



Recent advances in occupational dermatitis

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Purpose of review

This review examined recent advances in occupational contact dermatitis (OCD).

Recent findings

Both genetic and environmental factors contribute to OCD. There is continuing growth in our understanding of the genetic factors, particularly related to filaggrin mutations. In spite of increased understanding of irritant exposures, the prevalence of hand eczema in workers with wet work exposures remains high at approximately 20%. Patch test database surveillance systems have documented reductions in the occurrence of sensitivity to some allergens such as chromium wherein regulatory efforts have reduced workplace exposures. These surveillance data have also documented increases in sensitivity to several allergens in particular trades, serving as an effective system to identify new exposure situations or new allergens. The impact of OCD on quality of life and mental health conditions, employment and financial aspects is increasingly documented. Progress in understanding the underreporting of OCD and the underlying reasons continues. Several groups have developed robust multidisciplinary secondary and tertiary prevention programmes and the evaluations demonstrate promise. Although several recent systematic reviews have documented the evidence for various prevention strategies, there is increasing understanding of the gaps in prevention practices in actual workplaces.

Summary

Understanding of the underlying genetic and environmental agents contributing to OCD is increasing. In spite of progress with reducing exposure to some allergens, the prevalence of OCD continues to be high, particularly related to wet work. New prevention programmes are being developed and evaluated and hold promise for improved outcomes.

Keywords

allergic, irritant, occupational contact dermatitis, patch testing, prevention

INTRODUCTION

Contact dermatitis is the most common occupational disease in many countries. It can be either irritant or allergic in nature. It has a large impact on the worker, workplace and society. There is substantial research underway, much carried out by major contact dermatitis programmes in Europe

MECHANISMS

Contact dermatitis is a complex disease that results from both genetic and environmental factors. There are a number of steps in the development and response wherein sensitization to one or several different allergens occurs. Schnuch *et al.* [1^a] reviewed recent work on genetic factors and contact allergy. Areas that polymorphisms may impact include availability of the allergen (barrier function, metabolism of allergen, cellular membrane trafficking), inflammatory costimulatory factors (innate immune system, cutaneous anti-inflammatory repertoire)

and basic cellular signalling and immunological factors.

In the past 10 years, the importance of filaggrin has been recognized. Kaae *et al.* [2] examined filaggrin loss-of-function mutations in various hand eczema phenotypes and propose that there is a particular type of hand eczema characterized by the filaggrin mutation. The hands of those with filaggrin mutations are described as having palmar hyperlinearity and xerosis and hyperkeratosis on the dorsa of the fingers. Individuals with the mutation

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Curr Opin Allergy Clin Immunol 2013, 13:145–150

DOI:10.1097/ACI.0b013e32835e12cf

KEY POINTS

- Approximately 20% of workers in wet work occupations such as healthcare workers and hairdressers have hand eczema.
- Patch test surveillance systems are useful for detecting changing trends in contact allergens such as decreasing sensitization to chromium and increasing sensitization to epoxy.
- Interdisciplinary secondary and tertiary prevention programmes are showing promise in helping workers with OCD have better outcomes.
- There are continuing gaps in primary prevention practices for OCD.

exposed to environmental irritants develop a homeostatic mechanism to attempt to restore the skin barrier, initially developing hyperkeratosis and eventually dermatitis.

Ross-Hansen *et al.* [3] examined filaggrin mutations and nickel reactivity. Nickel dermatitis was found in 10% of those without a history of atopic dermatitis and no filaggrin mutation, 12% of those with filaggrin mutation and no atopic dermatitis, 18% of those with atopic dermatitis and no filaggrin mutation, and 30% of those with atopic dermatitis and filaggrin mutation. Those with the filaggrin null mutation were significantly younger when they developed nickel dermatitis and the severity of the nickel reaction on patch testing was associated with the proportion of null mutations.

Visser and Landeck and colleagues [4,5] examined irritant contact dermatitis (ICD), filaggrin genotype and atopy. ICD was increased in those with filaggrin mutations [adjusted odds ratio (OR) of 1.6] and those with atopy (OR of 2.9) [4]. For those with occupational ICD (OICD), the presence of a filaggrin mutation and atopy led to poorer clinical and professional outcomes [5]. Atopy was the key predictor, but filaggrin mutation increased the impact.

