39.1 Introduction

In different ways, occupational contact dermatitis impacts heavily on the working lives of dermatologists, as well as on those of their patients. The clinician should keep in mind the leading role that work plays in people's lives. Patients with occupational contact dermatitis naturally want their dermatitis to be cleared, without their livelihood being lost at the same time [1]. The reduction in the quality of life may be considerable, particularly in severe chronic cases. This is now an area of active research [2–5].

39.2 Definition and Links

A broad definition of occupational contact dermatitis is contact dermatitis due wholly or partly to the patient's occupation. Occupation must be a major factor in stricter definitions, and is essential to causation in a still stricter sense, i.e., an occupational contact dermatitis is a contact dermatitis that would not have occurred if the patient had not been doing the work of that occupation [1]. These medical definitions may deviate considerably from legal definitions, which are the basis for workers' compensation claims (Chap. 46).

Occupational contact dermatitis constitutes over 90% of the wider spectrum of occupational dermatoses [6], with the remaining including contact urticaria, oil folliculitis (oil acne), chloracne, leukoderma, scleroderma-like disease, ulceration (Fig. 1), bacterial, viral, and mycotic infections, as well as epidermal neoplasia [7, 8]. Some substances that cause occupational contact dermatitis also cause other occupational disorders, including: asthma, for example, colophonium [9]; eye irritation, for example, formaldehyde; anosmia, for example, hexavalent chromium; paresthesia, for example, methyl methacrylate; and psychiatric disturbance, for example, organotins.
39.3 History

The history of modern occupational contact dermatitis began in 1915, with the publication of Prosser White’s *The Dermatergoses or Occupational Affections of the Skin* (England), with further impetus being provided in 1939 by Poul Bonnevie’s *Aetiologie und Pathogenese der Ekzemkrankheiten* (Denmark) and Louis Schwartz, Louis Tulipan, and Samuel M. Peck’s *Occupational Diseases of the Skin* (USA).

Charles Calnan recorded how it was Professor Hageman at the University of Lund in Southern Sweden who gave Sigfrid Fregert the opportunity to make Europe the focus of occupational contact dermatitis over the past 35 years [11], the late Niels Hjorth [12], Helmut Ippen [13], and Veikko Pirilä [14] all striving, among others, to maintain this impetus. Robert Adams [7] in the USA, and Jean Foussereau [15] and Eberhard Zschunke [16] in Europe are the authors of major contemporary texts. Recently, an atlas was also published [17].

39.4 Epidemiology

Coenraads et al. (Chap. 10) and other authors elsewhere in this textbook suggest an incidence of occupational skin disease of 0.5–1.9 cases per 1,000 full-time workers per year. The highest incidence rates are seen in hairdressers (97/10,000 per year), followed by bakers (33/10,000), and florists (24/10,000) [2, 18, 19]. These authors also consider that prevalence studies suggest that age and sex are not risk factors in themselves, but that they are associated instead with different exposures. Evidence remains that black skin tends to be more resistant to contact dermatitis than white [20].

39.5 Etiology

Irritant contact dermatitis remains generally more common occupationally than allergic contact dermatitis, though the more patients who are patch tested, the greater the proportion of allergic contact dermatitis tends to become [11, 21] (Fig. 2). As irritation facilitates the induction of contact allergy [22], many cases of occupational contact dermatitis are likely to be of mixed irritant and allergic etiology (Fig. 3).
39.5.1 Irritants

Irritancy in general is covered in Chaps. 4 and 15. The common high-risk occupations for irritant contact dermatitis are:

- Baker
- Butcher
- Caterer
- Cleaner
- Construction worker
- Dental technician
- Florist
- Food producer
- Hairdresser
- Healthcare worker
- Homemaker
- Horticulturist
- Masseur/masseuse
- Metalworker
- Motor mechanic
- Nurse
- Painter
- Printer
- Tiler

The principal occupational contact irritants are:

- Water
- Soaps and detergents
- Alkalis
- Acids
- Metalworking fluids
- Organic solvents
- Other petroleum products
- Oxidizing agents
- Reducing agents
- Animal products
- Physical factors

The wide individual variation in susceptibility to chronic irritant contact dermatitis is gradually becoming better understood. Past or present atopic eczema at least doubles the risk of irritant contact dermatitis of the hands in occupations such as those listed above [23, 24]. A nonatopic genetic marker, involving a tumor necrosis factor (TNF) α polymorphism, has recently been identified as being linked to irritant susceptibility [25] (see also Chaps. 4 and 9).

