



## Review Article

## Wet-work Exposure: A Main Risk Factor for Occupational Hand Dermatitis

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## ABSTRACT

Wet-work can be defined as activities where workers have to immerse their hands in liquids for >2 hours per shift, or wear waterproof (occlusive) gloves for a corresponding amount of time, or wash their hands >20 times per shift. This review considers the recent literature on wet-work exposure, and examines wet-work as a main risk factor for developing irritant contact dermatitis of the hands. The aim of this paper is to provide a detailed description of wet-work exposure among specific occupational groups who extensively deal with water and other liquids in their occupations. Furthermore, it highlights the extent and importance of the subsequent adverse health effects caused by exposure to wet-work.

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## 1. Introduction

Occupational skin diseases are ranked internationally as the second largest group of occupational diseases after musculoskeletal disorders [1]. They account for >45% of all occupational illnesses [2]. The most common occupational skin disease is contact dermatitis (CD), which makes up around 80% of all occupational skin diseases [3]. CD is an inflammation of the upper layers of the skin, which may manifest itself with the main signs and symptoms of dryness, redness, itching, flaking, scaling, cracking, blistering, and pain [4]. This condition may be caused by irritant or allergic reactions to the agents with which the skin comes into contact; consequently, it is usually divided into irritant contact dermatitis (ICD) or allergic contact dermatitis (ACD) [4,5]. The probability and severity of the reactions depend on such factors as the type and intensity of exposure. There is no absolute visual distinction between ICD and ACD [6].

ICD accounts for 50–80% of all occupational CD cases [7,8]. Industries such as printing, metal machining and treatment, food

preparation, painting, beautician services, hairdressing, and healthcare experience higher incidence rates of contact dermatitis than other types of occupational disorders and complaints [3]. More disproportionate rates of dermatitis have also been seen in industries such as agriculture compared to low-risk occupations such as office workers [9].

Dermal exposure to irritants and/or allergens is a necessary condition to cause CD. The main pathogenetic mechanisms are damage to the skin barrier for ICD, and immunological reactions for ACD [7]. Depending on their genetic constitution, some people may not develop an allergic reaction after exposure to potential allergens. An allergic reaction is a response of the immune system to a particular substance, with which an individual has previously come into contact, and to which he/she has been sensitized. It may be considered as an unwanted adverse side effect of the function of the immune system [10]. All allergic reactions are allergen specific and not dose dependent. Small quantities can cause allergy, whereas a certain minimum exposure to an irritant is necessary for the development of ICD [7]. The most common skin allergens vary

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among countries and over time, depending on specific industrial profiles. A recent Australian publication listed rubber accelerators, hairdressing products such as ammonium persulfate, 4-phenylenediamine base, glycerylmonothioglycolate, potassium dichromate, epoxy resin, and formaldehyde as being among the top sensitizers [11]. Further discussion of ACD is out of the scope of this paper.

In contrast, ICD and hand dermatitis in particular, which is the main concern of this paper, is a local inflammatory reaction, without any immunological response and production of specific antibodies. ICD is usually multifactorial, and not necessarily caused by a single agent [11]. Although chemical causes of ICD are well recognized, the contributions of physical, environmental, and mechanical factors to ICD are underestimated and often neglected. This paper looks at the contribution of wet-work exposure as a major risk factor of hand eczema, as demonstrated by several studies [5,12–14].

## 2. Search strategy

This study was carried out through a multidisciplinary review of the literature. Internet searching was the primary tool for this review. Relevant articles in the fields of dermatology, industrial hygiene, and exposure assessment were found using various databases such as Google Scholar (<http://scholar.google.com>), ScienceDirect (<http://scholar.google.com>), ScienceDirect ([www.sciencedirect.com](http://www.sciencedirect.com)), and PubMed (<http://www.ncbi.nlm.nih.gov/pubmed>). Searches were conducted using the combinations of terms “wet-work exposure”, “hand dermatitis”, “detergents”, “workers”, “hand eczema”, “occupation” and “industry”. The search was limited to papers in English language and covered the period of 1990–2013. These searches yielded >500 papers. After an initial review of the title and abstract of the papers found in the first step, >100 references remained. The abstracts were reviewed for information about wet-work exposure and occupational hand dermatitis. This further examination resulted in >70 citations relevant to this review, which are included as references in this paper.

