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Review

Work-Related Hand Eczema in Healthcare Workers: Etiopathogenic Factors, Clinical Features, and Skin Care

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Abstract: Work-related skin conditions, including work-related irritant and allergic contact dermatitis, rank as the second most prevalent among work-related diseases. The most commonly reported manifestation of these conditions is hand eczema, which develops due to exposure to various substances in the workplace. Understanding the origins and triggers of eczema and contact dermatitis enables healthcare professionals to educate themselves and their patients about effective preventive measures, such as avoiding specific irritants and allergens, using protective equipment, and maintaining proper skincare hygiene. Additionally, this knowledge facilitates the development of new recommendations to enhance skin protection in work-related settings, regulate the use of substances known to cause work-related skin diseases, and provide healthcare practitioners with the necessary training to recognize and manage these conditions. Given that approximately one in every five healthcare workers is considered to have hand eczema, the objective of this study was to review the existing literature regarding the characteristics of eczema in healthcare workers. Furthermore, this study aimed to comprehensively investigate environmental and constitutional factors (including years of work experience involving exposure to skin hazards, frequent glove use, regular handwashing and water contact, frequent use of disinfectants and detergents, and a history of previous allergies and atopic dermatitis) that influence the occurrence and progression of eczema.

Keywords: contact dermatitis; hand eczema; medical doctors; dentists; etiology; allergy; allergens; patch test; skin irritation; skin care

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1. Introduction

Work-related skin diseases are among the most common work-related diseases, ranking second in frequency after musculoskeletal diseases [1,2]. The majority of work-related skin diseases (80–95%) are contact dermatitis, which can be both irritant and allergic in nature [3–5]. Lesions are most commonly described as hand eczema and occur as a result of contact with various substances (irritants and allergens) in the workplace [6–10]. The term "eczema" is generally used to describe a group of skin lesions in which the skin is itchy, dry, and inflamed. However, the term eczema usually involves a non-specific clinical picture but is commonly used in real-life and medical settings when working with patients. Additionally, in the literature, the term "eczema" encompasses a wide range of conditions (ranging from childhood atopic dermatitis to work-related allergies in adults). Therefore, due to such a range, "eczema" serves as an undefined general term for any form of inflammatory skin condition, which is often reported by individuals themselves. Healthcare workers are considered a high-risk population for the development of hand

eczema, with prevalence mostly estimated at around 20% compared to a 14.5% lifetime prevalence in the general population [11–15]. Thus far, studies investigating the prevalence/incidence of hand eczema among healthcare workers have mainly been performed with nurses, nursing apprentices, and dental practitioners, rarely being performed with physicians [16]. A recent review of work-related skin diseases among physicians showed a similar prevalence of hand eczema of around 20%, particularly among surgeons, internists, and gynecologists [17]. It has been pointed out that there are little or no data on the specific prevalence of irritant or allergic work-related dermatitis among physicians. Data on surgical and non-surgical physicians and dentists are even scarcer, including the impact of surgical work on work-related contact dermatitis [18]. Therefore, the purpose of this review was to present the literature data on the characteristics of work-related eczema in physicians, dentists, and other healthcare workers and describe environmental and constitutional factors (Figure 1) influencing the occurrence and course of eczema.

