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Prevention of Irritant Contact Dermatitis among Health Care Workers by Using Evidence-Based Hand Hygiene Practices: A Review

Günter KAMPF[1, 2]* and Harald LÖFFLER[3, 4]

[1] Bode Chemie GmbH & Co. KG, Scientific Affairs, Melanchthonstrasse 27, 22525 Hamburg, Germany
[2] Institut für Hygiene und Umweltmedizin, Ernst-Moritz-Arndt Universität Greifswald, Walther-Rathenau-Str. 49a, 17487 Greifswald, Germany
[3] Department of Dermatology, SLS-Kliniken GmbH, Am Gesundbrunnen 20–26, 74078 Heilbronn, Germany
[4] Department of Dermatology, Philipp-University of Marburg, Deutschhausstr. 9, 35037 Marburg, Germany

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Abstract: Irritant contact dermatitis is often found on the hands of healthcare workers and is generally caused by frequent hand washing, gloves, aggressive disinfectants or detergents. Alcohols have only a marginal irritation potential, although they may cause a burning sensation on pre-irritated skin. A burning sensation when using alcohols therefore, suggests that the skin barrier is already damaged. Two options for hand hygiene are generally available in clinical practice: (1) hand washing with some type of soap and water or (2) hand disinfection with alcohol-based hand rubs. Most clinical situations require the use of an alcohol-based hand rub for decontamination, which is especially useful for reducing the nosocomial transmission of various infectious agents. Washing one's hands should be the exception, to be performed only when they are visibly soiled or contaminated with proteinaceous material, or visibly soiled with blood or other body fluids. The overall compliance rate in hand hygiene is around 50%, which is far too low. In addition, healthcare workers quite often wash their hands with soap and water, when they should use an alcohol-based hand rub. This not only adds to the degree of skin irritation, but is also potentially dangerous for patients, due to the low efficacy of hand washing when compared to hand disinfection with alcohol rubs. Adhering to evidence-based hand hygiene protocols and following international guidelines on hand hygiene practices therefore, can help prevent irritant contact dermatitis among healthcare workers.

Key words: Irritant contact dermatitis, Alcohol-based hand rub, Hand disinfection, Compliance, Prevention, Hand wash

Introduction

Irritant skin changes are frequently seen in health care workers (HCW) such as doctors, nurses, midwifes and elderly care staff. In the following article, we review the risks and benefits of hand disinfection when compared to hand washing. The aim is to develop evidence-based procedures which are safe for the skin of HCW, and which also help prevent the transmission of nosocomial pathogens by the hands, as effectively as possible.

Frequency of Occupational Hand Dermatitis among Healthcare Workers

Hand dermatitis is a classic occupational health problem for healthcare workers (HCW) in many countries[1–3]. A far higher point prevalence of hand dermatitis (for example 17–30%), can be found among them when compared to the general

*To whom correspondence should be addressed.

population[4]. The consequences are serious because many employees are forced to change their jobs or quit work entirely, due to hand dermatitis (occupational skin disease). In a population-based register study of occupational skin diseases in Northern Bavaria, Germany for example, an annual incidence rate of 7.3 cases per 10,000 HCW was observed[2].

Causes of Occupational Hand Dermatitis due to Hand Hygiene Measures

Among HCW, the pathogenesis of contact dermatitis is most frequently an irritant dermatitis, with allergies being of secondary importance[2, 5]. Meding and Swanbeck for example, provided relevant epidemiologic data by investigating over 1,300 patients with hand dermatitis. 35% of these patients had irritant hand dermatitis, 22% atopic dermatitis and only 19% allergic dermatitis[6]. Besides many topical preparations such as skin protection and skin care products, HCW also work with water, gloves, disinfectants and detergents, which are the most frequent contact substances[7, 8]. Contact sensitizations to various ingredients of detergents and disinfection products has been reported, as well as to topically applied skin care products used by the HCW or their patients[9, 10]. Many nurses complain about burning sensations following contact with alcohol-based hand rubs and assume they have an allergy against the product[11]. In these cases, allergic patch testing often reveals no sensitization. An allergy to alcohol-based hand rubs therefore, can often be neglected[5, 12].

Irritation is the most frequent cause of occupational hand dermatitis[13], and is mostly caused by hand washing and work in occlusion caused by the wearing of gloves[14]. The potential for irritation by alcohol-based hand rubs should also be considered. In a detailed patch test study, it has been shown that a 60% n-propanol solution (the concentration used in daily practice) was unable to induce any irritation on healthy skin[15]. Even on experimentally pre-irritated skin, propanol-induced damage to the skin (evaluated by measurement of transepidermal water loss and skin surface capacitance) was very low. Only for a 100% n-propanol solution, was the irritation remarkably stronger[15]. From this, it can be concluded that the alcohol part (at least n-propanol and ethanol) of alcohol-based hand rubs rarely provokes relevant irritation on intact skin[16, 17], and that—when compared to hand washing with water and detergents—for most procedures of daily hand hygiene, alcohol-based hand rubs would be preferred[18].

