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Dermatology in COVID-19 Pandemic: A review of manifestation, prevention, and treatment of personal protective equipment adverse skin reactions

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ABSTRACT

COVID-19 poses a new challenge to healthcare workers with a new standard of care and managing COVID-19 patients. Healthcare workers must adhere to stricter hand hygiene, and the new personal protective equipment (PPE) protocol brings forth new problems for healthcare workers. Skin problems have become the most common and preventable adverse effects of the daily and prolonged use of PPE. This could inadvertently cause protocol breaches, such as mask touching, scratching, or off-protocol PPE adjustment. Damage in the skin could also cause discomfort, and skin exposure may serve as a new port of entry for a secondary infection. This study reviewed adverse effects, prevention, and therapy of skin problems related to COVID-19 PPE use.

Keywords: Personal protective equipment, PPE, COVID-19, novel coronavirus, dermatology, skin
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INTRODUCTION

Since declared as a global pandemic by World Health Organizations on 11th March 2020, on the early July 2020, COVID-19 total confirmed cases count had reached 11 million cases. With the world today is globally interconnected, the containment of the virus is becoming a global challenge. Various efforts have been undertaken to curb the number of cases, such as lockdowns, public campaigns on self-hygiene, social distancing, mandatory mask ruling, and travel restrictions.

COVID-19 also presents a new challenge to healthcare. The virus transmission initially was thought only in proximity contact between an infected person facilitated by droplets that come out with cough or sneezes, but a newer study has shown that COVID-19 is also capable of airborne transmission and remains viable on surfaces for days.[1] Therefore, healthcare workers pose a susceptible high risk of infection as the frontline workers in this pandemic. As a new standard of care and managing COVID-19 patients, healthcare workers must apply hand hygiene protocol and the personal protective equipment (PPE) guideline to reduce the risk of virus transmission.[1,2]

Personal protective equipment has proven to reduce the risk of transmission from patients to the healthcare worker.[2] Healthcare workers must adhere to the strict PPE protocol that requires prolonged and regular use of PPE. However, the increase in the frequency of use of PPE brings forth new problems for healthcare workers. Unintended skin adverse effects have become one of the preventable adverse effects of the daily and prolonged use of PPE. Skin problems could inadvertently cause protocol breaches, such as mask touching, scratching, or off-protocol PPE adjustment.[3] For instance, an N95 mask is a standard respiratory protective equipment that often causes skin damage in the nasal bridge area.[4] Damage in the skin can cause discomfort, and skin exposure could serve as a new port of entry for a secondary infection.

Although most PPE-related manifestations are often mild and self-limiting, if overlooked, can increase the risk of healthcare workers in treating COVID-19 patients. Especially when the luxury of off-days and recovery time needed to treat the adverse effects is not necessarily available, prevention measures and prompt treatment to the adverse effect of PPE related skin problems are necessary. In this study, we review various studies regarding the adverse effects, prevention, and therapy of the skin problems that are often found among healthcare workers related to PPE use.

DISCUSSION

Mask

The length duration use of masks has led to a varied

spectrum of dermatologic conditions. From the studies, the mask has been reported to cause contact irritant dermatitis, pressure-related injury, acne, and moisture-associated skin irritation.[3,5] Among the 61 healthcare workers who regularly used the N95 mask, according to Hu *et al.* study, fifty-eight (95.1%) reported adverse reactions.[6] A similar result was also reported in Gheisary *et al.* study, 35.5% of the staff who used N95 masks regularly experienced acne, contact dermatitis, and pigmentation of the nasal bridge, cheeks, and chin. Acne is the most common skin adverse effect related to N95 respirator masks.[7] Commonly reported region of mask adverse reactions are the nasal bridge, cheek, periocular, perioral, and zygomaticus regions.[3,5,8]

Mask-induced contact dermatitis might occur due to adhesives, rubber straps mask, free formaldehyde released from the non-woven polypropylene, and the clip metals material.[5] The soverly tight use of the N95 mask can cause skin damage due to the pressure it caused on the skin. Moisture can accumulate under the mask and predispose the skin breakdown and superinfection of acne vulgaris.[5] Other possible mechanisms of acne are the rupture of comedones caused by the pressure and friction of the mask, occlusion of pilosebaceous duct, microcirculation dysfunction due to the long-term pressure, and humid environment created by the mask, which is conducive to bacteria proliferation that accumulated from prolonged and regular use of a mask to acne.[9,10] Accumulation of mental stress, heavy workload, and sleep deprivation also become a risk factor in causing acne or exacerbate current acne condition.[9]

