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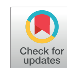
Occupational Dermatoses Related to Personal Protective Equipment Used During the COVID-19 Pandemic



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KEYWORDS

• COVID-19 • Personal protective equipment • Allergic contact dermatitis • Irritant contact dermatitis • Seborrheic dermatitis • Rosacea • Acne • Mask dermatitis

KEY POINTS

- There has been a significant increase in prevalence of reported occupational dermatoses due to the enhanced infection prevention measures adopted by both health care workers and the general public in response to the COVID-19 pandemic.
- Irritant contact dermatitis is the most common occupational dermatitis reported and most often due to excessive hand washing and wearing of facial personal protective equipment such as masks and respirators.
- Gentle skin care, adequate moisturizing, and strategies to alleviate pressure are important preventative strategies for occupational dermatoses related to personal protective equipment.

INTRODUCTION

The outbreak of Coronavirus disease of 2019 (COVID-19) began in December 2019 in Wuhan, China[1] due to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2).[2,3] The first confirmed case in the United States (US) was reported on January 20th, 2020,[2] and on March 11th, 2020 the World Health Organization declared COVID-19 as a global pandemic.[4] By the end of 2020, there were 2 million reported cases and 345,000 deaths in the US due to COVID-19.[5]

SARS-CoV2 spread quickly due to its multiple modes of transmission: contact, droplet, and airborne transmission.[6] The Centers for Disease Control (CDC) released guidelines emphasizing the importance of wearing a facemask, handwashing, and disinfecting surfaces,[7] which led consumers and hospitals to stock facemasks, gloves, disinfectants, detergents, soaps, and hand sanitizers. In addition, the CDC guidelines for proper use of personal protective equipment (PPE) to protect health care workers (HCWs) recommended the routine use of N95 respirators, surgical masks, isolation gowns, eye protection (goggles or face shields), and gloves.[8]

Prolonged wearing of PPE, frequent handwashing, and disinfecting of surfaces have resulted in an increased number of skin complaints in both HCWs and non-HCWs. One study surveyed 542 HCWs and 97% reported skin damage caused by enhanced infection-prevention during the COVID-19 outbreak.[9] The associated dermatoses include allergic contact dermatitis (ACD), irritant contact dermatitis (ICD), seborrheic dermatitis (SD), acne, and rosacea. In this review, the incidence and diagnosis of PPE-associated occupational dermatoses in both HCWs and non-HCWs as well as recommendations for the prevention and treatment of these dermatoses are also discussed.

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COMMON TYPES OF OCCUPATIONAL DERMATITIS

ACD and ICD are the 2 most common causes of occupational dermatitis. According to the American Academy of Dermatology, contact dermatitis (including both ACD and ICD) was the fifth most common diagnosis in the dermatology clinic and costs more than 1.54 billion health care dollars in 2016.[10]

ACD accounts for 20% of occupational contact dermatitis cases.[11] ACD is a biphasic type IV delayed type hypersensitivity reaction that develops in response to contact allergens such as preservatives (formaldehyde), dyes (disperse blue), and metals (nickel).[12] Acute episodes of ACD can present with edema, erythema, and vesiculation.[11] Chronic ACD can lead to lichenification and fissuring of the skin.[11] Epicutaneous patch testing is the gold standard for the diagnosis of ACD.[11] During the COVID-19 pandemic, ACD has been reported due to PPE and personal care products (soaps, moisturizers, etc.) for the hands, trunk, and face (**Table 1**).[13]

ICD is responsible for 80% of all cases of occupational contact dermatitis.[11] ICD occurs from direct cytotoxic injury to the skin induced by a physical or chemical irritant.[12] ICD may include ulcerations and fissuring at the affected site,[12] with symptoms of pruritis and burning sensation occurring immediately after exposure.[11] ICD has been reported as a result of prolonged wearing of PPE and rigorous and frequent hand washing in the setting of COVID-19 (**Table 2**). Common body areas affected by ICD include the hands and convex surfaces of the face including the nose, ears, and cheeks from facemasks, goggles, and face shields.[19]

SD is a chronic inflammatory skin condition that presents as erythematous patches with greasy, yellow scales most commonly in areas densely populated with sebaceous glands such as the face (nasolabial folds, ears, eyebrows, and central forehead), scalp, chest, back, axilla, and groin.[26] SD is likely due to an overgrowth of the *Malassezia* yeast and subsequent inflammatory reaction elicited by the yeast. It is thought that increased wear of facial PPE provides the ideal temperature and moist environment for *Malassezia* to grow and increases the risk to developing SD (**Table 3**).[27]

