



Irritant Contact Dermatitis: Why It Happens, Who Suffers It and How to Manage

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Abstract

Purpose of Review Irritant contact dermatitis (ICD) is defined as a localized skin reaction to irritants which does not require prior sensitization of the immune adaptative system. ICD is a consequence of direct toxic effect of physical or chemical agents resulting in keratinocyte damage. The purpose of this review was to highlight the various aspects of ICD to improve its management.

Recent Findings It is now known that ICD is a complex reaction that involved both endogenous and exogenous factors, and does not represent a homogenous entity but can cover various clinical subtypes. The management of ICD is based on its accurate diagnosis and the identification of the irritants if possible. The treatment is based on the avoidance of irritants, and strategies such as personal protective equipment (gloves, barrier creams) to be implemented at the workplace.

Summary ICD is the most frequent cause of contact dermatitis. It represents up to 95% of contact dermatitis in occupational context. This review focuses on the practical management of ICD: why it happens, which are the main clinical subtypes and what to do.

Introduction

Irritant contact dermatitis (ICD) is defined as a localized skin reaction to irritants which does not require prior sensitization of the immune system. Nevertheless, its physiopathology is multifactorial and involves a combination of exogenous and endogenous factors. ICD is the most common type of contact dermatitis and a major public health interest as it represents up to 80% of occupational contact

dermatitis [1•, 2•]. It causes significant functional impairment, disruption at work and has a high impact on the quality of life. In Western countries, ICD accounts for approximately 30% of the total occupational disease burden [3, 4•, 5], but it can occur in both occupational and non-occupational context. The aim of this review is to summarize what it is known and the latest progress about ICD.

Physiopathology

ICD is a skin reaction to irritants which, contrary to allergic contact dermatitis, requires no prior sensitization, and thus may be observed from the first exposure. However, its physiopathology is complex and it is now known that it implies endogenous and exogenous factors that activate an immune response [6••]. ICD is caused by the direct effect of an irritant on the skin. After irritant exposure, the barrier disruption and the keratinocyte damage lead to a release of pro-inflammatory cytokines, such as IL-1 α , IL-1 β , IL-6, IL-8 and TNF- α that trigger the innate immune system [7, 8]. But the associated transcriptional response is not well characterized yet.

Irritants can also be recognized as “danger signal” by the innate immune system through Toll-like and Node-like receptors which activate the inflammasome and NF κ B pathways [9•]. Recently, Toll-like Receptor 3 (TLR3) was shown to modulate cutaneous response in mice. In TLR knock-out mice, both ICD and allergic contact dermatitis (ACD) were reduced whereas they were increased in TLR3-overexpressing mice [10].

Because the disruption of the barrier causes an increased permeability, patients with ICD are more susceptible to the development of contact sensitization to allergens. Besides, when contact with an allergen is preceded by ICD, it is introduced in an already activated innate immune system, lowering the threshold for the development of ACD [11, 12].

Who Suffers It

Exogenous and endogenous factors both contribute in the development of ICD.

Endogenous factors are involved in the susceptibility to ICD

- Age. Irritant reactivity decreases with age, probably due to changes in the stratum corneum [13–15]. Nevertheless, the skin in elderly patients is characterized by a lower lipid content and a delayed reconstitution of the epidermal barrier after skin irritation. Hence, exsiccation and perineal ICD are the most important subtypes of irritant contact dermatitis in the elderly [16]. ICD is common in children who may

