

Occupational skin dermatoses among health care workers: A review of adverse skin reactions to personal protective equipment

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Abstract

Occupational skin-related problems include dermatoses caused by agents in the working environment. For health care workers, these occupational dermatoses could be due to usage of Personal Protective Equipment (PPE), such as gloves, masks, goggles, and other protective equipment. These PPE contribute to both allergic and irritant contact dermatitis. This review summarized the skin damage after PPE usage and hand hygiene protocol. Recommendations should be established to prevent these occupational dermatoses from PPE usage.

Introduction

Occupational dermatoses refer to modifications of skin, mucosa, and annexes due to agents found in the occupational environment and work-related activities. The diagnostic criteria for this type of dermatoses include: area of skin lesions corresponding to exposure, improvement after the exposure is diminished, and recurrence upon re-exposure.¹ For health workers, dermatoses due to usage of Personal Protective Equipment (PPE) are labeled as occupational dermatoses. It is compulsory for health-care workers to wear PPE when taking care of patients during the Coronavirus Disease 2019 (COVID-19) outbreak. The types of PPE include: eye protection (goggles and face shield), mouth and nose protection (masks and respirator), gloves, head cover

(hair cover and hood), foot-wear (closed shoes and rubber boots) and body coverings (coverall and gown). All of these PPE work together to protect health care workers from infection.² In addition, occupational dermatoses also include skin irritation due to hand hygiene protocols which can cause skin alterations. Occupational dermatoses consist of irritant and allergic contact dermatitis, and are commonly called as occupational contact dermatitis. This skin alterations tend to be caused by heat, friction or pressure by physical agents, radiation, sensitizers, strong, acid base, acnegenic agents, and photosensitizers.^{3,4}

A previous study reported that, of all occupational dermatoses, not limited to healthcare workers, the percentage of allergic contact dermatitis was 60% and irritant contact dermatitis was approximately 32%.⁵ However, a study conducted in only the healthcare worker group showed that irritant contact dermatitis had a larger percentage (44.4%) compared to allergic contact dermatitis (16.5%). Results revealed that the most common allergens in this group were nickel, benzalkonium chloride, glutaraldehyde, and rubber chemicals.⁶ Nurses were also exposed to airborne antibiotics, such as cephalixin and ceftiofur, which can cause contact urticaria and airborne contact dermatitis.⁷ However, airborne antibiotics will not be discussed in this paper since during the COVID-19 pandemic, nurses must wear masks and/or face shields which can protect them from this type of occupational dermatoses.

Materials and Methods

Relevant publications related to occupational skin reaction to health care workers were reviewed, via PubMed and Google Scholar databases, with search terms or key words, such as “skin reaction”, “dermatitis”, “health care worker”, “PPE”, “occupational dermatitis”, “health care”. Case report with fewer than 10 patient, duplicates, and review articles were excluded. The authors performed manual selection of relevant titles and abstract. Five notable publications were identified (Table 1).

Hand hygiene

Hand hygiene protocol can be done by washing hands with either an alcohol-based hand sanitizer or soap and water.⁸ For healthcare workers, this protocol is compulsory before and after handling the patients, performing invasive procedures, or having any contact with patients' body fluids,

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blood, bed, and following the collection of samples, and after wearing gloves.⁹ Regarding hand sanitizers, they are avail-

able as gel, foam, or liquid containing an active ingredient which is either ethanol or isopropanol. Other ingredients in hand sanitizers include triclosan, Quaternary Ammonium Compounds (QACs), glycerin, propylene glycol, and polyacrylic acid. It is known that alcohol has the ability to kill organisms by protein denaturation.¹⁰ Hand soap is a hand washing agent containing detergents which eliminate microorganisms and dirt. There are two types of hand soap, which are plain soap or non-antimicrobial, and antimicrobial soap.¹¹ Generally, hand soap contains surfactants, preservatives, and fragrance.¹²

Irritation from both irritant and allergic contact dermatitis have been reported due to performing hand hygiene protocols. Hand hygiene products contain agents which cause protein denaturation in the stratum corneum, decreased skin capacitance and corneocyte cohesion, and intercellular lipid modification. Irritant contact dermatitis is a common complaint of healthcare workers using antiseptic solvents containing iodophor, chlorhexidine, chloroxylenol, triclosan, and alcohol-based products. Allergic contact dermatitis from the routine hand hygiene protocol is frequently caused by fragrances and preservatives.⁹