Acne vulgaris and rosacea (maskne) are the 2 types of papulopustular eruptions that have been associated with the prolonged use of facial PPE during the COVID-19 pandemic (see **Table 3**).[21,28,34] Acne has 4 pathogenetic factors: the production of excess sebum, follicular epithelial hyperproliferation and plugging, follicular colonization by *Propionibacterium acnes*, and the presence of inflammation.[35] The use of face masks allows for a warm, humid, and occlusive microclimate on the skin, which contributes to the development of acne.[34,36] Rosacea has been seen to a lesser degree in the recent COVID-19 pandemic, although this may be due to underreporting.

Table 1
Reported cases of allergic contact dermatitis due to personal protective equipment and hand hygiene during COVID-19

Authors (Alphabetical), Year Published	Country of Origin	HCWs or Non-HCWs	Number of Patients	Location of Dermatitis	Causative Agent
Aerts et al,[14] 2020	Belgium	HCWs	1	Nose Cheeks	Formaldehyde and 2-bromo-2-nitropropane-1,3-diol (bronopol)
Bothra et al,[15] 2020	India	Both	4	Periauricular	No patch testing—suspected thermoplastic elastomer, rubber, latex
Ferguson et al,[16] 2020	United Kingdom	HCWs	13	Face	Unknown
			30	Hands	Limited patch testing—"rubber accelerators"
Singh et al,[17] 2020	India	HCWs	3	Face	Unknown
Xie et al,[18] 2020	China	Non-HCWs	1	Nasal Bridge Cheeks	Toluene-2,4-diisocyanate, diaminodiphenylmethane, and hexamethylene diisocyanate

Table 2
Reported cases of irritant contact dermatitis due to personal protective equipment and hand hygiene during COVID-19

Authors (Alphabetical), Year Published	Country of Origin	HCWs or Non-HCWs	Number of Patients	Location of ICD	Cause of Irritant Contact Dermatitis
Alluhayyan et al,[20] 2020	Saudi Arabia	HCWs	Not specifically reported 200	Nasal bridge Cheeks Ears Hands Wrists Forearms	Pressure from goggles and facemasks Chemicals from hand cleansers, disinfectants, and natural rubber/latex gloves
Bothra et al,[15] 2020	India	Both	5	Retroauricular	Mask straps (thermoelastic polymer, latex) Dyes and disinfectant use on masks
Chaiyabutr et al,[21] 2020	Thailand	Non-HCW	Not specifically reported	Face	Multilayer surgical masks leading to occlusion; N95 mask borders leading to abrasion
Ferguson et al,[16] 2020	United Kingdom	HCWs	69 110	Face Hands	Pressure from fitted mask and length of mask worn Chemicals from Clinell wipes (GAMA Healthcare, Watford, UK), benzalkonium chloride
Hu et al,[22] 2020	China	HCWs	58 54 37	Face Nasal bridge Ears Hands Body	Pressure from N95 respirators Latex gloves Disposable gowns worn 10 h daily for 3.5 mo
Kiely et al,[23] 2020	Ireland	HCWs	26.28% 76.43% *223 total HCW—some complained of facial and hand dermatitis	Forehead Nose Cheeks Hands	Length of use of facial PPE Excessive handwashing
Metin et al,[24] 2020	Turkey	HCWs	194 782 200	Face Hands Body	Excessive face washing Excessive hand hygiene Excessive glove use Excessive daily showering

(*continued on next page*)

Table 2
(*continued*)

Authors (Alphabetical), Year Published	Country of Origin	HCWs or Non-HCWs	Number of Patients	Location of ICD	Cause of Irritant Contact Dermatitis
Singh et al,[17] 2020	India	HCWs	28	Forehead Temple Ears Eyelids/canthus Cheeks and chin Nasal bridge Lips/mouth	Duration of wear and fitting of goggles, N95 respirators, and face shields
Techasatian et al,[25] 2020	Thailand	Both	454	Ears Face	Physical/frictional from ear straps and pressure from face masks

Rosacea can be clinically characterized as transient erythema, telangiectasias, and inflammatory papules/pustules.[37] Acne can be distinguished from rosacea due to the presence of comedones.