There are several recommendations to prevent the adverse reaction from mask usage. Face washing twice a day using foamless cleansing products containing a moisturizing agent is recommended to reduce the sustained damage of skin barrier caused by soaps and other alkaline detergents. Using hot water, 75% ethanol or facial cleanser as a face washing regimen is not recommended.[10] A moisturizer containing an oil control agent is recommended at least thirty minutes before and after using a mask to reduce the risk for acne.[10,11] Petrolatum based products are not recommended as the skin sealing or repair agent because they may interfere with the integrity of the mask itself, which contradicting recommendation from Gheisari *et al.* and Yan *et al.,* who recommend applying a topical moisturizer such as petroleum jelly or baby napkin cream before wearing the mask at least 1 hour before using facial PPE.[5,7,10] Alternatively, the application of an alcohol-free barrier film wipe may be used to help protect the skin.[5] Hadjieconomou *et al.* recommend a hydrocolloid dressing to alleviate the pressure on the skin. To ensure the mask efficacy is not compromised by the intervention, a repeat 'fit mask testing' with dressing applied is recommended.[12] Some studies recommend avoiding applying it for face make-up, while some suggest that light make-up is tolerable.[5,9,13] Working in a lower temperature environment is supposedly beneficial because it helps regulate skin oil and moisture.[7] In case there are some allergic reactions to the mask material, adding a surgical mask inside the N95 or applying layers of gauze inside the mask is recommended if other mask material is not available.[6,10]

Mild lesions of contact dermatitis could be treated with topical antibiotics and retinoids. For severe conditions, systemic treatment with minocycline, fluorine-free glucocorticoids, or isotretinoin could be added to the therapy.[9,10] Using a full facepiece respirator mask could be used as a last-resort option if a severe skin reaction persists. The management of acne vulgaris includes; use topical antibiotic creams or benzoyl peroxide for mild papules and pustules and topical retinoids creams for blackhead and whitehead.[10]

Headcap

Headcap is recommended to protect the hair and scalp region. There are various materials of the head cap currently in use. Head caps made from plastic or rubber caps often cause local inflammatory reactions manifested in itching and peeling. In severe conditions, seborrheic dermatitis and a worsening of a pre-existing condition such as psoriasis or atopic dermatitis are documented in some cases. As prevention, healthcare workers recommended washing their heads with mild or balancing shampoo.[13] Furthermore, a short haircut is recommended to ensure the head and scalp region are entirely covered by a surgical cap and reduce the cap's humidity.[10]

Googles

Skin injury also may occur as the result of the continual pressure and friction caused by googles. Googles are the most common culprit agent of dermatoses among healthcare workers.[11] Other frequent skin damages that may occur are indentations, frictions, and scratches.[9] Skin reactions such as acne, allergic contact dermatitis, and irritant contact dermatitis are also reported among health care workers. Google pressure on the skin may cause friction on the skin and may factor as the underlying mechanism of the skin damage. This mechanism is also supported by Gheisary *et al.*, that revealed that 87.9% of healthcare workers, who were wearing goggles for more than 6 hours, developed skin reactions on their nasal bridge while the other commonly affected parts include cheeks, nose, and ear.[7]

Skin emollients, silicone foam dressing, and hydrocolloid dressing are recommended to prevent skin damage. Applying the emollients or dressings could reduce the friction and pressure on the skin before donning a mask and goggles, without any significant effect on google efficacy. Minor skin indentation does not require any specific treatment.[9] Applying topical application of polysulphone mucopolysaccharide cream or heparin cream for persisting and repeated skin indentation may improve local blood circulation and help recover the skin.[3] Antibiotics can be applied topically to prevent secondary infection, and petrolatum gauze is also recommended as the wound dressing to help protect the skin.[9] Overall, google is intended to prevent the transmissible splash from the patient to healthcare workers and avoid overly tight google as it may cause damage to the skin without any increased protection benefit.