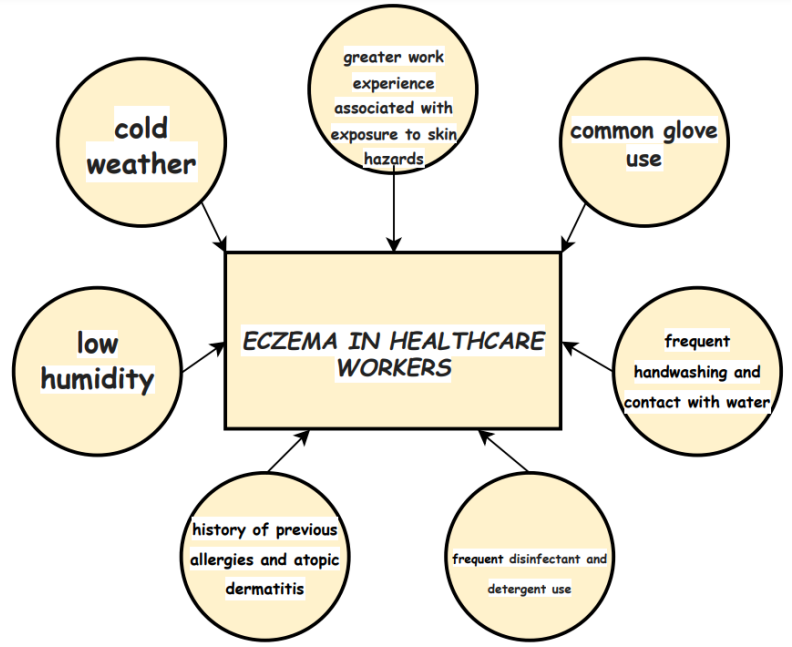

Figure 1. Key factors participating in the occurrence and course of hand eczema in healthcare workers (an original scheme based on current literature data).

2. Key Features and Etiopathogenesis of Work-Related Hand Eczema

Hand eczema is predominantly the consequence/result of the skin coming into contact with different substances. It mainly manifests as contact dermatitis, including irritant contact dermatitis and allergic contact dermatitis, for which the pathogeneses are different. Irritant contact dermatitis and allergic contact dermatitis are relatively frequent dermatoses, with irritant contact dermatitis being more common than allergic contact dermatitis [1,2]. Recognizing and diagnosing them requires a thorough patient history and, crucially, a detailed clinical picture. As the clinical picture is commonly similar in both, patch tests can differentiate the two dermatoses (a positive patch test, along with a history of allergen sensitivity, indicates allergic contact dermatitis) (Figure 2). Sometimes histology may be helpful (Figure 3). Histologically, prominent features of acute irritant contact dermatitis are spongiosis, irregular acanthosis, the dilation of capillaries in the subepidermal dermis, and perivascular infiltration of neutrophils and lymphocytes in the dermis. A diagnosis of chronic irritant contact dermatitis is made based on the history, clinical picture, and negative patch test results, as histological findings are often non-specific. A diagnosis of acute allergic contact dermatitis is also made based on a patient's history and clinical picture, though with a positive result to a patch test (epicutaneous) using a standard series of allergens or "target allergens". Histologically, in allergic contact dermatitis, lymphocytic

perivascular infiltrate, edema of the dermis, and epidermal spongiosis and exocytosis are observed. Chronic allergic contact dermatitis is also diagnosed based on a detailed clinical picture and patient history, and it is confirmed with a positive patch test result.

Figure 2. Clinical finding of work-related hand eczema.

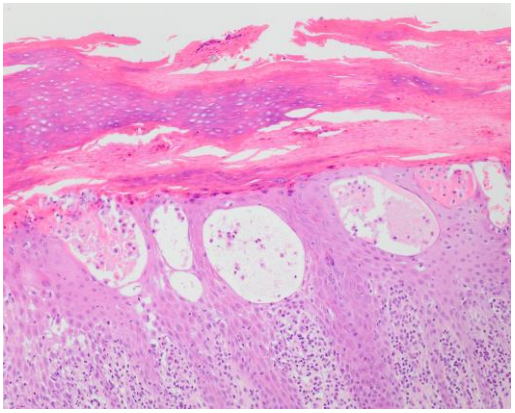

Figure 3. Histological finding of acute allergic contact dermatitis.