FACIAL PERSONAL PROTECTIVE EQUIPMENTS

Facial PPE are one of the most important methods to prevent the spread of COVID-19 in the hospitals and the community. Various forms of facial PPE are used, including respirators (eg, N-95), cloth masks, surgical/medical masks, goggles, and face shields that are used by both HCWs and non-HCWs. Previous studies have shown that increased wearing of facial PPE leads to an increased prevalence of ACD, ICD, pressure-related skin injury, and worsening of underlying dermatoses such as acne and rosacea.[9,12,38] Since March 2020, there has been an increase in reported cases of occupational dermatoses related to facial PPE.[32] The type of mask, composition of mask, duration of wear, and underlying skin conditions are all potential factors in the development of occupational dermatoses to facial PPE.

The composition of the facial PPE materials are important to consider in potential cases of occupational dermatitis.[19] ACD to facial PPE has been reported to textile dyes,[39] elastic bands,[12] metal wiring for nosepiece,[40] and formaldehyde[41] that may remain from the manufacturing process of the polypropylene shell. Wearing facial PPE for extended periods of time also increases risk of ICD, pressure-induced dermatitis, and worsening of preexisting skin conditions such as acne and rosacea.[34] In one survey of HCWs, 61.7% experienced worsening of their preexisting skin condition due to wearing facial PPE, and 90.5% of HCWs had reported developing new skin problems related to PPE use.[32] One study showed that cloth facemasks resulted in less adverse skin reactions compared with surgical masks and N95 respirators.[21]

In addition to masks and respirators, goggles and face shields are other common forms of facial PPE used. Reported adverse skin reactions with the use of goggles and face shields include pressure injury, ICD, ACD, urticaria, xerosis, and worsening of preexisting facial dermatoses such as acne and rosacea.[13,42] In one survey, 28% of HCWs complained of eczema and xerosis from the use of masks, goggles, and face shields, most frequently involving the nasal bridge, ears, and periocular region.[24] In another study, the use of surgical masks and goggles for 8 hours or more had led to skin erosions on the forehead, nasal bridge, and zygoma.[43] Skin damage over the nasal bridge was also seen in 87.9% of HCWs who wore goggles for more than 6 hours.[9] Goggles led to 51.92% of facial occupational dermatoses in one study, followed by N95 respirators (30.77%) and face shields (17.31%).[17]

Allergic Contact Dermatitis to Facial Personal Protective Equipment

Cases of ACD to facial PPE reported during the current COVID-19 pandemic are summarized in **Table 1**. The most common causes of ACD due to facial PPE are additives and materials used in the manufacturing of respirators, surgical masks, face shields, and goggles.[40] ACD has been reported to rubber accelerators such as thiurams, carbamates, dialkyl thioureas, and N-isopropyl-N-phenyl-p- phenylendiamine in elastic bands[12] used to secure the facial PPE on the face.[40,44] Facial PPE also contain potentially allergenic metals such as nickel and cobalt in the nose piece

Table 3
Reported cases of seborrheic dermatitis, acne, and rosacea during COVID-19

Authors (Alphabetical), Year Published	Country of Origin	HCWs or Non-HCWs	Number of Patients	Type of Dermatitis	Location of Dermatitis	Treatment/Outcome
Chaiyabutr et al,[21] 2020	Thailand	Non-HCWs	248	Acne	Face	-
Chiriac et al,[28] 2020	Romania	HCWs	1	Papulopustular rosacea	Face	Slight improvement after 2 wk of metronidazole, 1 g/d, twice a day and pimecrolimus 1% 1 h after removal of facemask
Daye et al,[29] 2020	Turkey	HCWs	44	Acne	Face	-
Giacalone et al,[30] 2020	Italy	Non-HCWs	1	Seborrheic Dermatitis	Nose Cheeks Beard	Low-potency steroid for 5 d and pimecrolimus 1% daily for 10 d
			1	Acne	Jaw and chin	Adapalene gel 0.1% and benzoyl peroxide gel 2.5% for 8 wk, zinc gluconate, 175 mg, and nicotinamide, 27 mg, daily for 3 mo
			1	Rosacea	Cheeks	Doxycycline, 40 mg, for 12 wk Treatments provided clinical benefit
Han et al,[31] 2020	China	Non-HCWs	5	Acne	Cheeks and nose	Good response to Adapalene gel 0.1%, +/− face peel with 20% α-hydroxy acid
Hu et al,[22] 2020	China	HCWs	1	Acne	Face	-
Ferguson et al,[16] 2020	United Kingdom	HCWs	16	Seborrheic Dermatitis	Face	-
			26	Acne		
			5	Rosacea		
Metin et al,[24] 2020	Turkey	HCWs	82	Seborrheic dermatitis	Face and scalp	-
			131	Acne/folliculitis	Face	
Singh et al,[17] 2020	India	HCWs	5	Acne	Face	-
Techasatian et al,[25] 2020	Thailand	Both	333	Acne	Face	-
Trepanowski et al,[32] 2020	USA	HCWs	11	Seborrheic dermatitis	Face	-
			79	Acne		
			31	Rosacea		
Veraldi and Angileri,[27] 2020	Italy	Both	20	Seborrheic dermatitis	Face	-
Zuo et al,[33] 2020	China	HCWs	9	Seborrheic dermatitis	Face	-
			44	Acne		
			14	Rosacea		

