. The most recent case-control study was by Heltoft *et al.*,[9] and is the largest and longest case- control study investigating the risk of skin

cancer in welders. Unlike in earlier studies, Heltoft *et al.*[9] found a significantly increased risk of BCC in the head and neck region of welders compared with controls [hazard ratio (HR) = 2.49 (95% CI 1.03–5.99) for welders exposed for > 20 years; HR = 2.46 (95% CI 1.02–5.94) for welders exposed for > 30 years]. However, they found no support for the hypothesis that welding increases skin cancers at other sites (HR = 0.99; 95% CI 0.941.04)]. The strengths of that study, particularly in comparison with earlier reports, include using a cohort of 4333 metal arc welders followed up for 25 years with little or no loss to follow-up. The cohort of welders in the study was also larger than that of any other study; Emmet *et al.* investigated 158 workers, Zamanian *et al.*[19] investigated 200 workers and Bajdik *et al.*[21] investigated 225 workers with welding exposure. Suarez *et al.*[20] grouped leather workers, welders, electricians and glass workers together in their analysis of skin cancer, so it is unknown how many workers actually had a definite welding-related exposure.

Additionally, it is known that NMSC predominately develops in older individuals.[1] In the study by Emmett *et al.*,[22] the mean age of welders was 43 years. Similarly, Zamanian *et al.*[19] found no significant differences in skin cancers in welders vs. nonwelders, yet the mean age of welders in their study was only 36 years. The patient populations in these studies may have been too young to appropriately investigate skin cancer risk. Importantly, the study of Heltoft *et al.*[9] was the only one to investigate skin cancers at different body sites, rather than skin cancer in general. However, that study also had a number of limitations that the authors addressed. Notably, they did not observe a clear dose-response relationship, and the number of cases in each subgroup based on location (such as the neck) were small, limiting the statistical power and increasing the likelihood that the elevated risk is merely incidental. In addition, they did not account for welder skin type, eye colour, number of freckles, time spent outdoors or indoors welding, time spent outdoors for leisure activities, and whether safety precautions were taken when in the sun. These could all be potential confounders that on their own could account for increased skin cancer risk. While earlier studies addressed some of these potential confounders, no study accounted for all of them. In addition, no studies have investigated only one specific type of welding (such as mild steel, stainless steel, copper-nickel), probably because most welders perform numerous different types of welding in their careers, making it difficult to investigate welding type and skin cancer risk.

Summary, recommendations and conclusions

Many factors complicate the findings from the limited number of studies investigating skin cancer in welders. Environmental exposure including radiation from other sources, time spent outdoors, length of time welding and type of welding performed, as well as personal factors such as family history of skin cancer, skin type, and use of personal protective equipment (PPE) and sunscreen, can affect skin cancer risk. Given these difficulties and the limited number of reports published on this topic, a definitive link between welding and increased risk of skin cancer cannot be proven at this time. The American Welding Society recommends the use of helmets, gloves and safety glasses to protect welders from UVR, as well as screens or curtains to protect bystanders. However, some reports have indicated that welders do not always wear proper PPE because the work environment is hot and uncomfortable, and the equipment can seem more of a hindrance than help.[8] Increased engineering controls, promoting regular use of sunscreen when outdoors and developing

more comfortable PPE could further protect welders. Nevertheless, future studies, including controlled animal studies to investigate UVR exposure from welding, are needed to better determine the risk of skin cancer in welders.

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CPD questions

Learning objective

To review the effects of ultraviolet radiation and dermatological hazards faced by welders.

Question 1: Which of the following statements concerning ultraviolet (UV) radiation (UVR) is true?

- **(a)** Gas metal arc welding produces the least UVR, whereas plasma arc welding produces the most.
- **(b)** UVB exposure causes skin ageing, whereas UVA exposure causes skin cancer.
- **(c)** UVC exposure is not a hazard to humans because it is prevented from reaching the Earth's surface.
- **(d)** UVR is classified as a Group 2B risk by the International Agency for Research on Cancer (IARC).
- **(e)** Welders are exposed to the full spectrum of UVR (UVA, UVB and UVC).

Question 2: Which of the following types of melanoma is a welder at greatest risk of developing?

- **(a)** Acral lentiginous melanoma of the palm.
- **(b)** Lentigo maligna of the face.
- **(c)** Mucosal melanoma.
- **(d)** Ocular melanoma.
- **(e)** Superficial spreading melanoma of the neck.

Question 3: Which of the following actions can reduce a welder's exposure to ultraviolet radiation (UVR)?