## 3. Irritancy of wet-work

Water is a potential irritant, which may penetrate relatively easily through the stratum corneum [15]. Frequent exposure to water causes swelling and shrinking of the stratum corneum and can lead to hand dermatitis (hand eczema). Tsai and Maibach argued that several mechanisms such as osmolarity, pH, mineral content, and temperature might account for the irritancy of water [16]. It has also been argued that another factor in the development of ICD might be the extraction or dilution of the natural moisturizing factors in the stratum corneum [17]. People exposed to wet-work often wear water-resistant (occlusive) gloves (rubber or plastic) as a form of personal protective equipment. Within these gloves heat and moisture might collect through the occlusion effect [16,17]. The barrier function of the skin may be further impaired by occlusion. Occlusion might also be produced by clothing, rings, and sometimes inadvertently by barrier creams [15]. The physiology of the skin might be changed by occlusion and this may facilitate the activation of other potential irritants [18]. Continual exposure to water may also produce maceration (often called “cleaning woman’s hands”) [19]; and cutaneous irritation through desiccation of the skin may result from the repeated evaporation of water from the skin [20]. In addition to exposure at the workplace, domestic exposure to water and aqueous mixtures may also contribute to the development of hand eczema [21].

ICD can happen at any age and occur anywhere on the body, but hand dermatitis is the most common form of ICD. This is associated

with the way that hands interact with the environment and are often in contact with irritants [22]. Due to a thin layer of stratum corneum on the dorsum of the hands compared to the palms, ICD usually affects the backs of the hands first [23].

Elsner, amongst others, has argued that wet-work exposure is one of the important risk factors for hand eczema [24]. Duration of exposure to wet-work and high frequency of hand washing have been found to be associated with occupational contact dermatitis of the hands [1,25].

Household cleaning, dish washing, healthcare sector work, hairdressing, food preparation, metal work, and flower arranging are examples of occupations that might experience increased exposure to water, aqueous mixtures and wet objects [26]. A common feature of these jobs is the frequent use of fluids and the repeated or prolonged wetness of the hands; accordingly these jobs are often grouped as “wet-work”.

Wet-work has been recognized as a risk factor for developing hand eczema in hairdressing [12,27], nursing [13,28,29], cleaning [14], food handling [5], and metal working [14]. The main risk determinants of wet-work exposure for development of ICD in these occupations have been reported as the duration and frequency of exposure [7,28–31]. Other industries that have a high risk of hand dermatitis include manufacturing, construction, machine tool operation, food preparation, printing, metal plating, leather work, engine servicing, and floristry [3,32].

Development of ICD is a complex process. It is now recognized that defining it as a nonimmunological, nonspecific reaction of the skin to irritants is too simplistic [30]. Rather, ICD is determined by a number of endogenous (individual susceptibility) and exogenous factors (exposure characteristics), which trigger a series of pathophysiological changes including skin barrier disruption, cellular damage to the keratinocyte membrane, and proinflammatory mediator release (cytokines, which are principally released from keratinocytes) [22,32]. These cascade events eventually result in a clinical presentation that may be divided into several possible subtypes of ICD such as acute irritant contact dermatitis, subjective or sensorial irritation, cumulative irritant contact dermatitis, traumatic irritant contact dermatitis, pustular and acneiform dermatitis, frictional dermatitis, and hyperkeratotic hand dermatitis [33].

In a population-based study carried out by Meding and colleagues, hand eczema was predominantly caused by exposure to water, and a large proportion of this exposure occurred outside the workplace [34]. According to Jungbauer and colleagues, the contribution of frequency of wetting and drying cycles is more than that of total duration of wet-work exposure in development of hand dermatitis [1]. Flyvholm and Lindberg report that multiple short exposures to wet-work are more damaging than a single long exposure [35]. Ibler and colleagues also found a significant relationship between frequent hand washing and the presence of hand eczema [36]. These studies suggest that frequent hand-washing and drying episodes seem to be implicated in the causation of a greater number of cases of dermatitis compared to immersing the hands in water for longer periods.

In most countries, women have higher representation in wet-work occupations such as housekeeping, nursing, hairdressing and floristry, compared with men, and this might be a reason for their higher prevalence of hand dermatitis [37,38]. Hand dermatitis in women is also more common among younger women in their 20s, compared with older age groups [36,39]. This might be associated with decreasing transepidermal water loss and aging [40]. Having children aged <4 years in the household is also associated with the presence of hand eczema among healthcare workers in Denmark [34]. However, it is still not clear whether this is because of an increased susceptibility to hand dermatitis in women or greater exposure of women to irritants, particularly wet-work [30]. Further

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