2.1. Irritant Contact Dermatitis

Previously, it was believed that the development of irritant contact dermatitis did not involve an immune response; however, it is now acknowledged that the immune system plays a crucial role in the onset of irritant contact dermatitis [19]. Irritation can occur either by damaging the cells in the outermost layer of the skin (epidermal cells) [20], disrupting the epidermal barrier, or a combination of both processes [21]. The disruption of the epithelial barrier leads to increased permeability to irritants [22]. Keratinocytes, which are responsible for converting external stimuli into the secretion of cytokines, adhesion molecules, and chemotactic factors act as "signal transducers" in initiating cutaneous inflammation [23]. When keratinocytes are damaged, primary cytokines, such as interleukin-1 alpha (IL-1α), IL-1β, and tumor necrosis factor-alpha (TNF-α), are upregulated [24], which stimulates the proliferation of keratinocytes and the production of lipids [25], contributing to the restoration of the epidermal barrier. Subsequently, additional cytokines, including IL-6, IL-8, and granulocyte-macrophage colony-stimulating factor (GM-CSF), are secreted, activating Langerhans cells, dermal dendritic cells, and endothelial cells [22], which further recruit inflammatory cells to the site of chemical trauma [26]. The adhesion molecule intercellular adhesion molecule 1 (ICAM1) is upregulated on endothelial cells and fibroblasts in the

skin, leading to the secretion of additional chemokines, such as C-X-C motif chemokine ligand 8 (CXCL 8), C-C motif chemokine ligand 20 (CCL 20), and interferon gamma (IFN -γ) [27]. Also, C-C motif Chemokine Ligand 21 (CCL21), a chemokine that facilitates the migration of naive T lymphocytes, is upregulated in irritant contact dermatitis [24,28]. T lymphocytes recruited to irritated skin often express the cutaneous lymphocyte-associated antigen (CLA antigen), which plays a significant role in the migration of T lymphocytes across endothelial cells. Irritants can also activate pattern recognition receptors, such as toll-like receptors (TLRs) and nucleotide oligomerization domain-like (NOD-like) receptors, triggering the activation of the innate immune response through the inflammasome and Nuclear factor kappa-light-chain-enhancer of activated B cells' (NFκB) pathways [22,29,30]. Increasing evidence suggests that oxidative stress and the generation of reactive oxygen species contribute to the pathogenesis of irritant contact dermatitis [31,32]. Concerning the relationship between contact dermatitis and antioxidants, it is possible that most skin irritants and allergens keep their inactive redox status, though some of them can be a source of free radicals and produce reactive oxygen species (ROS) and/or reactive nitrogen species (RNS) [31,33]. In epidermal keratinocytes, some substances may generate free radicals. For example, in keratinocytes, organic hydroperoxides and organic peroxides generate free radicals. Also, in the presence of metals such as chromium and nickel, the levels of free radical formations increase. It has been shown that peroxides inactivate antioxidants in keratinocytes. Also, in the lesions of both irritant contact dermatitis and allergic contact dermatitis, increased levels of iNOS protein expression have been immunohistochemically shown. In addition, the exacerbation of skin inflammation is accompanied by excessive production of ROSs, like superoxide (O^{2+}) and hydroxyl radical (OH^{+}) [34]. It has been hypothesized that targeting oxidative stress could be beneficial in treating irritant contact dermatitis, and clinical studies have shown the therapeutic benefits of antioxidants [32]. According to research data, emollient cream, as well as a combined topical glucocorticoid and emollient cream therapy, reduced glutathione redox status [34].

2.2. Allergic Contact Dermatitis

Allergic contact dermatitis occurs due to skin contact with an allergen to which the person is sensitized and a subsequent T-cell-mediated response (type 4 hypersensitivity reaction) [35–37]. The initial severity of the condition plays a crucial role in determining its duration and the effectiveness of treatment and ultimately affects the patient's overall well-being. This disease has two phases: sensitization to the antigen and the response to re-exposure (elicitation). The pathophysiology of allergic contact dermatitis initiates when the allergen comes into contact with the skin. The allergen permeates the stratum corneum and is taken up by Langerhans cells [38,39]. These Langerhans cells then migrate towards nearby lymph nodes, where they process the antigens and present them on their surface. Adjacent T lymphocytes come into contact with the presented antigens, leading to the creation of antigen-specific T lymphocytes through clonal expansion and cytokine-induced proliferation. These newly formed lymphocytes can travel through the bloodstream and reach the epidermis, marking the sensitization phase of allergic contact dermatitis. The elicitation phase occurs upon re-exposure to the antigen. Langerhans cells, which still contain the antigen, interact with the antigen-specific T lymphocytes, triggering a cytokine-induced proliferation process. This localized inflammatory response leads to the characteristic symptoms of allergic contact dermatitis. According to experimental models, acute damage to the skin's epidermal barrier after exposure to allergens stimulates keratinocytes and antigen-presenting cells (through toll-like receptor activation) to release cytokines IL-1, IL-6 and TNF-α, which are crucial for pro-inflammatory and chemotactic effects on immune cells, initially directing them towards the regional lymph nodes and, subsequently, towards the site of damage or skin contact with the allergen [40,41]. It is important to note that although small molecular weight substances (haptens) can penetrate intact, undamaged skin, the maintained epidermal barrier can partially prevent sensitization to specific allergens. In addition to keratinocytes and antigen-presenting cells, other immune cells play