Table 1. Signs and symptoms of hand dermatitis

Clinical signs	Individual symptoms
Erythema	Itching
Xerosis	Burning
Infiltration	Tickling
Fissures	Pain
Papules	Tightening
Vesicles	Smarting
Exudation	
Erosion	
Excoriations	
Lichenifications	
Crusts	
Hyperkeratosis	

Clinical Symptoms of Occupational Hand Dermatitis due to Hand Hygiene Measures

Clinical signs and symptoms of hand dermatitis are polymorphic. An acute dermatitis is characterized by the presence of erythema, vesicles, exudation and papules, whereas the chronic stage especially displays lichenification, xerosis, infiltration, erosion and fissures, as well as crusts and hyperkeratosis (Table 1). Irritant dermatitis can mostly be found in the interdigital spaces and on the back of the hands. However, especially for chronic hand dermatitis when the whole skin of the hands is involved, it is difficult to make a definitive diagnose as allergic or irritant.

Symptoms of hand dermatitis include itching, burning, tickling, pain, tightening and smarting. Especially following the application of alcohol based hand rubs HCW often complain about burning sensations. The reason for these sensations is generally pre-irritated skin. If the skin barrier is disrupted, e.g. by frequent wet work[19–22] alcohol may penetrate more easily into the epidermis and even into the dermis. Yet in the epidermis there are interoceptors[23–25] which are stimulated by the alcohol, resulting in a burning sensation, but not in further irritation[11]. The problem of burning sensations tends to be the pre-irritated skin, leading to an impaired epidermal barrier, rather than the irritation caused by alcohol, which is somewhat of an old myth[26]. The burning sensation after alcohol application suggests to the user that their skin barrier is seriously impaired and that measures regarding secondary prevention should be promptly instigated.

Pathogenesis of Occupational Hand Dermatitis

In HCW, the predominant mechanisms of irritation are

frequent wet work, work with occlusive gloves and contact with aggressive surface disinfectants[2, 3]. Even water on its own, is a known irritant[27], especially with repetitive contact. Occlusion (e.g. with gloves) may worsen the damage induced by these irritants. Risk activities lead to a subclinically impaired skin barrier, before the first clinical irritations (often in the interdigital spaces) become visible (Figs. 1 and 2)[28, 29]. The strongest influence on manifestations of irritant skin changes is by far the individual's behaviour. When mild irritations like hand washing are affecting the skin frequently, the regenerating mechanism can no longer maintain a sufficient barrier[30]. The skin barrier becomes more and more disrupted and further irritation may occur more easily.

Fig. 1. Early clinical signs of interdigital eczema.
Slight erythema and superficial scaling in the interdigital spaces.

Fig. 2. Full clinical picture of interdigital eczema.
Strong widespread erythema, infiltration, rhagades, erosions and crusts.

Types of Hand Hygiene Procedures

Two principal options are available: (1) hand washing with plain or antimicrobial soap and water, or (2) hand disinfection with an alcohol-based hand rub. It is important to understand that in clinical practice each type of hand hygiene procedure has clear indications[31].

- A hand wash with plain or antimicrobial soap should be performed when hands are visibly dirty or contaminated with proteinaceous material or are visibly soiled with blood or other body fluids (category of evidence: IA).
- A hand disinfection should be performed if the hands are not visibly soiled for routinely decontaminating hands (category of evidence: IA). The most important clinical situations for hand disinfection are described in Table 2.

The categorization of each recommendation is based on current CDC / HICPAC guidelines which are based on existing scientific data, theoretical rationale, applicability, and economic impact (Table 3)[31]. It is evident that an alcohol-based hand rub should be used in the vast majority of clinical situations requiring decontamination of hands. In some countries, the development towards alcohol-based hand rubs was partly accelerated by the emergence of antibiotic-resistant bacteria such as MRSA and VRE, because commonly used agents like chlorhexidine gluconate were found to be largely ineffective against them[32–34]. Washing hands should be the exception. In clinical practice, however, the proportions of hand washing among all hand hygiene procedures is probably far higher than it should be[35]. This may be due to our education, because starting as a child, most people are trained to wash our hands when they are dirty. For HCW however, it is important to understand that hands contaminated with microbes need disinfection, not just washing.