- develop diaper dermatitis, perianal dermatitis, sweaty sock syndrome, woollen clothing-induced ICD and perioral dermatitis [17].
- Sex. ICD is more frequent in women but many female-dominated occupations involve extensive wet work. Besides, no experimental studies have confirmed difference of irritant reactivity between sexes. Hence, the difference of the prevalence of ICD in women and men is most likely due to a difference of exposure [18].
 - Anatomic sites. The face, dorsal aspect of the hands and the finger webs are more prone to chemical irritants than the palms, soles and the back. This is mostly due to the thickness of the skin in these areas [17, 19]. A recent randomized controlled trial investigate the existence of anatomical variations of skin response to Sodium Lauryl sulphate irritation between the upper back and volar forearms and its' effects on response to treatment [20]. The upper back had higher transepidermal water loss (TEWL) values after irritation in comparison to the forearms indicating higher barrier disruption. This could be of interest for patch testing.
 - Pre-existing skin diseases, atopic dermatitis. Patients with altered barrier function are more susceptible of developing ICD, especially with atopic dermatitis [21].
 - Heritability. Twin studies indicate that genetic factors other than atopy may influence susceptibility to ICD [22].

Exogenous factors

- Skin irritants. Almost all chemicals have the potential to cause ICD. The nature of irritants, and then the potential for irritancy, is determined by its chemical and physical properties. Molecular size, ionization state and fat solubility play a key role in the potential of skin penetration.
- Exposure to irritants. Amount of exposure, concentration of irritants, duration of the exposure and repetition of the exposure must be taken into account to evaluate the skin's reaction to irritants.
- Physical irritants. Physical irritants must not be neglected. They include mechanical factors such as friction, occlusion, pressure or vibration.
- Environmental factors. Environmental factors such as temperature, air-flow, humidity and occlusion may affect the skin's response to irritants [23]. The most common and important skin irritation is wet work. Criteria for wet work include an exposure of the skin to liquid longer than 2 h per day, the use of occlusive gloves for longer than 2 h per day or frequent hand cleaning [24].
- Occupations. Occupations with repeated contact with water, and wet work, household and industrial cleaning agents, organic compounds, alkalis (cement...), acids, cutting oils, foodstuff, plants, pesticides, animals and other chemicals increase the risk of developing ICD. These occupations are especially of high risk: cleaners, medical and paramedical workers, hairdressers (Fig. 1), metalworkers (Fig. 2), food workers (Fig. 3) and construction workers [5, 17, 25]. Table 1 lists the main high-risk professions and the irritants involved).



Fig. 1. Contact with permanent agents in a hairdresser (Dr. Cleenewerck, MB).

Clinical Presentation

The diagnosis of ICD is often clinically suspected, but may be only possible after the exclusion of ACD with patch testing, especially in an occupational context. Nevertheless, we have to keep in mind that ICD and ACD can be both involved.

It is important to have a precise history to clearly identify potential irritants and allergens and exclude other diagnoses. For this purpose, the history must be detailed with the daily activities, the hobbies, manipulations at work, gloves wearing, etc.

The distribution of the dermatitis can be an important clue to the diagnosis of contact dermatitis. In ICD, the site of eruption is usually limited in the area of contact with the irritant.

Clinically ICD has a wide range of symptoms which depend on the type of irritant, its concentration, the type of exposure, environmental factors (such as



Fig. 2. ICD in a metalworker due to cooling fluids (Dr. Crepy, MN).



Fig. 3. Contact with meat and brine (Dr. Cleenewerck, MB).

humidity, temperature, mechanical pression) and the individual response. The main symptom of ICD is itching although it may not be present. Burning, stinging or pain are also often reported. Several different types of ICD have been described.

Acute ICD is caused by the exposure to a strong irritant or caustic chemical, for example strong acids or alkaline solutions [27] (Fig. 4). Symptoms of acute ICD are burning, stinging and soreness of the skin. The classical clinical features are erythema, oedema, bullae and possibly local necrosis. The typical situation is an accident at work and the healing is described as the decrescendo phenomenon as the irritant reaction starts immediately after the exposure, in contrast to ACD, in which there is a transient increase in the reaction before healing occurs (crescendo phenomenon) [6]. Hence, the diagnosis is easy in most cases, and the association between exposure and skin reaction is generally clear.