During the COVID-19 outbreak in Wuhan, China, the hands were the most frequent areas that had adverse skin reactions. This condition was due to the regular hand washing by health care workers which exceeded 10 times per day. Among these workers, less than 25% applied moisturizers after the hand hygiene protocol.¹³ Generally, it is recommended to apply hand creams to maintain the skin hydration.¹⁴ Another study reported similar results that health care workers who washed their hand more than 11 times per day were more prone to have contact dermatitis than the workers who performed hand washing 5 and fewer times per day.¹⁵ In addition, health care workers' exposure to soaps, detergents, and antiseptic was related to the prevalence of occupational irritant contact dermatitis.⁶

Gloves

A previous study showed that 21.4% of health care workers reported skin-related problems after wearing gloves. These gloves-related adverse skin reactions were dry skin, itch, rash, and wheals after using

rubber gloves, whereas no health care workers who used plastic gloves had any complaints about skin problems. The health care workers who had the skin reactions either went to the doctors, took no action, or did self-medication.¹⁶ Another study showed that the total pairs of gloves used per day were correlated with the occurrence of contact dermatitis. The risk to have contact dermatitis increased by 3.22 times in the health care workers who used 5 and more pairs of gloves per day compared to those who used a single pair of gloves per day. It can be assumed that the skin barrier was affected by prolonged occlusive effects of wearing gloves.¹⁵ In addition, protective gloves tended to induce occupational irritant contact dermatitis since the gloves possibly removed the surface lipid layer, thus, causing cellular damage.⁶ It was reported that skin damage was significantly observed in the subjects with the highest mean period of daily glove usage.¹

It was also reported that out of 13.7% of Singaporean health care workers who had adverse skin reaction after wearing gloves, 22.9% of those were sensitized to latex. In this study, the glove-related symptoms were itching, contact urticaria, and hand eczema. Personal and family history of atopy was

Table 1. Notable publication identified.

Publication	Year	Method	Exposure	Location of skin problem	Type of skin problem
Skin damage among health care workers managing coronavirus disease-2019 ³⁶	2019	Self-administered online questionnaires	N95 mask Goggles Face shield Gloves Hand hygiene	Cheeks Nasal bridge Forehead Hands Hands	Dryness/tightness Tenderness Itching Burning/pain
Self-report occupational-related contact dermatitis: prevalence and risk factors among healthcare workers in Gondar town, Northwest Ethiopia, 2018—a cross-sectional study ¹⁵	2018	A structured interviewer-administered questionnaire	Gloves Hand hygiene	Hands	Redness Burning Blisters Itching Dry skin
Adverse skin reactions to personal protective equipment against severe acute respiratory syndrome – a descriptive study in Singapore ¹⁶	2006	Surveyed using questionnaires	N95 mask Gloves Gown	Nosebridge Cheeks Chin Wrist	Acne Itch Dry skin Rash
Short-term skin reactions following use of N95 respirators and medical masks ³⁰	2020	N95 vs surgical mask usage	N95 mask Surgical mask	Face	Redness or erythema Facial indentation
Adverse skin reactions among healthcare workers during the coronavirus disease 2019 outbreak: a survey in Wuhan its surrounding regions ¹³	2020	A cross-sectional questionnaire survey	All PPE and hand hygiene	Hands Cheeks Nasal bridge	Dryness or scales Papules or erythema Maceration
COVID-19 and impact of personal protective equipment use: From occupational to generalized skin care need ⁴¹	2020	Report on health care worker skin consultation	All PPE and hand hygiene	Nasal bridge Hands Cheeks Periocular Perioral regions	Dryness Itching Stinging sensations

higher in sensitized workers compared to those who were not.¹⁷ Allergens in latex are latex proteins, dyes, sensitization materials, and antioxidants.¹ Previous studies also revealed that thiuram mix and carba mix were among the most frequent allergens in health care workers.^{6,18,19} These allergens can be found in the rubber gloves.⁶

Gloves could provide another layer of protection against disinfectants, detergents, soap, and other irritative agents, however, the occlusive effect of gloves can also create skin problems especially hand dermatitis. A previous study investigating the effect of different layers of gloves (one, two, three or more layers) toward adverse skin reactions reported that approximately 74% of medical staffs using one layer of gloves had complaints about skin problems, while there were 73.8% from those who used two layers, and 80% of workers who used three or more layers.¹³ Since COVID-19 can survive for several hours on used PPE, it is recommended to do double gloving to decrease the chance of contamination during the PPE removal.²⁰