In their daily routine, HCW are exposed to both the washing of hands and disinfection with alcohol-based hand rubs. If the epidermal barrier is disrupted and alcohol causes a burning sensation during use, this is often interpreted by the user as the "aggressiveness" of the alcohol-based hand rub. As a logical consequence, users often reduce their reliance on the alcohol-based hand rub and thus try to

Table 2. Indications for hand disinfection with the attributed category of evidence, according to CDC guidelines for hand hygiene[31]

Before	After
Having direct contact with patients (IB)	Contact with body fluids or excretions, mucous membranes, non-intact skin, and wound dressings if hands are not visibly soiled (IA)
Donning sterile gloves when inserting a central intravascular catheter (IB)	Contact with a patient's intact skin (e.g. when taking a pulse or blood pressure, and lifting a patient) (IB)
Inserting indwelling urinary catheters, peripheral vascular catheters, or other invasive devices that do not require a surgical procedure (IB)	Removing gloves (IB)
Coming to a clean body site during patient care when coming from a contaminated body site (II)	Contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient (II)

Table 3. Description of the categories of evidence, adapted from[31]

Category of evidence	Description of category
IA	Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiologic studies.
IB	Strongly recommended for implementation and supported by certain experimental, clinical, or epidemiologic studies and a strong theoretical rationale
IC	Required for implementation, as mandated by federal or state regulation or standard
II	Suggested for implementation and supported by suggestive clinical or epidemiologic studies or a theoretical rationale

compensate with increased hand washing[36]. Unfortunately, this often leads to increasing barrier disruption, which passes for a while unnoticed, but will often lead to clinically relevant hand dermatitis. A vicious circle is then initiated which may lead not only to severe hand dermatitis, but in several cases, also to occupational disability.

Prevention of Occupational Hand Dermatitis

There are several measures to prevent such a severe course of events. The most effective one is primary prevention[37], which can be differentiated by collective and individual measures. In addition, secondary prevention also has its place[38]. The development of low irritant disinfectants (like alcohol-based hand rubs) is a classical collective measure of prevention, a part of the creation of a safe occupational environment. The correct use of hand disinfectants is a classical part of individual prevention measures[39] and should be learned during professional training (e.g. in nursing schools)[40]. For preventive aspects, it is unlikely that irritations like hand washing are avoided completely, as in most cases, a reduction of the duration and frequency of washing is sufficient[41]. In addition, the extensive replacement of skin irritating behaviour such as hand washing, with less irritating measures such as alcohol-based hand rubs, is highly recommended. Even individuals with problematic preconditions (atopic constitution, earlier hand dermatitis) may benefit from a curriculum of regular skin care using appropriate disinfection behaviour.

Compliance in Hand Hygiene

Compliance in hand hygiene has so far mainly been addressed in the scientific community as the overall compliance rate. This approach, however, does not determine if an appropriate hand hygiene procedure was actually performed in a specific clinical situation, or if the hand hygiene procedure was performed correctly[42]. A more distinct approach to compliance is therefore necessary, and will increase awareness for evidence-based hand hygiene, which can be a large step towards the prevention of irritant contact dermatitis. Compliance in hand hygiene can be divided on three different levels:

- Overall compliance rate: There is no distinction between hand wash and hand disinfection. The number of performed hand hygiene procedures is in the numerator, the number of clinical situations in which a hand hygiene procedure should be performed is in the denominator. This evaluation allows one to assess if any type of hand hygiene procedure was done. It does not permit assessment if the correct hand hygiene procedure was done, or if the performed hand hygiene procedure was carried out correctly. The overall compliance rate in hand hygiene is around 50%[12].
- Specific compliance rate: Hand wash and hand disinfection are distinguished. The number of performed hand wash (or hand disinfection) procedures is in the numerator, the number of clinical situations in which a hand wash (or hand disinfection) procedure should be performed is in the denominator. This evaluation allows to assess if the correct type of hand hygiene procedure was performed (e.g. a hand disinfection was performed when it should have been performed) or if the wrong type of hand hygiene procedure was done (e.g. a hand wash was done instead of a hand disinfection). It does not allow to assess if the performed hand hygiene procedure was carried out correctly. As far as we know this evaluation has never been done in clinical practice. But data obtained by observation of HCW indicate that almost 50% of all hand hygiene procedures in clinical practice are hand washes[12]. This proportion is probably too high indicating that HCW wash their hands even if a hand disinfection would have been the correct hand hygiene procedure[34].
- Correct performance of hand hygiene procedure: This evaluation can be done for both hand wash and hand disinfection. The number of correctly performed hand wash (or hand disinfection) procedures is in the numerator, the total number of hand wash (or hand disinfection) procedures is in the denominator. A short hand wash with a mild soap and cold water followed by a final rinse to remove residual soap would be classified as a correctly performed hand wash procedure. A long hand wash with hot water and a brush would be classified as an incorrectly performed hand wash procedure.