Abbreviation: HCW, healthcare workers

to mold the mask to the wearers' face.[12,40,44] Textile dyes in surgical or cloth masks have also been reported to lead to ACD.[39] Furthermore, formaldehyde used in the manufacturing of surgical masks and N95 respirators may still remain in the final product and have been reported to cause ACD.[14,18,41,45] Other preservatives with potential to induce ACD due to facial PPE include methyldibromoglutanitrile,[40] 2-bromo-2-nitropropane-1,3-diol,[14] toluene-2,4-diisocyanate,[18] diaminodiphenylmethane,[18] and hexamethylene diisocyanate.[18]

The only way to prevent and treat ACD is to avoid the causative allergen, which can be identified via epicutaneous patch testing.[19] Persistent exposure to the allergen can lead to worsening ACD resulting in inappropriate wear or fit of PPE, thereby increasing risk for contracting COVID-19. If avoidance is not possible or the relevant allergen is not identified, effort should be made to treat the cutaneous symptoms until a suitable alternative is found.

Irritant Contact Dermatitis to Facial Personal Protective Equipment

ICD is common with widespread use of facial PPE in both HCWs and non-HCWs. Reported cases of ICD due to facial PPE during the current COVID-19 pandemic is summarized in **Table 2**. One survey compared non-HCWs who wore cloth masks with those who wore surgical masks or N95 respirators.[21] Pruritis was the number one complaint among all facial PPE.[21] There were also more ICD in those who wore facial PPE for more than 8 hours daily.[21] The study revealed that surgical masks had a greater number of adverse skin reactions when compared with cloth masks.[21] A study in China surveyed HCWs who wore N95 respirators for an average of 12 hours a day for 3.5 months; 95.1% reported adverse skin reactions to N95s, including nasal bridge scarring (68.9%) due to pressure from the metal nose piece, facial itching (27.9%), skin damage (26.2%), dry skin (24.6%), and rash (16.4%).[22] These findings were also similar to a study conducted during the 2003 SARS outbreak in Singapore where 307 HCWs were surveyed and 35.5% of those wearing N95 respirators complained of adverse skin reactions, most commonly acne (59.6%), facial itch (51.4%), and rash (35.8%).[34] One group in India noticed an increase of cases in retroauricular dermatitis caused by wearing of cloth or surgical masks and N95 respirators with ear loops (composed of latex or thermoelastic polymer).[15] In 1 month, 14 patients complained of skin pruritis, scaling, and erythema.[15]

Prevention of ICD relies on strategies to alleviate friction and pressure and are outlined in **Table 4**.[19] Hydrocolloid dressings and barrier products made of acrylate, silicon, or dimethicone may be used on areas that are frequently irritated, such as the bridge of the nose, cheeks, and ears.[19] Application of a thin dressing (such as DuoDERM Extra Thin, ConvaTec, Deeside, UK) between the facial PPE and the skin can offer some barrier protection.[19] However, the effect on the seal of N95 is unknown. One recent small study analyzed the effect of 5 barrier protectants on the fit of 3M 1860 N95 respirator (St. Paul, MN). They found fit-testing pass rates ranged from 56% to 88% depending on the skin protectant used; only 36% of their cohort passed with all 5 protectants.[46] Therefore, it is imperative to make sure that these dressings or barrier products do not interfere with the fit and safety of the facial PPE, and refit testing is necessary especially with N95 respirators to ensure a tight seal. To avoid retroauricular pressure-related irritant dermatitis, surgical masks with ear loops can be alternated with masks that tie to the back of the head to limit possible ICD to the tight elastic bands.[19]