roles in both phases of allergic contact dermatitis. For example, neutrophils and mast cells, activated via local inflammatory reactions, participate in the secretion of pro-inflammatory cytokines (such as IL-6 and TNF-α) [41]. Mast cells, upon contact with allergens, can release various cytokines and histamine, thereby influencing the endothelium and recruiting a greater number of immune cells to the site of allergen contact [35,41]. Antigen presentation of allergens to lymphocytes in the regional lymph nodes also leads to the development of specific regulatory T cells (Tregs), which, through the secretion of suppressive cytokines, reduce and halt the contact hypersensitivity reaction [41]. Their role is to restore immune balance and interrupt excessive contact hypersensitivity reactions to allergens.

3. Clinical Expressions of Work-Related Eczema in Physicians, Dentists, and Other Healthcare Workers

Hand eczema is a common skin disease with a one-year prevalence of at least 9.1% (6.4% in men and 10.5% in women). In the general population, hand eczema in women usually occurs between the ages of 19 and 29 and declines with age, while in men, the frequency gradually increases with age [42]. Healthcare workers are among the groups with an increased risk of developing contact dermatitis due to constant exposure to allergens and irritants [43]. Work-related hand eczema predominantly presents as contact dermatitis, primarily in the form of irritant contact dermatitis, due to the constant exposure of the skin of the hands to irritants [37] (Figure 2). It can manifest clinically as an acute or chronic disease. The acute form occurs in the form of erythema, blisters, pustules, bleeding, scabs, scales, and erosions with accompanying itching or pain. The chronic form is characterized by diffuse or localized lesions with poorly defined erythematous scaly spots and plaques, dry skin, lichenification, and desquamation [2]. Hand eczema can also manifest in the form of allergic contact dermatitis. Its acute form is characterized as erythematous, eczematous, or vesicular dermatitis, while the chronic form more often exhibits lichenification, cracks, scales, and pruritus [44]. Irritant contact dermatitis occurs more rapidly, whereas allergic contact dermatitis has a propensity to spread [2]. Aside from hand eczema, healthcare workers are prone to facial eczema. Prolonged wearing of protective equipment, especially face masks, can also lead to facial eczema [45]. Facial contact dermatitis (allergic and irritant) manifests in the form of papules, erythema, maceration, scales, desquamation, rashes, and fissures. Furthermore, symptoms of dryness, tightness, sensitivity, itching, burning, and pain can represent diagnoses related to wearing protective equipment [46]. Facial irritant contact dermatitis commonly occurs due to pressure and friction from protective equipment and frequently manifests on the cheeks and nasal bridge. This dermatitis is common in atopics and specifically related to prolonged mask use (>6 h per day). Prolonged use of face masks and other personal protective equipment (PPE) can also cause pressure urticaria, itching, acne, and pitting [47]. Protective caps can aggravate seborrheic dermatitis and cause folliculitis and itching, while prolonged wearing of protective glasses affects the nasal bridge. Contact dermatitis prognosis depends on the underlying cause. If the exposure ceases, the prognosis is good, but unfortunately, relapse is common if the cause is not determined. The condition requires treatment via an interdisciplinary approach that includes a dermatologist, allergologist, family medicine doctor, pharmacist, and occupational health specialist in the case of work-related etiology of the disease [48].