39.5.2 Allergens

Common high-risk occupations for allergic contact dermatitis are:

- Adhesives/sealants/resins/plastics worker
- Agriculturalist
- Cement caster
- Construction worker
- Dental technician
- Florist
- Glass worker
- Graphics worker
- Hairdresser and barber
- Horticulturist
- Leather tanner
- Painter
- Pharmaceutical/chemical worker
- Rubber worker
- Textile worker
- Tiler and terrazzo-maker
- Woodworker

The principal occupational contact allergens are:

- Biocides (including isothiazolinones)
- Chromate (cobalt)
- Dyes
See also Fig. 4. Atopics do not appear to incur a generally increased risk of allergic contact dermatitis along with their increased risk of irritant contact dermatitis (see also Chap. 9).

### 39.6 Clinical Features

The hands are, clearly, by far the most likely primary site of occupational contact dermatitis. Airborne (or exposure-pattern) contact dermatitis is also commonly occupational [26]. Rarer presentations, such as fingernail dystrophies unaccompanied by fingertip dermatitis, are more easily missed [27] (Fig. 5).
39.7 Prognosis

The prognosis of occupational contact dermatitis severe enough to be referred to a specialist dermatologist is one of persistence in more than half of all cases, though with improvement in more than half of these [11, 28, 29]. This applies to irritant as well as to allergic contact dermatitis. Appropriate occupational changes improve the prognosis for most patients, but around 10% of such severe patients develop persistent post-occupational dermatitis [28].

However, many cases less severe than those referred to specialist dermatologists have a much better prognosis. And even in severe cases, dermatitis may become more manageable after thorough investigation and adequate treatment [30]. Improved patient education, via a specially trained nurse, has been shown to improve prognosis [31]. Reasons for the persistence of contact dermatitis, particularly occupational hand dermatitis, are discussed by Hogan et al. [32], who admit that this often remains unexplained.

39.8 Diagnosis

39.8.1 Clinical

Taking the history of a case is a clinical skill requiring adaptation to the individual patient, but every history is based on certain essential facts.

- Time of onset. This is frequently initially set aside by the patient and replaced by the time of onset of the eventual exacerbation that led them to seek medical advice, which may be many months later [11].
- Primary site. The hands or exposed skin favor occupational causation, rather than covered areas of the trunk or feet.
- Secondary spread. Distant spread to the feet or face is more common in allergic than in irritant occupational contact dermatitis [33].
- Occupation. The following are required: the type, the length of time in it, and the precise tasks involved.

There are some particularly useful additional facts to establish:

- Work relatedness. Occupational contact dermatitis initially shows greater and more consistent improvement away from work than nonoccupational dermatitis, though with chronicity such work relatedness may become less clear. Allergic occupational contact dermatitis tends to worsen more rapidly than irritant dermatitis on return to work.

- Prevention. The effects of gloves, other personal protective equipment, or skin care products may help to confirm occupational causation or point to a secondary contact factor.

- Other cases. Involvement of fellow workers (and in what proportion) increases the probability of occupational contact dermatitis (- with larger proportions favoring irritant rather than allergic).

39.8.2 Patch Tests

A standard series is rarely sufficient in occupational cases, and its supplementation with additional series (Table 1) and patients’ own samples is frequently required. De Groot’s systematic handbook is recommended for readily accessible guidance on appropriate patch test dilutions of individual chemicals [34]. While there is no substitute for practical training and experience in patch testing patients’ own samples, certain guidelines are given later in the section on individual occupations (see also Chaps. 49 and 50).