A recent study examining ways to maintain skin integrity and prevent skin irritation and injury after the use of N95 respirators found alcohol-free liquid acrylate film and hydrocolloid dressings to be the most effective.[47] A headband face mask may help limit retroauricular irritation and pressure when wearing a mask for a long time.[15] Another way to prevent irritation is to relieve the pressure on the skin by removing the mask for 5 to 15 minutes every 2 to 4 hours if it is safe to do so.[48–50]

Treatment of Facial Personal Protective Equipment–Induced Allergic Contact Dermatitis and Irritant Contact Dermatitis

For all cases of potential ACD or ICD due to facial PPE, avoidance of possible allergen or irritant is preferred. Gentle skin care management such as washing with a fragrance-free, hypoallergenic nonsoap cleanser and applying daily moisturizer are key foundations to prevent xerosis that may increase susceptibility to ACD and ICD.[19] Treatment of facial ACD and ICD include low-potency topical steroids for short periods of time,[11] as prolonged use of topical steroids can increase the risk of periorificial dermatitis, cutaneous atrophy, and striae formation. Nonsteroidal alternatives suitable for long-term use on the face include topical calcineurin inhibitors such as tacrolimus 0.03% or 0.1% ointment, pimecrolimus 1% cream, and crisaborole 2% ointment. Discontinuation of current PPE and switching to a suitable alternative may be necessary in recalcitrant cases.

Table 4
Clinical features and recommendations for the prevention and treatment of dermatoses associated with PPE wear and hand hygiene

	Allergic Contact Dermatitis	Irritant Contact Dermatitis	Seborrheic Dermatitis	Acne	Rosacea
Prevention	Avoidance of known allergen	Use of 100% cotton or less occlusive facemasks alone or under surgical masks (if not in health care setting) Schedule 15-min breaks every 2 h for HCWs wearing facial PPE[51] Use of hydrocolloid dressings, silicon or dimethicone barrier creams, acrylate film at pressure or irritated areas[19,47] Use of daily gentle skin cleansers and moisturizer throughout the day	Use of daily gentle skin cleansers and moisturizer throughout the day If recurrent, can use ketoconazole 2% as shampoo or face wash empirically 2-3x/wk as prevention	Daily gentle cleansing with salicylic acid or benzoyl peroxide Use of noncomedogenic facial products Use of cloth/less occlusive facemasks for the general public[25] Schedule 15-min breaks every 2 h for HCWs wearing facial PPE[51]	Use of daily gentle skin cleansers and moisturizer throughout the day Avoid triggers: extreme temperature, sunlight, spicy food, alcohol, strenuous exercise, acute psychological stressors[52]
Clinical Diagnostic Features	Well-demarcated, intensely pruritic eczematous eruptions; vesicular (acute) or lichenified (chronic)	Acute ICD presents as painful, pruritic, erythematous, edematous lesions with vesicles and bullae[11] Chronic ICD presents as lichenified and hyperkeratotic lesions[11]	Pink patches with greasy white/yellow scale in areas with high concentration of sebaceous glands (nasolabial folds, ears, eyebrows, scalp)[26]	Presence of open and/or closed comedones. Inflammatory lesions such as papules, pustules, nodules, or cysts may also be present[53]	Involvement of the nose, malar, and perioral areas. Involvement of at least one primary and secondary feature. Central facial erythema, flushing, telangiectasia, inflammatory papules/pustules, rhinophyma[54]

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Table 4
(*continued*)