4. Factors Associated with Eczema Occurrence in Physicians, Dentists, and Other Healthcare Workers

In healthcare workers, most work-related skin diseases are caused by hyperhydration and skin irritation, as well as by contact allergies that may result from prolonged use of personal protective equipment. Additionally, a history of pre-existing skin conditions further increases the risk of aggravated skin changes. Hand eczema in physicians and dentists has rarely been studied; however, a recent literature review reveals a higher incidence of hand eczema among dental professionals compared to other medical professionals [16]. According to research conducted on dental professionals and students, skin lesions are relatively common (56%), and they appear more frequently with longer exposure (more

years of work experience), more frequent glove use and handwashing, and a history of previous allergies [49]. In addition, a recent systematic review showed that the incidence of work-related contact dermatitis is over 100 times higher in apprentices than in older cohorts of healthcare workers [16]. This issue can be partially explained by the "healthy worker effect", i.e., the selection of apprentices and young workers with work-related contact dermatitis from the occupation that caused or worsened the skin disease. However, it can be speculated that such selection is more evident in cases of the allergic form of contact dermatitis, where achieving efficient secondary and tertiary prevention without a change in workplace or occupation becomes challenging, unlike the irritant form of the disease. In the last few years, the negative impact of the COVID-19 pandemic on healthcare workers' skin has been examined. A study conducted on final-year apprentice nurses during the COVID-19 pandemic revealed that half of them already exhibited signs of hand eczema [50]. Those individuals with observed skin changes reported spending more days per month on practical work than those with healthy skin, confirming the cumulative effect of hazards on the skin barrier [50]. During the COVID-19 pandemic, proper hand hygiene was the main preventive measure against the transmission of the disease itself, and healthcare workers were on the frontline of defense. Since the onset of the COVID-19 pandemic, there has been a notable increase in the use of soaps and alcohol-based hand sanitizers and the frequency of handwashing [51], leading to a higher prevalence of hand eczema among healthcare workers [52–54]. However, eczema occurrence in healthcare workers commonly manifests as irritant contact dermatitis that occurs in response to irritants, which can be physical, chemical, or mechanical in nature [55,56]. Females and individuals with a predisposition to atopic conditions are more susceptible to developing irritant contact dermatitis [57]. Frequent hand washing can lead to various changes in skin texture, ranging from dry skin to the more common irritant contact dermatitis and, in rare cases, even allergic contact dermatitis [58]. Continuous exposure to soaps, detergents, or solvents can lead to chronic irritant contact dermatitis due to their ability to remove lipids from the skin surface, damage proteins found in the skin, denature keratin in the epidermis, or induce changes in the cell membrane itself [59]. Using an alcohol-based hand sanitizer can also cause skin dryness and irritation [58]; however, they are considered less irritating than washing hands with soap and water [60]. In addition to the already mentioned exogenous factors that affect the naturally acidic pH of the skin, endogenous factors, such as skin moisture, anatomical position, age, sweat, and sebum production, are also related to the pathogenesis of irritant contact dermatitis [61]. According to recent field research on physicians and dentists and the environmental and personal factors that influence the development and clinical presentation of hand eczema among them (both surgeons and non-surgeons were assessed), each subject group reported a significantly higher prevalence of hand eczema and exposure to work-related skin hazards (handwashing, glove use, and disinfectant use) than the control group (psychologists, administrative workers, and social workers) [18]. According to other research data, a higher incidence of hand eczema was recorded among dental professionals than medical professionals, and the work-related exposures to hazards were different for the two different fields [16,49]. The main difference was the duration of glove use, which was significantly longer for dentists (both dental surgeons and non-surgeons) than physicians (medical surgeons and non-surgeons). Based on recent research, wearing gloves frequently (for more than one hour daily) was recorded as an independent predictor of self-reported current hand eczema or hand eczema reported within the last year, with a 3-4 times higher risk compared to those who used gloves for less than one hour per day [18]. Similarly, other studies have shown that healthcare workers who wear gloves more than 2 h per day have a higher risk of developing hand eczema [62,63]. Glove use, particularly prolonged use, is a recognized risk factor for the development of irritant contact dermatitis due to the moist environment under the glove [12,15,64,65]. Additionally, improper donning or removal of gloves can lead to skin contamination, even if a suitable glove has been selected. Using gloves that are not the correct size can also increase the risk of glove perforation [66]. Gloves also contain rubber accelerators (e.g., benzothiazoles,