Although not sufficient, the standard series still detects many case of occupational skin diseases, as a...
recent evaluation on 4,112 patients reported to health authorities in Northern Bavaria (Germany) shows [35]. Nickel sulfate was the most common sensitizer (29.5%) but had an occupational relevance in only 11% of the cases sensitized. The most occupationally relevant sensitizers were thiuram mix (71%), epoxy resin (67%), PPD free base (59%), PPD black rubber mix/IPPD (53%), potassium dichromate (48%), formaldehyde (38%), chloromethylisothiazolinone/methylisothiazolinone (37%), and mercaptol mix/mercaptobenzothiazole (35%). Occupational groups at risk of acquiring delayed-type sensitizations were, in particular, electroplaters, tile setters/terrazzo workers, construction and cement workers, solderers, wood processors, and leather industry and fur processors.

### 39.8.3 Other Tests

Tests for immediate hypersensitivity are described in Chap. 26. Simple chemical tests for the identification of special allergens are described in Chap. 25.

More advanced chemical methods of analysis, such as high-performance liquid chromatography and gas chromatography–mass spectrometry, have contributed greatly to our knowledge of the allergenic fractions of occupational sensitizers, including phenol-formaldehyde resin [36], colophonium [37], D-limonene [38], and the tulip [39]. Dermal exposure assessment techniques [40] to measure the degree of skin contamination have been made more accurate by the further development of video imaging of fluorescent tracers [41]. Recently, a new method for assessing dermal exposure to permanent hair dyes has been described [42].

### 39.8.4 Workplace Visits

When Fregert et al. were pioneering the practice of occupational dermatology in Southern Sweden, they “soon found that the opportunity of visiting working-places and factories was a requisite for adequate solving of problems of occupational dermatology” [43].

The information useful to be acquired from workplace visits is detailed in Table 2, and the benefits to be gained are listed in Table 3. Similar principles apply to telephoning, faxing, e-mailing, or writing to medical, nursing, employer, or employee representatives. But the answer obtained to a question posed in this way depends greatly on who is asked, whereas trained direct observation is more likely to be accurate (Fig. 6).

### Table 2. Information useful to be acquired from workplace visits

<table>
<thead>
<tr>
<th>Information</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational</td>
<td>Name, address (including postal code), telephone and fax numbers, and e-mail address of workplace Name and status of all medical, nursing, employer, and employee representatives questioned</td>
</tr>
<tr>
<td>Demographic</td>
<td>Numbers employed overall and in the patient’s work area Current expansion, contraction, and turnover Shift pattern and pay scheme</td>
</tr>
<tr>
<td>Technical</td>
<td>Broad concept of process as a whole Detailed understanding of work carried out by patient and in patient’s work area, including all potential irritants and allergens observed and their degree and extent of skin contact Names, addresses, telephone and fax numbers, and e-mail addresses of suppliers of materials requiring further identification</td>
</tr>
<tr>
<td>Preventive</td>
<td>Broad impression of working conditions (space, lighting, ventilation) More detailed review of protective installations, personal protective equipment, skin care products, and education Assessment of actual uptake and effectiveness of above</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Industrial relations, psychological, sociological, and economic factors Comparison with sister factory</td>
</tr>
<tr>
<td>Clinical</td>
<td>Skin complaints in employees other than the patient Their clinical assessment and subdivision into occupational and non-occupational (often provisional)</td>
</tr>
<tr>
<td>Epidemiological</td>
<td>Frequency of skin complaints as a proportion of the total number exposed Estimate of frequency of occupational dermatoses</td>
</tr>
<tr>
<td>Etiological</td>
<td>Opinions of others, with attribution as to source and estimate of reliability Own opinion, with grounds for it (may be inconclusive)</td>
</tr>
<tr>
<td>Operational</td>
<td>Summary of findings Recommendations for future investigation, management, and review Follow-up</td>
</tr>
</tbody>
</table>
39.8.5 Epidemiological Surveys

An epidemiological survey of dermatoses within a work area may be needed when the clinical assessment of individual patients fails to delineate an occupational dermatosis clearly enough. Such surveys should always be planned with epidemiological and statistical advice from the very beginning, since this may affect the fundamental design of the study. Coenraads et al. have identified the crucial concepts to be understood in Chap. 10.