EPIDEMIOLOGY

There have been a number of studies of the prevalence of hand dermatitis in the population. A recent review by Thyssen *et al.* [6] suggested that on the basis of studies between 1964 and 2007, the point prevalence was 4%, one-year prevalence 10% and lifetime prevalence 15%. Because prevalence and incidence data for OCD often come from agencies such as insurance schemes or government reporting,

the values obtained are subject to significant under-reporting. A study [7] of hairdressers examined underreporting and found that only 21% reported their hand eczema as occupational to the workers' compensation authority. A similar study [8] of healthcare workers (HCWs) found only 12% notified authorities.

Wet work is recognized as a leading cause of OICD. Several studies have examined various components of wet work to try to identify the most hazardous activities. Keegel *et al.* [9] examined exposure to wet work in working Australians. Ten percent of workers reported washing their hands more than 20 times per day and 4.5% reported immersion in liquids for more than 2 h per day. Workers more likely to report wet work exposures were women, those in the lowest occupational skill level and workers reporting skin exposure to chemicals. Fartasch *et al.* [10] examined skin irritation after wet work, teasing out the effect of water exposure and occlusion. Although both caused some effect on irritated skin, water exposure for more than 3 h per day induced physiological changes in normal skin.

There continues to be ongoing investigation of particular industries and job categories associated with wet work. HCWs have been the focus of studies to examine prevalence and risk factors. A Danish study [8] of HCW found a 1-year prevalence of hand dermatitis of 21%, a point prevalence of 12% and a lifetime prevalence of 35%, whereas a study [11] of Hong Kong nurses found a prevalence rate of 22%. Risk factors for hand dermatitis in HCW include atopic dermatitis and a personal or family history of atopy [8,11,12]. One study [12] found that atopic dermatitis increased the risk of hand eczema 3.8 times, though it is important to note that only 17% of nurses under study had atopic dermatitis. Studies [11–13] examining workplace exposures have consistently found frequent hand washing to be associated with hand dermatitis. It is important to note that frequent hand washing is a risk in those even without atopic dermatitis [12]. A nonoccupational risk factor is having a child under the age of 4 years at home [13].

Hairdressers are another group with exposure to wet work. Lysdal *et al.* [14] undertook a study of hairdressers including those working and not working. Hand eczema was reported by 38% of current hairdressers and 48% of former hairdressers. Bregnhøj *et al.* [15] reported on the prevalence of hand eczema in Danish hairdressing apprentices. The point prevalence of hand eczema (self-reported) was 2% at the beginning of their programme and 5% at follow-up. The dropouts were also analysed. They reported an incidence of self-reported hand eczema of 21 and 11% of dropouts said they did so

because of their skin. They also had a control group and were able to demonstrate a possible healthy worker effect in the hairdressing apprentices, as the controls had higher rates of previous hand eczema and atopic dermatitis [16].

Turning to occupational allergic contact dermatitis (OACD), the existence of patch test databases has led to surveillance for the key causes of allergic contact dermatitis (ACD). There have been several key reports using patch test surveillance that have clearly demonstrated both decreases in sensitivity due to preventive strategies and increases in sensitivity due to new exposures [17].

The construction sector demonstrates the effects of both prevention efforts and new exposures [18[•]]. Using the German Information Network of Departments of Dermatology

(IVDK) data, the control of chromates in cement has resulted in a decrease in potassium dichromate skin patch test positives in construction workers from 43.1% in 1994–1996 to 29% in 2006–2008. Conversely, the percentage of epoxy resin positives has increased from 8.4% in 1994–1996 to 12.4% in 2006–2008. There are a series of articles describing a newer application of epoxy in pipe relining, typically at small temporary worksites and the resultant OACD in workers [19,20].

Analysis of the epoxy positives in the Danish Contact Dermatitis Group database from 2005 to 2009 [21] identified common sources of epoxy exposure, including glue, paint, surfacing products, flooring products, grout, insulation and electronics. The majority of those with epoxy sensitivity had a relatively short time of exposure, with 37% less than 3 months, 26% 3–11 months, 23% 1–5 years and 15% greater than 5 years.