thiurams, carba mix, etc.) known to be contact allergens [67]. The derivatives of thiuram are considered the most common sensitizers, followed by dithiocarbamates [68,69]. According to recent research conducted on physicians and dentists, self-reports of hand eczema (currently or within the last year) were associated with younger age, though with borderline significance, which is in line with previous studies, suggesting that being of a younger age is a risk factor for developing work-related skin diseases [11,18,70]. Young workers are often not sufficiently skilled or educated regarding protective measures against skin hazards at work, making them more susceptible to the development of skin disorders. Also, a recent study of physicians and dentists observed an influence of gender. Men had more frequently observed skin lesions/changes on the hands than women, and men's skin changes were more severe, with a two times higher risk of developing more severe forms of hand eczema than women. This issue could be related to the fact that men are more present in surgical professions and, thus, spend more time working with gloves [18]. The literature data are inconsistent regarding the influence of sex on the occurrence and course of hand eczema. Some studies of healthcare workers explain that self-reported hand eczema was more common in women [64,71], while other studies found the same result for men [11,72,73]. More severe forms of hand eczema were additionally associated with reported atopic dermatitis; in a recent field study, it tripled the risk of having more severe forms of the disease [18]. Atopic dermatitis is commonly considered a prominent predisposing factor for work-related irritant contact dermatitis [23,74–77]. The role of atopic dermatitis in patients with allergic contact dermatitis is less clear, and the data from the literature are conflicting [78–81].

5. Allergens as Etiology Factors

Common allergens associated with allergic contact dermatitis include nickel, balsam of Peru, chromium, neomycin, formaldehyde, thiomersal, fragrance mix, cobalt, and parthenium [82]. A recent study conducted by Martins et al. [83] supports this finding, as fragrances, followed by skin-conditioning agents, surfactants, and preservatives, were identified as the most common allergens for sensitive skin in a pool of 88 facial–skin cosmetic products. Common means of exposure to allergens for healthcare workers are gloves, hand sanitizers, hand lotions, and antiseptic products [84]. When analyzing potential contact allergies involved in the occurrence of skin lesions in healthcare workers, according to the study by Huang et al., which included nurses (40%), allied health professionals (22%), and doctors (18%), the most frequent allergens were rubber chemicals, fragrances, preservatives, and topical corticosteroids. According to clinical pictures, the most common skin manifestations were hand eczema (49%) and facial or neck dermatitis (25%). Furthermore, 57% of healthcare workers tested positive for at least one contact allergen in patch tests, with 28% showing relevance in positive results. Among the relevant allergens, the most frequent were hydroxyisohexyl 3-cyclohexene carboxaldehyde (4%), methylisothiazolinone/methylchloroisothiazolinone (4%), and methylisothiazolinone (4%). In addition, 69% of participants in their research had a background of atopic dermatitis [85]. In a study by Rubins et al., rubber gloves and disinfectants were identified as the primary causes of work-related allergic contact dermatitis in healthcare workers, especially among surgical staff, due to the presence of 1,3-diphenylguanidine (DPG) and cetylpyridinium chloride, respectively [61]. According to research by Minamoto et al. on dental staff, the most common allergens were acrylates, along with rubber additives, among the relevant work-related allergens [74]. Similar data were observed in a study by Kocak et al. involving 461 respondents (dental technicians, dentists, and nurses), where acrylates were identified as the most common contact allergens, with nickel sulfate being the most common (12.3% of participants), followed by acrylates (6.1% of participants, especially ethylene glycol dimethacrylate [EGDMA]) [86]. Also, in recent field research conducted on physicians and dentists, contact sensitization to specific work-related allergens (rubber accelerators, isothiazolinones, acrylates, etc.) was only observed in three dentists who tested positive for acrylates (bearing in mind the relatively low response of participants