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Table 3. Benefits of visiting workplace

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection of relevance of previously unexplained positive standard patch test reactions</td>
<td>[140]</td>
</tr>
<tr>
<td>Detection of missed allergen</td>
<td></td>
</tr>
<tr>
<td>Substantiation of diagnosis of irritant contact dermatitis</td>
<td>[120, 140, 141]</td>
</tr>
<tr>
<td>Diagnosis of slight or unfamiliar occupational dermatoses</td>
<td>[142]</td>
</tr>
<tr>
<td>Substantiation that various non-occupational dermatoses have been grouped together as a pseudo-occupational dermatosis and why</td>
<td>[141]</td>
</tr>
<tr>
<td>Recognition of phenomenon of visible dermatoses, whether occupational or not, causing anxiety and subconsciously imitative symptoms in fellow employees</td>
<td>[141]</td>
</tr>
<tr>
<td>Initiation of research on new occupational dermatoses</td>
<td></td>
</tr>
<tr>
<td>Incidental effects, such as improved dermatologist–occupational physician and dermatologist–patient relationships</td>
<td></td>
</tr>
<tr>
<td>Progressive increase in dermatologist’s overall knowledge of patients’ working contactants</td>
<td></td>
</tr>
</tbody>
</table>

---

Core Message

- Occupational contact dermatitis is the most frequent cause of occupational skin diseases. It has a major socioeconomic impact. Affected persons often experience severe impairment in the quality of life. The ratio of irritant to allergic contact dermatitis varies considerably among occupations, and depends also on the experience and diagnostic thoroughness of the examining dermatologist.

39.9 Treatment

The treatment of occupational contact dermatitis is founded on accurate diagnosis and subsequent partial or complete separation of the patient from the cause. Besides the treatment principles outlined for contact dermatitis generally in Chap. 44, there are some that are specific for occupational cases.
39.9.1 Acute

Initial absence from work should be restricted to that required for adequate, rather than necessarily complete, recovery if the resulting disability is to be minimized [1]. In large companies, a temporary transfer to alternative duties allows an early but safe return to work.

39.9.2 Chronic

With certain exceptions, as indicated below, the primary aim of managing the chronic case of occupational contact dermatitis is to return the patient to his or her original job. If this cannot be achieved, the emphasis should then shift to appropriate retraining and redeployment, rather than to lump-sum compensation payment and medical retirement [44].

The first exception to attempting to return patients to their original job is in cases of isolated uncomplicated allergic contact dermatitis from substances such as epoxy resin, biocides, other specific chemicals, or plant allergens. A rapid and permanent change of occupation in such cases usually results in complete clearance, and no change of occupation in almost certain chronicity.

The second such exception is in certain types of wet work, where there is evidence of an increased susceptibility to irritation in those with sensitive skins (see Sect. 39.5.1, Irritants). The prognosis for such individuals tends to be bad, even after a change of occupation, but it is made so much worse by continuation in the same job – for example, catering, hairdressing, and metalworking – that the only realistic option is early redeployment.

In all chronic cases of hand dermatitis, the acquisition of secondary contact allergies to ingredients of skin care products or medicaments must be kept in mind (fragrances, preservatives, rubber allergens, corticosteroids; [45] and Chap. 19).

In hairdressers and other high-risk occupations, the value of teaching programs regarding the avoidance of irritants and allergens as well as the regular use of adequate skin protection and application of skin care products has been well documented (Chap. 44, Sect. 44.3). Chronicity can, thus, often be avoided or minimized in order to keep the worker at his/her job. This is particularly important for employees who seem to be too old or intellectually unsuitable for a retraining procedure.