	Allergic Contact Dermatitis	Irritant Contact Dermatitis	Seborrheic Dermatitis	Acne	Rosacea
Diagnostic Tests	Patch testing is the gold standard Skin biopsy can be helpful to differentiate from other dermatoses	Skin biopsy if clinical diagnosis is not possible	Skin biopsy if clinical diagnosis is not possible	Skin biopsy if clinical diagnosis is not possible	Skin biopsy if clinical diagnosis is not possible Presence of *Demodex* mites in follicles[55]
Treatment	Avoid known allergen Localized: topical steroids or calcineurin inhibitors Widespread: systemic corticosteroids or other immunosuppressive therapies	Avoid known irritant Topical steroids or calcineurin inhibitors appropriate for body region	Ketoconazole 2% shampoo/body wash or antifungal cream as needed Low-potency topical corticosteroid or topical calcineurin inhibitors for itching and erythema	Mild - Wash daily with benzoyl peroxide or salicylic acid wash - Topical retinoid (tretinoin, adapalene, tazarotene) - Topical antibiotics such as clindamycin 1% lotion daily Moderate - Follow all recommendations for mild acne and add in oral antibiotics (eg, doxycycline) - For women, combined oral contraceptives and/or oral spironolactone are also appropriate Severe - Consider oral isotretinoin	Mild - Azelaic acid 15%, topical ivermectin 1%, topical metronidazole 0.75% cream or 1% gel, sodium sulfacetamide wash Moderate/severe - Follow all recommendations for mild rosacea and add in oral antibiotics (eg doxycycline) - Consider isotretinoin for severe cases For erythema - Topical brimonidine 0.33% gel - Topical oxymetazoline 1% cream

Seborrheic Dermatitis

Long-term use of facial PPE may increase the skin permeability and temperature, which causes a change in the microbiota allowing *Malassezia* to proliferate and thrive in these conditions leading to worsening SD.[27] During the COVID-19 pandemic, there have been several cases of SD exacerbated by facial PPE (see **Table 3**). A survey identified 37.5% of HCWs whose underlying SD had worsened due to facial PPE.[33] Another study showed 34 new cases of SD in HCWs after the first month of the pandemic and worsening of SD in 47% of HCWs.[24] Wearing facemasks for 6 to 10 hours per day exacerbated SD in 46.5% of patients in one series.[27] Of these patients with worsening symptoms, 75% were men and 35% of them worked in health care settings.[27]

The best method to prevent exacerbation of SD is to cleanse the face with gentle facial cleansers before and after prolonged mask wearing and limit the time of continuous contact with facial PPE if possible.[33] Treatment of underlying SD is also important with antifungal shampoos and creams such as ketoconazole 2% and low-potency topical steroids or calcineurin inhibitors.

Papulopustular Eruption (Acne and Rosacea)

New onset and exacerbation of acne and rosacea on the face occurs frequently due to facial PPE (see **Table 3**). Among HCWs and non-HCWs, acne flares were the biggest complaint with facial PPE (39.9%).[25] The use of facial PPE for extended periods leads to a warm and humid environment under the PPE that can increase the sebum secretion rate and occlude pores, leading to comedone formation predisposing to acne flare-ups.[31] During the 2003 SARS pandemic, 59.6% of HCWs complained of facial acne as one of the most difficult adverse skin reactions to wearing N95 respirators for many hours.[34] The pressure from the close-fitting facial PPE also leads to pilosebaceous duct occlusion, resulting in acne mechanica.[34,36] A survey of 390 HCWs reported that 61.7% had worsening of their skin since the start of COVID-19 pandemic with acne being the most frequently reported.[32] HCWs had more symptoms compared with non-HCWs due to the increased duration of facial PPE worn and the use of N95 respirators.[25] Another study in non-HCWs showed cloth masks led to fewer acne flares compared with surgical masks.[21] It was recommended to decrease the flare ups, non-HCWs should use cloth masks instead of surgical masks.[25] Because of the shortage of surgical masks, many HCWs and non-HCWs would reuse their disposable surgical masks. Compared with those who did not reuse their surgical masks, reusing surgical masks contributed to 1.5× increased risk of adverse skin reactions including acne.[25]

Practicing proper facial skin care is important to help prevent and treat acne and rosacea. Washing with gentle cleansers and, if tolerated, salicylic acid or benzoyl peroxide cleansers is an effective first step in treatment of acne and rosacea.[51] Limiting cosmetics and make up products on the days of extended mask wearing can also be helpful. Application of retinoids such as retinol, adapalene, and tretinoin nightly can aid in follicular turnover preventing acne formation. Moderate-to-severe cases can be treated with systemic antibiotics if necessary.[19,42] Prolong wearing of mask can aggravate existing acne vulgaris,[34,36,44] and taking breaks from the mask 15 minutes every 2 hours can be helpful, if it is safe to do so.[51]