to patch testing—49%) [18]. While acrylates were once considered work-related allergens specific to dental practitioners, they have recently become prevalent work-related contact allergens for beauticians and hairdressers due to the presence of acrylates in cosmetic glues [87]. Regarding rubber additives, a study by Schnuch et al. found the highest rates of sensitization to thiurams were among surgeons (15.7%), dentists (12.5%), and surgical nurses (13%) [88]. A recent study found that for analyzed eczema in physicians and dentists who were patch tested with a mixture of thiurams and carbamates, there were no positive reactions [18]. This issue might be attributed to false-negative results, the small number of respondents tested, or the selection of participants without work-related allergic contact dermatitis ("healthy worker effect") [18]. However, mixture testing did not always detect hypersensitivity; thus, about 20% of thiuram-sensitized patients received false-negative results [68]. Recent results generally suggest that the majority of hand eczema cases in physicians and dentists are of irritative origin, which was also found in a recent study of nursing apprentices [18,50]. A good hand hygiene regimen, proper glove usage, and the regular application of moisturizers, alongside adequate education of apprentices and workers, are considered minimum standards for the prevention of work-related hand dermatitis [79,89,90]. On the other hand, when treating allergic contact dermatitis, the complete avoidance of allergens has been demonstrated as the only effective option [91]. In addition, skin lesions may occur on the faces of healthcare workers, which could be due to protective mask use or cosmetic preparations. According to one systematic review, irritant contact dermatitis in healthcare workers who wear facial protective equipment may be triggered by pressure from elastic straps, formaldehyde released from mask fabric or glue, or other various features of the personal protective equipment (these cases rarely manifested as acneiform eruption or contact urticaria) [46]. Also, fragrances in cosmetics, to which the face is frequently exposed, can cause allergic contact dermatitis, irritant contact dermatitis, photosensitivity dermatitis, urticaria, or asthma [92]. The diagnosis of allergic contact dermatitis should initially be based on patient history and the distribution of lesions, and it should be confirmed via a patch test [93]. A recent wide analysis of patch test results confirmed many standard allergens were as being frequent allergens (hydroperoxides of linalool nickel, sulfate hexahydrate, methylisothiazolinone, Myroxylon pereirae resin, and others), and found that other substances (hydroperoxides of linalool and hydroperoxides of limonene, among others) also caused enough positive reactions to be considered allergens that should be added to the standard patch test series [94]. Limonene and linalool hydroperoxides, for example, were found in sterilium and other hydroalcoholic solutions. European consumer protection policies reflect research results, as EU directives and regulations require, for instance, that all cosmetic products comprised of more than 0.01% of certain fragrance allergens label these ingredients; prohibit lyral, atranol, and chloroatranol; and restrict the use of cancer-causing methyl eugenol [92,95].

6. Skin Care in Healthcare Professionals

Skin health is a critical aspect of overall well-being, especially for healthcare professionals, who are often exposed to a variety of potential skin irritants. The skin barrier, which is the uppermost layer of the skin, serves as a physical and functional protection system. It is composed of skin cells and specialized immune system cells that work together to recognize and keep out intruding organisms and substances. Certain conditions, such as eczema, can weaken this barrier. This issue leads to a cycle of uncomfortable dryness, irritation, and inflammation. These symptoms, in turn, can contribute to further degradation of the skin barrier, worsening symptoms, and a vicious cycle of skin damage [96]. Furthermore, individuals with pre-existing skin barrier dysfunction, such as atopic dermatitis, may experience magnified symptoms due to increased hand hygiene practices [97]. Healthcare workers, in particular, experience frequent hand sanitizer use and a higher incidence of irritant contact dermatitis. This issue may explain their significantly higher transepidermal water loss (TEWL, a measure of the skin's barrier function), as they already have a compromised skin barrier. Despite the use of emollients, TEWL increased, indicating that even