39.10 Prevention

Because of the poor prognosis associated with well-established occupational contact dermatitis (see Sect. 39.7, Prognosis), its prevention is of great importance (see also Chap. 44).

39.10.1 Pre-Employment Examination

Guidelines have been published on the pre-employment screening of prospective employees with skin disease [46]. Past or present skin atopy at least doubles the risk of irritant contact dermatitis of the hands in occupations such as those listed earlier [23]. Staphylococcal colonization of chronic occupational contact dermatitis may pose threats of cross-infection in health care and of food poisoning in catering [46]. “Rusters” (Fig. 7) should not work with ferrous metals, unless their hyperhidrosis can be successfully treated [47].

39.10.2 Skin Tests

Pre-employment patch testing with potential sensitizers should not be performed. Tests of irritant susceptibility are not yet robust enough for routine use.

Fig. 7. The hyperhidrotic hand of a “ruster” and the ferrous metal handled by him (courtesy of St. John’s Institute of Dermatology)
39.10.3 Occupational Hygiene

Substitution of irritants and allergens will always head the hierarchy of exposure controls [48]. Even “automated” processes continue to provide opportunities for skin contact [49], particularly for maintenance fitters (service engineers). Wearing gloves may be considered unsafe in the operation of rapidly rotating machinery.

39.10.4 Personal Hygiene

39.10.4.1 Personal Protective Equipment

Although extensive data are now available on the penetration of protective gloves and clothing by contactants [50], the prevention of contamination of the inside of gloves when putting them on and taking them off is often of even more importance. Detailed guidance as to the suitability of glove material is given in Chap. 44, Sect. 44.2. The actual protection provided depends not only on avoiding inadvertent contamination, but also on factors such as manufacturing quality, glove thickness, chemical concentration, duration of contact, and environmental temperature and humidity.

39.10.4.2 Barrier Creams

“Barrier” creams, in general, are realistically regarded as assisting in the prevention of contact dermatitis by their beneficial effects on the stratum corneum as moisturizers [51, 52], more than as barriers in their own right [53]. Skin care products with specific activities such as the chelation of nickel [54] or the inactivation of methylchloroisothiazolinone + methylisothiazolinone [55] may have a future role. Barrier creams may give weak irritant reactions on patch testing. True sensitization is rare. A critical update according to the criteria of evidence-based medicine has recently been published [56] (see also Chaps. 15 and 44).

39.10.5 Dermatitic Potential

Methods for assessing the irritant and allergic potential are reviewed in Chap. 12.

39.11 Medical Report

The demands on the dermatologist in the preparation of medical reports for compensation purposes vary from country to country. The items listed in Table 4 cover many of the areas requiring consideration for inclusion. It is helpful if medical terms not of common currency are explained as they occur.

Core Message

- The main goal in treatment and prevention is avoiding chronicity of the contact dermatitis. After a working diagnosis has been established, this goal can only be achieved by intensive cooperation with the patient and the employer. All contact irritants (chemical, thermal, mechanical) and contact allergens (workplace, skin care products, protective garments, etc.) must be evaluated as the cause or as contributory factors. Together with the employer and safety engineer, these factors must be scrutinized and, if possible, reduced or eliminated.

The worker’s motivation and knowledge about his/her disease must be increased in training schools.