The most important challenge in hand hygiene is to increase the overall compliance rate of hand hygiene measures, which will in turn, result in a reduction of the rate of nosocomial infections for substantial patient benefit[12]. But the compliance rate can only be raised if the HCW is not reluctant to perform hand hygiene procedures, e.g. due to irritant contact dermatitis on the hands[43]. That is why in future it will be crucial to teach healthcare workers that for routinely decontaminating hands, a well formulated alcohol-based hand rub should be used instead of washing hands. Most clinical situations require a hand disinfection procedure for the benefit of the patient (Table 2). If, for example, a hand wash is performed before inserting a urinary catheter, it would have to be classified as the wrong hand hygiene procedure in this particular situation. Improving the specific compliance in hand hygiene may require a complete change of habit among healthcare workers especially in countries where hands have traditionally been washed, and alcohol-based hand rubs are not routinely used in patient care. The HCW will benefit as the risk for irritant contact dermatitis will be reduced if hands are washed less frequently. Regular teaching would be one of the most important measures in the prevention of irritant contact dermatitis[3, 19, 40, 44]. The most important facts regarding hand disinfection in the daily routine are:

- When hands are washed, hot water and brushes should be avoided[36]. A short (e.g. 10 to 15 s) but thorough hand wash with cold or hand-warm water is usually sufficient[31].
- When decontaminating hands with an alcohol-based hand rub, the preparation should be applied to dry hands. A specific rub-in procedure should be followed to ensure that all parts of the hand are covered. Hands should not be washed following hand disinfection.
- Surgical hand disinfection should be performed without routine hand washing unless hands are visibly soiled or before the first surgery of the day. If hands need to be washed it should be done ideally 10 min or more before the application of an alcohol-based hand rub[45].

For all following surgical procedures, hand washing should be avoided and only hand disinfection should be performed.

It is essential to teach healthcare workers how a hand hygiene procedure is performed correctly. Teaching should be performed during job training (nursing and medical students) as well as in regular intervals during working practice[40]. Knowledge regarding irritation and irritants (actual irritants in a given working environment, advantages of alcohol-based hand rubs against hand washing) must be stressed and especially, all possibilities for individual means of prevention (protection by gloves and clothes, barrier creams, correct skin cleansing) should be considered[46]. Overall it may be wise to encourage infection control departments and occupational medicine departments together, with the aim to develop an institutional program for evidence-based hand hygiene in hospitals.

The Role of Skin Care

It is recommended in the CDC guidelines for hand hygiene that healthcare workers have access to hand lotions or creams with the aim to minimize the occurrence of irritant contact dermatitis associated with hand hygiene (category IA)[31]. Skin care lotions and creams should be used between hand hygiene procedures especially at the end of a shift. Older skin may require more intensive skin care. Hands should be dry before gloves are put on. Gloves should be worn only as long as necessary. In general, a 3-step concept (consisting of skin protection before work, cleaning and skin care after work) is recommended to prevent occupational contact dermatitis[9].

Practical Principles to Select a Soap and to Select an Alcohol-Based Hand Rub

A mild non-alkaline plain soap should be the first choice[36]. Antimicrobial soaps often contain chlorhexidine digluconate or triclosan as active agents. They have some antimicrobial activity[12]. This advantage over plain soap is countered by a higher risk of skin irritation and acquired bacterial resistance, especially among gram-negative bacteria[12]. Antimicrobial soaps are equally recommended as plain soap for washing hands indicating that the evidence in favour of antimicrobial soaps is rather weak[31].

Alcohol-based hand rubs should fulfil the relevant efficacy requirements[47] and be a formulation that includes emollients[31, 48, 49]. Lack of emollients may lead to dryness of skin and may impair compliance. A well-formulated preparation may even increase skin hydration[50]. Especially, the subjective assessment of the emollient effect may reveal considerable differences[51]. The hand rub should have only a minimal risk of skin irritation and sensitisation[52]. Finally, the user acceptability influenced by factors like smell, skin feeling after application and speed of dryness[53] may be a key factor irrespective of other objective factors. Gels should, in addition, be assessed for tackiness and built up[53, 54].

Conclusions for Clinical Practice

The use of well formulated alcohol-based hand rubs should become routine for the post contamination treatment of hands among healthcare workers. Washing hands with soap and water should be a rare exception, to be used only when hands are visibly soiled. This change of habit can help reduce irritant contact dermatitis and will, at the same time, provide significant patient benefits by reducing the risk of nosocomial infections. A more aggressive focus on the teaching of evidence-based hand hygiene practices is likely to be the key for future success in this respect.

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