GOWNS

Gowns in the hospital setting provide an additional barrier to protect HCWs from risk of contracting COVID-19 from patients. There are limited reports of occupational dermatoses associated with prolonged wearing of gowns.[45] Gowns that tightly adhere to the skin result in increased friction, moisture, and warmth can increase the risk of developing ICD especially in intertriginous areas such as the axilla, under the breasts, and in the skin folds.[45] In addition, chemicals and dyes used in the manufacturing of gowns including formaldehyde resins and textile dyes can contribute to the development of ICD and ACD.[45] During the SARS pandemic in Singapore, repeated wearing of disposable gowns led to increased complaints of pruritus and dermatitis at the wrists of HCWs.[34] One study found that protective clothing and gowns were the top nonglove PPE responsible for ICD.[44] A study conducted during the COVID-19 pandemic surveyed 61 HCWs who regularly wore disposable protective clothing for 10 hours a day for 3.5 months.[22] In that study, 60.7% of HCWs complained of adverse skin reactions such as dry skin (36.1%), pruritis (34.4%), rash (11.5%), and wheals (3.28%).[22]

HANDS

Because SARS-CoV2 can spread via contact and droplet transmission, proper hand hygiene is essential for decreasing viral transmission.[6] The CDC recommends wearing gloves, washing hands, and the routine use of disinfectant wipes on all contact surfaces to decrease the spread of COVID-19.[7] The US Environmental Protection Agency provides a database to search for effective surface

disinfectants for SARS-CoV2.[56] Disinfectant wipes containing citric acid, ethyl alcohol, hydrogen peroxide, quaternary ammonium, or sodium hypochlorite as the active ingredients are said to have virucidal effects on surfaces.[56,57] Because of these enhanced hygiene practices, there is an increasing prevalence of occupational hand dermatitis.[58] Hands are affected in greater than 80% to 90% occupational contact dermatitis.[59] In HCWs, hand dermatitis is the most prevalent form of occupational dermatitis with greater than 30% of HCWs affected before the current pandemic.[60] The most commonly reported hand symptoms in HCWs during the COVID-19 pandemic were dryness (92.9%), itchiness (50%), and redness (46.4%) mostly due to hand cleansers followed by the use of disinfectants and gloves.[20] Cases of allergic hand dermatitis and irritant hand dermatitis are presented in **Tables 1** and **2**, respectively.

Hand Hygiene

Occupational dermatoses due to excessive hand washing are the most common complaint seen during the COVID-19 pandemic.[9] The CDC recommends frequent handwashing with soap and warm water for 20 seconds.[7] Repeated exposure to water with soaps, detergents, and antiseptic handwashes can affect the pH of the epidermis and negatively affect the skin's structural integrity and protection against the environment.[61] In addition, excessive handwashing can deplete the lipid barrier of the stratum corneum, leading to an increase in transepidermal water loss (TEWL). A damaged stratum corneum can allow irritants and allergens to penetrate the epidermis, ultimately leading to irritant and allergic hand dermatitis.[62] One study showed that handwashing during the COVID-19 pandemic increased the risk of xerosis and eczema by 3.57 times.[24] Another study showed that 74.5% of HCWs complained of skin symptoms, which included dryness, tenderness, itching, and burning due to excessive hand washing.[9] Soaps, detergents, and antiseptic handwashes contain fragrances, surfactants, and preservatives that are potential contact allergens that can also cause ACD.[58]

The CDC recommends the use of hand sanitizers containing at least 60% ethanol or 70% isopropyl alcohol for use by HCWs.[7] Alcohol-based hand sanitizers (ABHSs) are thought to be better in preventing ICD because they often contain emollients and moisturizers, thus resulting in less disruption to the lipid barrier on the skin than hot water, harsh soaps, and detergents.[63] ABHSs with moisturizers are a better alternative to traditional soaps because they have the least sensitizing and irritancy potential with fewer allergens.[64] However, ABHSs has also been implicated in causing skin dryness and subsequent ICD.[64] ABHSs often contain ingredients (fragrances, tocopherol, propylene glycol, benzoates, and cetyl stearyl alcohol) that can also cause ACD.[64,65]