Gloves

The frequent hand contact requires healthcare workers to use gloves as the necessary protection. Gloves provide an extra barrier of protection covering fingers, palms, and the wrists area. Because of the prolonged and frequent use of gloves, various skin problems were reported among healthcare workers. From Hu *et al.* study, among sixty-one healthcare workers who regularly use latex gloves, fifty-four (88.5%) reported adverse skin reactions.[6] A new study has shown that long term use of gloves may cause skin maceration as it leads to overhydration of the stratum corneum resulting in softening, whitening, and wrinkling of the skin. Also, the latex gloves material is subject to cause contact or allergic dermatitis, especially in macerated and erosive skin.[9,10] Also, prolonged use of gloves will create an accumulation of sweat, warm and moist environment, which may induce a fungal infection and pompholyx.[6,9]

Choosing the appropriate glove size is instrumental in helping prevent the adverse effect of the gloves. Hand wash is necessary before putting on and after putting off the gloves. After the handwashing procedure, ensure the hand is completely dry before putting on new gloves.[9] Applying topical powder after hand disinfection procedure is recommended to help protect the skin from friction and excessive hydration.[10] Emollients could also be applied regularly after putting off gloves and regularly emphasized when not in direct patient care.[5] Using emollient enriched with hyaluronic acid, ceramide, or vitamin E is recommended to help repair skin damage. Lighter emollients (cream or lotion) are recommended applied during work-hour, while lipid-rich emollients could be applied at off-hour.[12] Although one layer of suitable latex gloves is adequate for skin protection against the possible transmission from direct contact, an extra layer of non-latex gloves inside the latex gloves could be used to prevent contact dermatitis.

For a non-self-limiting maceration, or if subsequent erosion and exudation occur, hydropathic compress with 3% boric acid solution or normal saline or topical use of astringent such as zinc oxide ointment is recommended.[6,10] For tinea infection, topical antifungals are recommended. In some cases of widespread skin lesions or topical-resistant conditions, systemic antifungal drugs could be considered therapy. The topical application of glucocorticoid may be considered the therapy for pompholyx or contact dermatitis.[9,10]

Boots

Boots cover the whole feet region causing skin problems that are similar to gloves. Prolonged use of boots often causes skin maceration that presents as softening, whitening, and wrinkling of the skin or cause pompholyx, or vesicular eczema, which presents as plenty of small blisters symmetrically occurring on hands and feet, and may be accompanied by itching, tingling or burning.[9,10] An increase in the moisture around the feet gives a suitable condition for the fungal infection to manifest on the feet.[14] Recommendations for the adverse skin reaction are also similar to gloves, which focus on ensuring the proper hygiene of the feet, drying of the feet before putting on boots, and applying moisturizers regularly.[10]

Skin injury/diseases cause by disinfectant

As the virus spread becomes more rapidly, hand hygiene is critical to breaking the chain of transmission in the population. Also, in a healthcare setting where regular contact between healthcare workers and patients occurred, hand hygiene is vital in preventing transmission. In a health care setting, hand hygiene procedure should adhere to "two before, three afters"; before touching a patient, before any aseptic procedure (including invasive procedure) is performed, after potential exposure to patient's body fluid, after touching a patient, and after touching a patient's surroundings or items that might be contaminated. In today setting, when PPE is regularly used, extra attention to hand hygiene must also be emphasized on some aspect; (i) before donning on PPE, (ii) before, during, and after donning off PPE, (iii) before leaving PPE donning off area, (iv) before and after defecation, (v) and after arriving home from work.[9,10]

A study showed that 66.1% of healthcare workers in the current pandemic setting washed

Table 1. Dermatoses adverse reaction related to personal protective equipment (PPE) use