39.12 The Major Occupational Problem Areas

39.12.1 Agriculture

The wide variety of contactants in farming raises a large number of possible causes of occupational dermatitis. Irritant contact dermatitis (ICD) can be caused by milking equipment, cleansers, tractor and machinery fuels, chemical fertilizers, animal feed preservatives [57, 58], and pesticides. Allergic contact dermatitis (ACD) arises from: rubber chemicals, including N-isopropyl-N’-phenyl-p-phenylenediamine (IPPD), as well as thiurams, in milking equipment, lambing rings [59], boots and gloves; plants, including members of the Compositae family, more commonly than pesticides; antibiotics in animal feeds and veterinary use [60]; animal feed additives, such as cobalt, vitamin K₃, ethoxyquin, olaquindox [61], dinitolmide, and phenothiazines; and chromate in cement. Contact urticaria (CU)/protein contact dermatitis (PCD) may be caused by animal hair and dander [62, 63].
Wet clay, plaster, and organic solvents are potential irritants. This remains one of the few areas of work where turpentine is a potential allergen [64]. Nickel, cobalt, and chromium can all be relevant allergens in pigments, together with colophonium and epoxy resin in the standard series. (Meth)Acrylates, formaldehyde resins, and polyurethane (diisocyanate) resins may all be used in modeling and repairs, requiring additional series to be tested. Azo and phthalocyanine dyes may be used in the creation of pigments [65].

### Table 4. Items to consider including in a medical report

<table>
<thead>
<tr>
<th>Item</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualifications</td>
<td>Sufficient detail to demonstrate expertise</td>
</tr>
<tr>
<td>Instructions</td>
<td>Sufficient detail to indicate purpose of report</td>
</tr>
<tr>
<td>Sources of information other than the patient</td>
<td>Previous medical records, previous medical reports, workplace inspecions</td>
</tr>
<tr>
<td>Personal history</td>
<td>Atopy, other allergies, other dermatoses</td>
</tr>
<tr>
<td>Family history</td>
<td>Atopy, other allergies, other dermatoses</td>
</tr>
<tr>
<td>Occupational history</td>
<td>Job titles, employers, types of contact, dates</td>
</tr>
<tr>
<td>Present occupation</td>
<td>Job title, employer’s name and full address, dates</td>
</tr>
<tr>
<td>Time in contact with suspected causal factors</td>
<td>May be shorter (or longer) time than time in present occupation</td>
</tr>
<tr>
<td>Description of the working process</td>
<td>Sufficient detail to give accurate assessment of degree and extent of skin contact, as well as range of skin contactants</td>
</tr>
<tr>
<td>Broader working background</td>
<td>Skin care products, personal protective equipment</td>
</tr>
<tr>
<td>Time and site of initial skin complaint</td>
<td>Previous injury at initial site? To whom reported? What treatment given?</td>
</tr>
<tr>
<td>Progress, with approximate dates</td>
<td>Gradual/sudden exacerbations/improvements; influence of weekends, holidays, sickness absence; early on, later on</td>
</tr>
<tr>
<td>Degree of incapacity during course</td>
<td>Dates of absence from work; level of earnings before and after dermatosis</td>
</tr>
<tr>
<td>Changes in occupation since onset</td>
<td>Job titles, dates, details of changes in contactants</td>
</tr>
<tr>
<td>Treatment and its effectiveness</td>
<td>Patient may need to obtain details from attending physician</td>
</tr>
<tr>
<td>Clinical findings</td>
<td>Present state. Have lesions been suppressed by treatment?</td>
</tr>
<tr>
<td>Special investigations</td>
<td>Patch tests, prick tests, open tests, repeated open application tests (positive and negative results, times of readings, concentrations, vehicles, application method, site). Who performed and read such tests? Hematological/bacteriological/mycological test results</td>
</tr>
<tr>
<td>Intercurrent diseases</td>
<td>Mycotic infections, light eruptions, fever</td>
</tr>
<tr>
<td>Diagnosis/diagnoses</td>
<td></td>
</tr>
<tr>
<td>Common knowledge of risk</td>
<td>Could the employer reasonably have been expected to have foreseen any risk to the skin?</td>
</tr>
<tr>
<td>Conclusions in terms understandable to non-medical readers</td>
<td>Probable connection between occupation and dermatosis: balanced against predisposing and contributory factors. Possibility of continuing in occupation: prospect of rehabilitation if required Probable medical prognosis (likelihood of relapse) Probable socioeconomic prognosis (capacity for work)</td>
</tr>
</tbody>
</table>