Gloves

Rubber gloves provide an additional layer of protection for HCWs and non-HCWs in preventing viral transmission.[66] Excessive glove use can be harmful to the skin, causing xerosis and hand dermatitis.[34] One study showed that excessive use of gloves can lead to a 2.68 times increased risk of developing xerosis.[24] Long-term use of gloves can also paradoxically lead to overhydration of the stratum corneum, which may lead to maceration and erosion of the skin.[42] One study reported that 88.5% of HCWs wearing rubber latex gloves during the COVID-19 pandemic for an average of 10 hours a day for 3.5 months complained of skin reactions.[22] The symptoms most commonly reported were dry skin (55.7%), itching (31.2%), rash (24%), and chapped skin (21.3%).[22] Frequent moisturizing of the hands and using a cotton glove liner can also decrease the risk of developing irritant hand dermatitis.[20]

Most rubber gloves contain rubber accelerators, such as thiurams, carbamates, diphenylguanidine, mixed dialkyl thioureas, and benzothiazoles, that accelerate the process to synthesize rubber consumer products from its raw material but are leading causes of glove-related ACD.[60,64] The American Contact Dermatitis Society recommends the use of accelerator-free gloves for those with suspected or confirmed hand ACD.[58,67] One study provided HCWs suffering from hand ACD a 1-month supply of rubber accelerator-free gloves, and both disease severity and patient quality of life improved dramatically.[68]

Surface Disinfectants

Because of the indirect contact transmission of COVID-19, disinfecting surfaces multiple times throughout the day has become a habitual practice. Repeated cleaning and use of disinfectants may damage the skin surface and compromise the skin barrier leading to ICD.[69] This exposes harsh chemicals such as N-alkyl dimethyl benzyl ammonium chloride on the skin.[70] Exposure to fat soluble disinfectants such as 75% alcohol, chlorine-based disinfectants, and peroxyacetic acid can lead to ACD and can present with desquamation, rhagades, pruritis, and bleeding.[43] Disinfectant wipes for surface cleaning should not be used directly on the skin. When cleaning

surfaces, proper skin protection such as the use of gloves when handling chemicals is recommended to protect the skin from any injury or direct chemical exposure. Rare cases of ACD have also been documented due to disinfectants. Cases of occupational airborne ACD have been seen from the use of a disinfectant spray containing linalyl acetate[71] and cleaning detergent containing N-alkyl dimethylbenzylammonium chloride and n-alkyl dimethylethylbenzyl ammonium chloride.[70]

If irritant hand dermatitis is suspected, the first step is to avoid the potential irritant whether it is in detergents, gloves, or harsh soaps. Switching to gentle cleansers and regularly moisturizing immediately after can alleviate most cases of hand dermatitis. Use of ABHSs with emollients can be helpful in select cases. Moisturizers that include petrolatum in the form of ointments can serve as a physical barrier and prevent further TEWL. Humectants such as urea and glycerin attract water and moisture to the epidermis.[72] It is recommended that patients apply a thick petrolatum-based emollient nightly to the hands and cover with white cotton gloves before bed, leaving the gloves on until the next morning. Treatment of acute, itchy, irritant dermatitis with potent topical steroids can also help alleviate symptoms through judicious use of potent topical steroids, given the thickness of the stratum corneum on the hands.[58]

Management of patients with allergic hand dermatitis includes identification of the allergen through patch testing and avoidance of the allergen. Potential allergens can be found in soaps, cleansers, gloves, and moisturizers. Avoidance of the allergen is curative in cases of ACD.

SUMMARY

In this review the authors discussed the common types of occupational dermatoses that have been reported due to increased use of PPE and enhanced hygiene practices used by both HCWs and non-HCWs to prevent the spread of COVID-19. They also discussed preventative, diagnostic, and treatment strategies for PPE-related occupational dermatoses. Until an effective vaccine and treatments become available worldwide, the authors will likely continue to see heightened prevalence of PPE-related dermatoses.

CLINICS CARE POINTS

- Irritant contact dermatitis is the most common dermatoses seen due to frequent use of PPE during the COVID-19 pandemic
- Allergic contact dermatitis has been reported to hand washing soaps, moisturizers, alcohol based cleansers, masks, rubber gloves, gowns, etc. Patch testing is key to diagnosis
- Acne, rosacea, and seborrheic dermatitis can occur due to chronic mask wearing as a result of friction, sweating, and perturbation of the microenvironment
- Avoidance of offending PPE and consideration of safe alternatives is essential

DISCLOSURE

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