Acute delayed ICD is characteristic for certain irritants such as benzalkonium chloride or dithranol which have the potential to cause a delayed inflammatory response, approximately 8 to 24 h or more after exposure [28]. The symptoms and clinical features are similar to acute ICD. The delayed response may lead to a misdiagnosis of ACD and patch testing may be helpful.

Chronic ICD is the consequence of multiple subthreshold damages to the skin [29] (Fig. 5). It develops slowly after repeated subthreshold irritations over a period ranging from days to years. It can result of a too frequent repetition of one impairing factor, but generally it is associated with a variety of stimuli which may occur both at work and in private life. Subsequently, the link between exposure and the disease may not be obvious. It is associated with a poor prognosis [2].

Irritant reaction ICD is defined as a type of subclinical irritant dermatitis for individuals exposed to wet work.

Subjective ICD is characterized by the lack of clinical features but individuals complain of subjective sensations of burning, stinging or itching. Lactic acid and propylene glycol are common subjective irritants. Neural pathways are considered to be responsible [30].

Non-erythematous ICD is also a subclinical form of ICD corresponding to early stages of skin irritation [31, 32].

Table 1. Sectors of activity and/or professions associated with irritant contact dermatitis (TE7007049ENC), [26 • •]

Sectors of activity and/or professions	Irritants involved
1) Cleaning and food handling • Cleaners, domestic help, • Food handlers, cooks, butchers, bakers, pastry makers, grocers, cheese-makers	• Acids (phosphoric, hydrochloric, acetic, citric, vinegar) • Bases/alkalis (sodium hydroxide, potassium hydroxide, ammonium hydroxide, concentrated Javelle water) • Repeated physical microtrauma (abrasion) • Solvents (acetone), diluted Javelle water, vinegar • Wet work, soaps, detergents • Foodstuffs
2) Construction Construction workers	• Cement, particularly rapid-hardening or quick-setting cement, very alkaline (pH = 13–14), lime • Physical agents: traumas, heat, cold • Wet work, washing hands with detergents, washing powders or soaps with abrasives, alkalis (pH > 10) • Glass fibres (reinforced, composite plastics), possibly ensimated (resin-covered)
Painters	• Paint removers • Wet work, detergents • Acids, alkalis (bases) • Solvents and thinners
Wood workers	• Physical agents: thorn, traumas, wood dust • Detergents • Paints and glues • Wood preservatives
3) Hairdressing, cosmetology Hairdressers, Beauticians manicurists	• Wet work, soaps, detergents, shampoos • Perms (base: ammonium thioglycolate and acid) • Bleach (hydrogen peroxide) • Hair dyes • Glues (acrylates)
4) Healthcare workers	• Wet work, Soaps, detergents • Antiseptics and disinfectants
5) Metal industry Metalworkers, Solderers, brazers, welders	• Physical agents: trauma, sharp particles of various metallic oxide, various fibres, insulating materials • Motor fuels • Abrasives • Battery electrolytes (sulphuric acid) • Glues with cyanoacrylates • Degreasing agents (TRI, gasoline, bases) • Dewaxing agents • Protection removers (alkalis: pH > 12) • Cleaning products • Acids and alkalis • Cooling lubricants (especially water-soluble)
6) Chemical industry Plastic manufacturers, plastic-processes operators Applicators of glues and adhesives Pharmaceutical industry	• Glass fibres (reinforced, composite plastics) • (meth)Acrylates • Epoxy systems • Wet work

Table 1. (Continued)

Sectors of activity and/or professions	Irritants involved
7) Agriculture and fishing sector	• Chemicals • Drugs • Wet work, soaps, detergents • Disinfectants • Fertilizers, pesticides • Trauma: thorns, cereal beards, wood, Calcium oxalate (crystals, raphides or microscopic airborne needles) • Flowers • Processionary caterpillars from oak, pine • Sea products: jellyfish, coral

Traumatic ICD may develop after acute skin trauma such as burns or acute ICD.