with the application of creams and lotions, skin barrier function was not fully restored [97]. Healthcare professionals are advised to follow a few key steps to maintain and improve skin health. Moisturizing is crucial because it improves the barrier function of the skin. For more severe dryness, experts recommend moisturizing after short "soaks" in a lukewarm bath. Thick ointments or creams may be preferable to lotions to prevent skin from drying out while also protecting it from irritants [96]. Minimizing exposure to allergens, irritants, and typical triggers is another important step. Common eczema triggers include dry skin, dust, pet dander, pollen, metals like nickel, cigarette smoke, soaps and household cleaners, fragrances, fabrics like wool and polyester, certain chemicals, dry air, and stress. Avoiding these triggers can help to strengthen the skin barrier and prevent further degradation [48]. A soap-free cleanser is recommended, since synthetic detergents have a neutral or slightly acidic pH, making them less irritating to the skin [98]. Soap-free cleansers also typically contain a relatively high amount of free fatty acids, which help moisturize the skin and prevent hand irritation and dryness. As an alternative to detergents, it is advisable to use alcohol-based hand sanitizers that include moisturizers and avoid common allergens [99]. Barrier creams are formulated to create a protective layer on the skin, aiming to prevent the penetration of irritants. While they are believed to play a role in preventing irritant contact dermatitis, they are generally recommended for use with low-grade irritants [100]. However, a recent Cochrane review indicated that using barrier creams alone may have a minor protective effect. Nonetheless, the evidence was considered low quality and not clinically significant [101]. While topical corticosteroids are commonly used for the treatment of irritant contact dermatitis, their effectiveness is disputed, with some studies suggesting they may reduce skin barrier function, and although they may be beneficial for some chronic hyperkeratotic lesions, prolonged use can lead to skin thinning and increased sensitivity, necessitating systemic corticosteroids during severe episodes [102–104]. Topical calcineurin inhibitors are topical immunomodulators that offer a safe alternative to corticosteroids. However, there have been suggestions of a potential association between topical calcineurin inhibitors and skin cancer and lymphoma, though the evidence is not strong [105,106]. In addition, for systemic treatments, alitretinoin has been found to be effective in treating chronic hand eczema, with 43.2% of patients diagnosed with irritant contact dermatitis showing positive results in one study [107]. In cases where other first- or second-line treatments have failed, oral immunomodulators may be necessary for chronic irritation. Cyclosporine has shown beneficial effects in treating chronic hand eczema [104], but its use should be cautiously due to associated side effects. Limited evidence has indicated that dupilumab, a monoclonal antibody treatment approved for treating atopic dermatitis, may be effective in treating chronic recalcitrant hyperkeratotic irritant contact dermatitis [108] and non-atopic hyperkeratotic hand eczema [109]. However, further studies are needed to determine the potential use of dupilumab as a therapeutic agent in irritant contact dermatitis. In terms of advancements in preventing irritant contact dermatitis, recent research on human subjects has shown the effectiveness of inflammasome-targeted therapies, such as topical disulfiram. This treatment has demonstrated inhibitory effects on irritant contact dermatitis, likely due to a reduction in the inflammatory cytokine IL-18 [110]. This development presents a novel approach to the prevention of irritant contact dermatitis. Despite these measures, healthcare workers continue to experience skin issues. This issue highlights the need for further research into the effects of specific emollients and the development of more effective skincare routines. It also underscores the importance of occupational health professionals regularly surveying employees about the acceptance of hand cleansing and hand care products and adjusting them to prevent work-related hand eczema. The goal is to maintain the integrity of the skin barrier, prevent skin diseases, and ensure the well-being of healthcare professionals.

7. Conclusions

Eczema and contact dermatitis research advances our understanding of their etiology, symptoms, and clinical presentation. Based on their own expertise (and sometimes even

their own experience), healthcare experts may be able to appropriately identify and differentiate them from other skin diseases. Furthermore, knowing the origins and triggers of eczema and contact dermatitis helps healthcare practitioners to educate patients about preventive measures, such as avoiding certain allergens or irritants, utilizing protective equipment, and maintaining appropriate skincare hygiene. Also, research aids in the creation of novel medicines and the enhancement of existing treatment approaches. It also lays the groundwork for the development of public health guidelines and policies, such as new recommendations for improved workplace skin protection, the regulation of the use of certain substances that can cause contact dermatitis, and the education of healthcare professionals about the recognition and management of these conditions.

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