Masks

Pressure injuries were frequently reported by mask users, which can cause erythema at level 1 and erosion and ulceration at level 2/3. This kind of injury is usually correlated with bony prominences, such as the nose bridge.²¹

Masks promote an occlusive microenvironment and increase skin temperatures. Several skin problems were reported related to occlusion, such as microbiome dysbiosis, whereas increased skin temperatures promote sweat/heat-related dermatoses.²² Previous studies revealed that microbiome dysbiosis triggered flare-ups of perioral dermatitis,²³ acne,²⁴ and eczema.²⁵ Disruption of the healthy skin microbiome is also related to pityrosporum folliculitis,²⁶ seborrheic dermatitis (in association with *Malassezia furfur*),²⁷ and also rosacea (in association with demodex mites).²⁸ Increased sweat retention tends to activate atopic dermatitis due to the sweat contents.²⁹ In addition, the moist and warm microenvironment due to mask usage is correlated with miliaria rubra, cholinergic urticaria, and yeast/fungal infections.²²

One study in China during the COVID-19 pandemic showed that health care workers who wore N95 surgical masks were more prone to have skin-related problem compared to those with medical masks. The clinical features among the frequent complaints were redness or erythema, facial

indentation, itch, pain or pricking and burning. These conditions might be related to higher skin hydration, TEWL, skin erythema, sebum secretion and pH level in the N95-covered areas compared to uncovered areas.³⁰ Another study showed that health care workers who used N95 masks regularly reported acne, facial itch, and rashes after they wore the masks. The areas frequently related to the symptoms were nose bridge, cheeks, and chin and the most common skin-related problem was acne. On the other hand, no complaint was reported from health care workers who used surgical masks. Parts of the respirator masks, including metal clips and rubber straps, could also cause dermatitis.¹⁶ One study reported that urticarial face eruption was suspected as a reaction to wearing N95 masks in three patients during the SARS epidemic in Toronto.³¹

Goggles and face shields

Health care workers need to protect themselves from the exposure to contaminated body fluids that may contain highly infectious diseases.^{32,33} During the Ebola outbreak, it was reported that eye protection usage, namely goggles and face shields, might cause heat and dehydration.³⁴ In addition, adverse skin reactions to these PPE were pressure injury, xerosis, urticaria, and contact dermatitis.³⁵ Approximately 87.9% of health care workers experienced skin problems on their nasal bridge after 6 hours of goggles usage, namely irritant and allergic contact dermatitis and acne, which might be related to the occlusion and friction between the skin and goggles. The most common area of complaint for goggles was the nasal bridge.³⁶ Health care workers reported that for eye protection, wearing a face shield was considered more comfortable than goggles.³⁴ A previous study, investigating the efficacy of face shields against the transmission of influenza virus, mentioned that there was 96% decreased risk of inhalational exposure soon after a cough aerosol simulator was performed at distances of 46 cm to a face shield.³²

Face shields serve as a barrier from immediately expelled aerosols of body fluids. Since the purpose is similar, face shields are frequently used as a substitute PPE for goggles. Moreover, face shields cover a larger area of the face.³⁷

The duration of face shield usage was also related to the adverse skin reaction. It was reported that during the COVID-19 outbreak, health care workers who wore a face shield longer than 6 hours per day

increased the risk of having skin-related complaints compared to those who face shield shorter than 6 hours per day, with 58.6% vs 48.1%, respectively. In addition, the most common area of skin problems was the forehead.³⁶ Another study also mentioned that face shields contributed approximately 17.31% of facial dermatoses due to PPE.² Another report during the COVID-19 pandemic found that goggles had the largest percentage among PPE that caused adverse skin reactions in the face. It was mentioned that these skin problems were related to the longer period of wearing goggles, ill-fitting masks, and excessive sweating. Increased skin temperatures during this occlusive microenvironment can elicit sweat/heat related skin problems.²

Coveralls and gowns

For protection, PPE gowns and coveralls should be resistant to absorption of droplets that may be contaminated with viruses (termed as water repellency). In addition, for comfort of the users, these PPE clothing should allow wearers to disperse the excess body heat (termed as water vapor permeability and air permeability). There are four types of PPE clothing available depending on the characteristics of water repellency, water resistance, and air permeability. The types include type A which has good water repellency and water resistance but poor air permeability; type B which has good water repellency and air permeability, but poor water resistance; type C which has poor air permeability, some water repellency, but poor water resistance, and lastly type D which has good water repellency, fair water resistance, and poor permeability.³⁸