### 39.12.2 Arts and Crafts

As in many other occupations, the difficulty the dermatologist has here is to identify the rarer cases of
contact sensitization against a background of irritancy provided by mechanical wear and tear, light oils, degreasing solvents, and synthetic mineral fibers [66]. Chromate is particularly important because of its use as an anticorrosive [67]. As well as standard (DGEBA) epoxy resin, the aerospace industry uses nonstandard epoxies, such as triglycidyl-p-aminophenol (TGPAP) and tetraglycidyl-4,4’-methylene diamine (TGMDA), which cannot be relied upon to cross-react. (Meth)acrylates are widely used as sealants and threadlockers. Unsaturated polyester (UP) resin systems, widely used on automobiles, rarely cause contact dermatitis, and a commercial plastics and glues series is a reasonably good screen for sensitization to their additives (see also Chap. 34).

### 39.12.4 Baking and Patisserie

CU/PCD must be looked for as well as ICD and ACD. Automation has reduced exposure to dough in many larger bakeries, but irritation from the degree of such contact still commonly occurs in smaller and specialist establishments. Cleaning the equipment and surfaces is another common source of irritancy. Spices and essences (cinnamon, cardamom) are important type-I as well as type-IV sensitizers, while flour [68] and flour improvers, such as α-amylase [69], can cause CU/PCD. Skin atopy is a significant risk factor in such work [70], where irritancy still seems to predominate over sensitization [71, 72].

### 39.12.5 Catering and Food Production

Cronin’s [73] review remains an extremely good starting point when approaching this large group of workers: “Chefs and kitchen staff handle raw, moist food for many hours each day. The work is wet, they use detergents and cleansers, they rarely wear gloves, and the insult to their hands is considerable.” Against this background of commonly occurring chronic ICD, both type-I (CU/PCD) and type-IV (ACD) sensitization require thorough investigation.

Garlic and onion (Alliaceae) are the most important foods to patch test with, their juices diluted to 50% in petrolatum, reducing the irritancy that they otherwise can cause. Diallyl disulfide is a useful additional test for garlic dermatitis, though it is not the only allergen in garlic [74]. Hardwood knife handles can sensitize and should be patch tested as fine scrapings. Compositae mix positives in food handlers’ hand dermatitis have been interpreted as indicating lettuce allergy [75], which is, therefore, also important to patch test with as well as to prick test with as a known type-I sensitizer (the leaf, as is, is not irritant). Other particularly important foods to prick test with are fish and shellfish [76], cucumber, tomato, and potato [73]. Staphylococcal colonization of food handlers’ hand dermatitis carries the public health risk of food poisoning [46] (Fig. 8).

### 39.12.6 Chemical and Pharmaceutical Production

Irritants and sensitizers are specific to each process and the dermatologist is often left with preparing cautious serial dilutions of unfamiliar chemicals. For example, they may often apply 0.1% and 0.01% initially, adding in 1% at the day-2 reading if 0.1% and 0.01% are negative. Halogenated chemical intermediates tend to be potent allergens. Many transient rashes, even if recurrent, turn out to be negative on both patch testing and prick testing, and are probably due to irritancy enhanced by local factors such as sweating and occlusion. Airborne ACD and erythema-multiforme-like eruptions in chemistry students from an aniline dye [77] and costus resinoid [78] have recently been observed.

### 39.12.7 Cleaning

Type-I and type-IV allergies to rubber gloves are the only major rivals to chronic ICD in this huge, mainly female, workforce [79]. The standard series can prob-
ably be relied on to detect most other contact allergens, such as biocides and fragrances, in cleaning products. D-Limonene, as a component of environmentally friendly cleaning agents, is a currently important exception to this [80]. The relevance of nickel is controversial [81, 82].