Pustular and acneiform ICD is a consequence of the exposure of certain irritants such as croton oil, mineral oils, tars, grease, naphthalenes, chlorinated aromatic hydrocarbons and fluorinated compounds [33]. The pustules are sterile and transient.

Traumiterative ICD is the result of a too early repetition of exposures differing in type.

Exsiccation ICD ("eczema craquelé") is a variant of ICD which is more common in elderly patients, especially those with frequent showering and bathing without remoisturizing their skin. The condition is more frequent in winter. Typically, the skin appears dry, cracked, with ichthyosiform scaling, and patients suffer from intensive itching and a sensation of skin tightness.



Fig. 4. Acute ICD due to hydrofluoric acid accidental exposure (Pr. Tennstedt, D).



Fig. 5. Chronic ICD in a cleaner (Dr. Crépy, MN).

How to Manage

The diagnosis of ICD may be challenging. Currently there is no laboratory test to confirm ICD and it is usually an exclusion diagnosis after patch-testing. Measurement of TEWL is a non-invasive method of assessing the skin response to an irritant, but is not easily available in routine. Skin biopsy has a limited value as the histological characteristics depend on the time of its realization during the course of ICD. Nevertheless, if realized during the first days following exposure, the histology of ICD is very different from allergic contact dermatitis: in ICD, the epidermal damage is caused directly by the toxic agents whereas it is due to the host's immune reactions in allergic contact dermatitis. In ICD, epidermal necrosis sets in, often with sub-epidermal blister formation; lymphocytes are rare [17, 34].

The exhaustive identification of the irritants is also challenging. Standardized questionnaires should be helpful for both patients and physicians to identify and quantify the exposition of irritants in both occupational and non-occupational context. A recent study showed the feasibility and usefulness of a form with different items addressing both occupational and non-occupational irritant exposures in a semi-quantitative way for hand dermatitis [35••]. The distribution of the dermatitis is often an important clue to identify the irritant exposure.

The treatment is based on the avoidance of irritants. After an irritant has been identified, preventive measures should be taken both at work and at home. This is achieved through technical measures at work, individual skin protection (gloves, protective creams) and, if necessary, sick leave. Topical treatment can be used to treat the inflammation of the skin. Topical corticosteroids are often prescribed, but their use remains controversial as some reports suggest they could compromise barrier function [36–38]. Topical tacrolimus are also used with success. The regular use of emollients enhances barrier function of the skin and is an important part of the management of ICD [17, 39–42].

As ICD is a major public health problem, its prevention, especially in occupational context, is of importance. Different specialist as Dermatologist and Occupational physicians plays a key role of counselling for individual and collective prevention. The use of personal protective equipment (gloves...) during occupation and household activities is crucial [43]. In the workplace, it is important to assess the protective equipment is secured and well used [44]. Barrier creams are used to prevent the irritant effects and are recommended for application before and during the exposure. They seem to have protective effects against irritants despite the lack of standardization of the studies evaluating their efficiency [45]. Regular, frequent and a correct application of moisturizers are important to have a positive influence [46].

Conclusion

ICD is a complex reaction that involved both endogenous and exogenous factors that have to be taken into account. Both patient's characteristics and the irritants should be considered for the diagnosis and the management of ICD. Its diagnosis is challenging, but there is no test to confirm it yet, and ICD is often a diagnosis of exclusion. The treatment is based on the avoidance of irritants including the use of appropriate protective measures. Moisturizers and barrier creams may be helpful. Although sometimes prescribed, the use of topical corticosteroids is controversial as some studies suggest they could compromise barrier function. As a major public health problem, especially in occupational context, patient with severe and/or chronic ICD should be refer to specialized physicians.

Compliance with Ethical Standards

Conflict of Interest

Seta Vannina and Crepy Marie-Noëlle declare no conflicts of interest relevant to this manuscript.

Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

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