Preservatives can cause OACD. Methylchloroisothiazolinone/methylisothiazolinone (MCI/MI) as a cause of ACD was identified in the 1980s, in part due to sensitization from exposure to skin care products. As a result, there has been a reduction in the concentration of MCI/MI in leave-on and rinse-off products. Using the German IVDK database, it was found that although there was a reduction in the prevalence of positive responses in those under 40 years in those with cosmetic-related dermatitis, there was an increase in those with occupationally related dermatitis, particularly in those less than 40 years [22]. Painters have been identified as a group at risk of OCD. There have been significant changes in the types of paints used, including an increase in water-based paints that contain preservatives. Painters in the Danish Contact Dermatitis Group database between 2001 and 2010 were analysed [23]. Compared with the controls, painters were found to be at an increased risk

of OCD (36 vs. 14%). Allergens that were more common in the painters than the controls on the European baseline series included MCI/MI, epoxy resin, formaldehyde and Quaternium-15. On additional testing, the three most common isothiazolinones were methylisothiazoline, octylisothiazolinone and benzisothiazolinone.

DIAGNOSIS

The importance of patch testing was demonstrated in work undertaken by the Danish group [24]. Using a classification system based on cause and clinical pattern, they looked to see whether they could predict etiological diagnosis as determined by patch testing based on clinical pattern. Although there were some associations, there was a substantial overlap. This points out the importance of an appropriate exposure history and patch testing to establish the etiologic diagnosis.

One of the concerns regarding patch testing is the purity and stability of the allergens. Work continues to demonstrate challenges with stability of volatile allergens such as acrylates and fragrances. One study [25] studied stated vs. actual concentrations of acrylate and methacrylate materials in allergen preparations, and only 63% of samples fell between 80 and 120% of the stated amount. Another study [26] found different concentrations depending on the chamber and storage conditions. Volatile allergens should be kept refrigerated (or frozen), used by the expiry date and should be placed in chambers immediately before application, at most 2 h before use.

Standard screening panels and panels directed at particular groups of allergens are used. The major patch test groups continue to publish their results, providing general information on baseline rates of sensitization for common allergens. Reporting key factors (MOAHLFPA), as is done by the European Surveillance System on Contact Allergy, is helpful in comparing differences between groups [27].

The use of workplace materials is viewed by many as critical. European data suggest that custom testing is used in the majority of cases [28]. Houle *et al.* [29] reported on epoxy custom testing and demonstrated that 25% would have been missed if custom testing was not done.

MANAGEMENT

Several groups have implemented multidisciplinary programmes for management and have reported on their results [30^{••}]. The German group has developed and implemented a model of care, including secondary and tertiary programmes. Wilke *et al.* [31]

report on the long-term results of an interdisciplinary secondary prevention programme for workers with occupational hand dermatitis. The programme included a 1-day skin protection seminar in addition to individual counselling and recommendations. The majority of patients were HCWs. Seventy-one percent remained in their original occupation, 13% reported job loss due to their skin problem and 16% had stopped working or changed jobs for other reasons. The prevalence of hand dermatitis decreased significantly from 84 to 58% and those with moderate to severe disease decreased significantly from 40 to 16%. The intervention was most successful in those with milder disease at baseline. There was a significant reduction in the frequency of hand washing but no change in the use of skin care products. Ninety percent reported improved coping with their disease and 85% reported having been able to put much of the advice into practice.

The German tertiary prevention programme features interdisciplinary integrated care (in-patient and out-patient) and rehabilitation measures for severe OCD and involves five sites across Germany. Weisshaar *et al.* [32] reported on the 12-month follow-up and found a significant reduction in severity, use of topical corticosteroids and days away from work. Around 87% returned and remained in the workforce.

Van Gils *et al.* [33,34] reported on a programme in the Netherlands involving a multidisciplinary care team, including a dermatologist, nurse and occupational physician. Key components of the intervention were coordination of care and the programme content included evaluation by the dermatologist, education by the specialist nurse and, when work issues were present, the involvement of an occupational physician. The effectiveness of the integrated programme was evaluated in a randomized controlled trial [33]. The intervention group had a significantly greater improvement in their severity in comparison to the control group. A process evaluation was also conducted [34]. Positive aspects of the programme mentioned by patients included advice about self-management and coping and behaviour change. Generally, the number of visits were thought to be appropriate and the value of reinforcement was important. The participants would have liked greater attention paid to psychological issues, more attention to the cause of contact dermatitis and involvement of other body parts. The professionals were also satisfied, particularly with the multidisciplinary nature of the programme and direct communication resulting in good cooperation and also having more time with the patient. Barriers to implementation, most mentioned by the professionals, included lack of flexibility of the

programme, resistance of the patients, supervisors or other healthcare providers. The most important facilitator was good internal communication, specifically knowledge exchange related to diagnosis and treatment from the different disciplinary perspectives.