PPE	Adverse Reactions	Recommendations	
		Treatment	Prevention
Mask	Acne	Mild: topical antibiotic or benzoyl peroxide Blackhead and whitehead: topical retinoid	Face washing twice a day Avoid hot water, ethanol, facial cleanser A moisturizer containing an oil control agent
	Contact dermatitis	Mild lesion: topical antibiotics + retinoids Severe condition: systemic treatment with minocycline, fluorine-free glucocorticoids, or isotretinoin could be added to the therapy	Additional surgical mask or a layer of gauze inside N95 Hydrocolloid dressing Alcohol-free barrier film
	Pressure-related injury	Full facepiece respirator mask	
Headcap	Seborrheic dermatitis Exacerbations of current psoriasis or atopic dermatitis		Washing head with mild or balancing shampoo Short haircut
Googles	Acne Allergic contact dermatitis Irritant contact dermatitis Skin indentations	Minor: does not require specific treatment Persisting and repeated: topical polysulphone mucopolysaccharide cream or heparin cream Accompanied by wounded skin: antibiotics + petrolatum gauze dressing	Skin emollients Silicone foam dressing Hydrocolloid dressing Avoid overly-tight google
Gloves	Skin overhydration	Non-self-limiting: hydropathic compress with 3% boric acid solution or normal saline or topical use of astringent such as zinc oxide ointment	Ensure appropriate gloves size Hand-drying measure Topical powder after hand disinfection Emollients after putting off gloves An additional extra layer of non-latex glove inside latex gloves
	Contact dermatitis	Topical glucocorticoid	
	Allergic dermatitis	Topical glucocorticoid	
	Fungal infection	Local: topical antifungals for local Systemic: systemic antifungals	
	Pompholyx	Topical glucocorticoid	
Boots	Pompholyx	Topical glucocorticoid	Proper feet hygiene Feet-drying Regular moisturizers
	Fungal infection	Local: topical antifungals for local Systemic: systemic antifungals	
Disinfectant	Skin irritation		Regular moisturizers such as ceramide or petroleum
	Irritant contact dermatitis	Topical corticosteroid Systemic corticosteroid Topical or systemic antibiotics	
	Allergic reaction	Stop and replace the current disinfectant agent Antihistamine Severe rash: mid-strength to potent topical corticosteroid cream Rash with secondary infection: topical or systemic antibiotics	
Gown	Dry skin Urticaria Allergy dermatitis Contact dermatitis		Ensure the appropriate gown size Sufficient hydration

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hands over ten times per day, but only 22.1% applied protective skin measures after washing.[10] An increase in hand hygiene frequency may pose a risk for irritation and contact sensitization and could affect healthcare workers in the health care setting.[5,9] Increased disinfectants use to the skin may damage the lipid layer on the skin surface and undermine the skin barrier, leading to irritant contact dermatitis.[10] Moisturizers such as ceramide or petroleum are recommended to help prevent the adverse effect of disinfectants. For an allergic reaction, it is recommended to stop using the previously disinfectant and replace it with non-allergenic products. A mild rash will improve spontaneously, while significant pruritus could be treated with H1 antihistamine. For severe rashes, mid-strength to potent topical corticosteroid cream is recommended. Rashes with bullae, secondary erosion, and exudates can be treated with short-term systemic corticosteroids (0.5–1.0 mg/kg/day), and rashes with a secondary infection, topical or systemic antibiotics may be benefit.[9]

Gown

Although rare, there is some adverse skin reaction caused by gown prolonged use. According to Hu *et al.* study, thirty-seven (60.7%) healthcare workers reported adverse skin reactions to gown such as dry skin (36.1%), itching (34.4%), rash (11.5%), and wheals (3.28%).[6] Less number was reported in the study by Foo *et al*., which four (1.6%) out of 258 cases developed adverse skin reactions related to the repetitive wearing of disposable gowns for an average time of 6.2 h during a mean period of 8.8 months during the Severe Acute Respiratory Syndrome (SARS) epidemic in Singapore (10). Friction, moisture, and warmth might factor in the risk for allergy dermatitis and contact dermatitis. There were reports of developing Acute Contact Dermatitis in the Toronto SARS epidemic due to the reaction to formaldehyde textiles and resin in gowns.[7] Avoiding over-tight gowns and sufficient hydration is of paramount importance for healthcare workers to prevent the adverse effects of the gown on the skin.

CONCLUSION

COVID-19 pandemic has drastically changed the patient care approach. Improved safety protocol emphasized in hand hygiene, and a new personal protective equipment is introduced. Unfortunately, the increase in duration and frequency of personal protective equipment use has become the leading risk factor for skin damage among healthcare workers. While PPE is undeniably essential in preventing virus transmission, the adverse skin reactions due to PPE should be considered to ensure no protocol breach in providing adequate healthcare in this time of crisis.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHORS CONTRIBUTION

Author IN and SS contribute to searching, collecting, and verifying articles. Author IN design, translate and write the manuscript. Author SS writes, edits, and translates the manuscript.

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