A study done during the SARS outbreak in Singapore revealed that only 1.6% of subjects reported skin-related problems after wearing PPE gowns for approximately 6.2 hour over a mean period of 8.8 months. The clinical manifestations in the skin were itch and rash on the wrist.¹⁶ The likelihood of allergic contact dermatitis risk was increased with friction, warmth, and moisture of the covered area.³⁹ It was reported that the contact dermatitis to this PPE were caused by the additive chemicals and dye fibers, since skin reactions due to natural and synthetic untreated fabrics were uncommon.⁴⁰ Another study during the SARS epidemic in Toronto reported that the sensitization in allergic contact dermatitis was due to formaldehyde textiles and resin in gowns.³⁹

A study during the Ebola outbreak also mentioned that health care workers experi-

enced heat and dehydration during their gown or coverall usage. Nonetheless, the difference was not significant between these groups.³⁴

Boots

A previous study comparing health care workers and white-collar workers revealed that Italian health care workers were more likely to be sensitized to p-phenylenediamine. It can be assumed that the sensitization occurred after occupational contact with rubber products containing cross-reacting dyes, including boots. Another study showed that allergen, frequently found in the rubber chemical, including thiuram mix and carba mix, were commonly observed to be positive in healthcare workers.^{18,19}

Discussions and Recommendations

Recent publications reported that there were skin damage or skin adverse reaction due to PPE usage during health care workers shift in the hospital to protect the workers from getting infected. Full body PPE usage was compulsory in the patient management during deadly infectious diseases, such as COVID-19, Ebola, and Severe Acute Respiratory Syndrome (SARS). Health care workers might experience skin damage after wearing PPE and performing hand hygiene protocol. Since these skin complications occurred during working hours, it can be included in occupational skin diseases.

Generally, skin problem frequently complaint by the health care workers were dryness, redness, and itchy. The location of the skin complaints depended on the type of the PPE, whether face (masks), hand (gloves and hand hygiene protocol), and wrist (gown).^{13,15,16,41} The skin damage was due to occlusive environment, friction, and high humidity.^{6,22,30} In addition, irritant and allergic contact dermatitis could also be observed during PPE usage and hand hygiene protocol.⁶ Health care workers with atopic skin were reported to be more prone to experience these skin damage. It was known that defect in skin barrier was observed in atopic skin.⁴²

Pressure injuries on the nasal bridge could be prevented by using nonadherent thin hydrocolloid dressing.⁴³ However, this protocol needs further investigation to determine whether or not these dressings decrease the safety of the PPE.²¹

Moisturizers can also be applied to protect the skin barrier during PPE usage. It was reported that the risk to develop irrita-

tion and allergic contact dermatitis decreased after moisturizer application under occlusive gloves. Moisturizers are able to provide another barrier which serves as skin protection against friction from gloves, injury from irritants, and invasion of glove allergens.^{6,44}

Regarding hand hygiene protocol, it is important for health professionals to perform it correctly.⁴⁵ It was mentioned that using alcohol-based hand rubs was less irritative than washing hands with soap and rinsing with cold water.⁴⁶ Specific hand hygiene protocols should be enforced in the hospitals. For example, it is imperative to hand wash with soap and water before performing a urinary catheter insertion even when the health care workers will use gloves for this procedure or repeat this procedure of hand hygiene using alcohol-based hand rubs.⁴⁵ The Centers for Disease Control and Prevention also suggested that hospitals provide skin care lotion or creams to minimize the risk of having irritant contact dermatitis related to hand hygiene procedure.⁴⁷ These hand creams and lotions are recommended to be applied between hand hygiene protocols, particularly after the shift has ended. Skin in older health care workers needs more thorough skin care. For health care workers, the three-step concept for skin care is recommended to protect from occupational contact dermatitis, which comprises: skin protection, cleaning, and care before, between, and after the medical shift.⁴⁸ Additionally, to prevent hand dermatitis, a mild non-alkaline soap is preferred.⁴⁹ For alcohol-based hand rubs, the formulation should include emollients.⁴⁷ It was also recommended to limit the duration of wearing PPE to no more than six hours per day.¹³ Sufficient hydration and avoidance of over-tight gowns should also be recommended as a prevention for adverse skin reaction related gowns.⁵⁰

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