IMPACT/OUTCOMES

There have been several reports of the impact of OCD. Boehm *et al.* [35] examined anxiety, depression and health-related quality of life (QoL) in patients with occupational hand dermatitis. They found that 20 and 14% of the patients had a positive anxiety and depression score, respectively. The authors emphasize the importance of psychological care in addition to dermatological care.

Benyamini *et al.* [36] examined illness perception and QoL in patients with contact dermatitis (CD). They studied patients with atopic, contact, occupational dermatitis and those with other dermatological conditions for comparison. Lower QoL scores were associated with perceived serious consequences, greater symptom burden and more uncertainty and worry. Generally, patients reported low personal control and understanding of their disease. Those with occupational dermatitis had the greatest effect on QoL. Approximately 90% of the occupational group was concerned about their ability to continue to work and their financial future, and approximately two-thirds were concerned that they might be terminated from their employment.

Lysdal studied work outcomes in Danish hairdressers who had trained in hairdressing between 1985 and 2007 [13]. Approximately 44% had left hairdressing work, on average 8.4 years into their career. Hand dermatitis was more common in ex-hairdressers. Of those with hand dermatitis, 75% were between 15 and 24 years old at onset and 45.5% changed their career because of their dermatitis. In a regression model, hand dermatitis was the overwhelming contributor to career change (OR of 50). For epoxy-sensitized workers, there was also significant employment disruption, with 47% changing workplace, 31% on sick leave and 27% with job loss [21].

PREVENTION

There have been several systematic reviews related to prevention, each with a slightly different focus. Previously, Saary *et al.* [37] examined CD, Bauer *et al.* [38] examined OICD and Nicholson *et al.* [39] OCD. Van Gils *et al.* [40] reviewed prevention programmes that included education for hand dermatitis. Their

results found moderate evidence for prevention programmes with respect to lowering the prevalence and improving adherence to preventive measures.

Lack of awareness of OCD is a key barrier to prevention. There has been major work on awareness campaigns in Europe with coordinated efforts of various social partners in high-risk industries such as hairdressing [30²²].

Skin protection is one of the mainstays of prevention of OCD. Information on actual practices is helpful in identifying gaps. Holness and Kudla [41] found that although the majority reported some health and safety training, the minority reported training related to glove use and skin care. Unionized workers were more likely to receive training, whereas those involved in wet work were less likely to receive training.

Lysdal *et al.* [42] reported on skin exposures and the use of protective gloves in Danish hairdressers. In 2009, they surveyed graduates from hairdressing vocational schools who had graduated between 1985 and 2007. Around 76% reported daily wet work for at least 2 h and 54% reported wet work for at least 4 h. Gloves use was predominantly associated with colouring and bleaching but less so for highlighting and lowlighting and permanent waving. Gloves were worn during washing only 10% of time.

Skin protective creams have been shown to be effective for the prevention of ICD. However, their use in experimental studies and actual dose received may not be the same as actual practice in the workplace. Schliemann *et al.* [43] examined how much skin protection cream is actually applied in the workplace in a group of nurses. Thirty-one nurses without hand dermatitis were given a skin protection cream in special monitoring tubes and asked to use the product as they usually would over 5 work days. The mean dose applied in practice was 4–25 times lower than those used in experimental studies. Work continues on prevention programmes for apprentices. Bregnhøj *et al.* [44] conducted a controlled, prospective prevention intervention study in Danish hairdressing apprentices. After 18 months, the use of gloves during wet work had increased and the incidence of hand eczema had decreased in the intervention group.

CONCLUSION

OCD is a complex disease. The understanding of the complex gene-environment interactions is growing, in particular the role of filaggrin mutations. Although knowledge of OCD has increased, it continues to be the most common occupational disease and there has been little progress in decreasing the

prevalence of OICD in workers exposed to wet work. On the contrary, measures implemented in some countries have reduced particular forms of OACD, whereas new allergens continue to emerge. There are some promising primary, secondary and tertiary multidisciplinary programmes being evaluated in Europe, but there are still substantial gaps in primary prevention, the ultimate objective to reduce the burden of OCD.

Acknowledgements

None.

Conflicts of interest

There are no conflicts of interest.

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- of special interest
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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 218).

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