- **(a)** Applying paints in the workplace with a high con¬centration of metallic particles and a low concentration of titanium dioxide.
- **(b)** Removing shields and curtains from a welder's workplace.
- **(c)** Switching from argon to helium as a shielding gas.
- **(d)** Using high UVR-reflecting paints on the walls of a welding workplace.
- **(e)** Welding exclusively with chromium, nickel, zinc, cobalt or cadmium.

Question 4: Which of the following statements concerning skin cancer or melanoma in welders is true?

- **(a)** Broad-spectrum ultraviolet (UV)A and UVB sunscreen provides adequate protection against UV radiation for welders.

(b) Personal protective clothing does not seem to mitigate skin cancer risk in welders.

(c) The International Agency for Research on Cancer (IARC) has classified ultraviolet radiation (UVR) from welding as carcinogenic to humans based on sufficient evidence of ocular melanoma in welders.

(d) Welders are at increased risk of skin cancer at all body sites.

(e) Welder skin type and age do not appear to affect skin cancer risk.

Question 5: Which of the following conditions is a proven derma-tological hazard to welders?

(a) Burns from flying metal, sparks or radiation.

(b) Erythroderma from the welding arc.

(c) Folliculitis from exposure to contaminated work materials.

(d) Head and neck melanomas from ultraviolet radiation.

(e) Hyperhidrosis from hot working conditions.

Instructions for answering questions

This learning activity is freely available online at http://www.wileyhealthlearning.com/ced Users are encouraged to

- Read the article in print or online, paying particular attention to the learning points and any author conflict of interest disclosures
- Reflect on the article
- Register or login online at http://www.wileyhealthlearning.com/ced and answer the CPD questions
- Complete the required evaluation component of the activity

Once the test is passed, you will receive a certificate and the learning activity can be added to your RCP CPD diary as a self-certified entry.

This activity will be available for CPD credit for 2 years following its publication date. At that time, it will be reviewed and potentially updated and extended for an additional period.

Learning points

- UVR is a known risk factor for skin cancer.
- In certain occupations, workers may be exposed to nonsolar sources of UVR, which could increase skin cancer risk.
- UVR from welding is known to increase the risk of ocular melanoma, thus welders or workers with a history of UV exposure should receive regular ophthalmology examinations.

- Absence of PPE may increase UV exposure and increase skin cancer risk, thus welders should receive adequate training concerning the derma-tological hazards of their occupation and take necessary precautions to minimize UV exposure and potentially lower their skin cancer risk.
- Physicians should consider occupational exposure to UVR and counsel patients to wear appropriate protective clothing and sunscreen, not just during outdoor leisure activities but also during outdoor work and when exposed to nonsolar occupational sources of UVR.
- The limited research concerning risk of skin cancer in welders is currently inconclusive and contradictory, and controlled animal studies are needed to better evaluate any potential increased risk of skin cancer in welders.

Table 1

Case reports in the literature on nonmelanoma skin cancers occurring in welders. While the link between ocular melanoma and welding is well-established, no reports on welding and nonocular melanoma have been published on PubMed.

Reference	Skin cancer type	*n*
Currie and Monk, 2000[16]	Basal cell carcinoma	3
Donoghue and Sinclair, 1999[17]		1
Ewing *et al.,* 1971[23]		1
Goetze and Elsner, 2014[24]		1
Ratner *et al.,* 2001[25]		1
Currie and Monk, 2000[16]	Squamous cell carcinoma	2
Wolfe *et al.,* 2013[18]		1
Caroe TK *et al.,* 2013[26]	Unknown or mixed types	5
Dixon *et al.,* 2007[15]		1

Table 2

Case-control studies in the literature investigating non-melanoma skin cancer risk in welders.

Reference	Cohort size, *n* *		Increased skin cancer in welders?
	Exposed	Unexposed	
Emmett *et al.,* 1981[22]	158	58	No
Bajdik *etal.,* 1996[21]	225	586	No
Zamanian *etal.,* 2015[19]	200	200	No
Suarez *et al.,* 2007[20]	Unknownt †		No
Heltoft *et al.,* 2017[9]	4333	512 057	Yes

No controlled animal studies have been reported on PubMed.

* Exposed refers to workers ever employed as welders or having a welding-related exposure, while unexposed refers to workers never having a known welding-related exposure;

† the exact cohort size in Suarez *et al.* is unknown as they grouped leather workers, welders, electricians and glass workers together in their analysis of skin cancer.