### 39.12.8 Construction, Tunneling, and Mining

The role of chromate in wet cement as the main cause of dermatitis in the construction industry has now disappeared in countries where cement has ferrous sulfate added to it [83], though not necessarily in others [84]. Chronic ICD can also occur from wet cement. Pneumatic drills can release irritant mineral oil and, under extreme winter conditions, ethylene glycol [85]. Machinery fuels and hydraulic oils are further sources of irritancy. The standard series can be relied on to detect the common sensitizations other than chromate, which are rubber processing chemicals (gloves and boots) and epoxy resin (flooring and civil engineering) [86].

### 39.12.9 Electrics and Electronics

This is one of the industries where itchy skin may be caused by low-humidity environments contrived to protect the product [87]. Automation diminishes many of the risks, but ICD can still arise from organic solvents and synthetic mineral fibers, chemical burns from hydrofluoric acid, and ACD from colophonium (rosin) in soldering flux (may be airborne) and epoxy resin and hardeners. Fiber optics manufacture involves UV-curing (meth)acrylates that the standard series would not detect (see Table 1).

### 39.12.10 Floristry and Horticulture

This group of workers is used to their hands showing wear-and-tear from tasks such as stripping off leaves and wiring stems, and they are familiar with many irritant plants, so that, when they do present to dermatologists, their dermatitis is frequently allergic [11]. Plant material and extracts [88], though bearing risks of false-negative and false-positive reactions and active sensitization, are frequently helpful. Compositae dermatitis can be screened for with the sesquiterpene lactone mix (Hermal) and, while some prefer the Compositae mix (Hermal), the latter has been reported to bear a substantial risk of active sensitization [89]. The standard series may provide further indications of sensitization with reactions to balsam of Peru (Myroxylon pereirae resin), fragrance mix, and colophonium, as well as primin (if included). The most common additional plant sensitizers currently are probably tulips [74] and alstroemerias [90].

### 39.12.11 Hairdressing and Beauty

This is another group of workers whose familiarity with low-grade chronic ICD, mainly from shampooing, makes allergy likely if they come to patch testing. Glyceryl thioglycolate (GTG) in acid perming solutions is currently the most common cause of ACD in European hairdressers [91] (Fig. 9), and should, therefore, be present in all hairdressers’ series (Table 1), which are essential to patch testing hairdressers. However, major manufacturers of hair care products have stopped the production of GTG because of the high prevalence of sensitization in hairdressers, but which is less frequent in clients. We may, therefore, see a decline in sensitization figures in the near future. para-Phenylenediamine (PPD) in the standard series remains the other allergen of major importance [92]. Some hairdressers and beauticians acquire sensitization to PPD not in the professional way by dyeing hair, but privately by a so-called temporary black henna tattoo, which contains a large amount of PPD (see Chaps. 14 and 29). The standard series will also detect relevant allergies to preservatives, such as formaldehyde, formaldehyde releasers and methylchloroisothiazolinone/ methylisothiazolinone (MCI/MI), fragrances and rubber chemicals, with type-I allergy to natural rubber latex also requiring consideration [93]. Sensitization to methylidibromo glutaronitride in shampoos and leave-on

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**Fig. 9.** Allergic contact dermatitis on pulps of hairdresser’s hands from glyceryl thioglycolate (courtesy of PJ Frosch)
products has become an increasing problem and has led to legislative action (see Chap. 29 and [94, 95]). Previously, cocamidopropyl betaine [96] in shampoos was relevant in some hairdressers, but, due to different manufacturing processes, the major allergen 3-dimethylaminopropylamine (DMAPA) in this surfactant is eliminated or greatly reduced in quantity [97]. The significance of nickel as an occupational allergen is controversial [98] – most hairdressers acquire this sensitization by wearing costume jewelry; nickel-containing objects and tools in hairdressing have virtually vanished [35]. Aromatherapy is increasing the exposure of beauticians to fragrance allergens [99, 100], for whom colophonium can also be relevant from its presence in depilatory wax [101].

39.12.12 Health Care

CU/PCD from type-I allergy to natural rubber latex (NRL) is more common in this group of workers than in any other [102] (Fig. 10), with ACD from rubber-processing chemicals remaining important. This group of workers also has a higher risk of sensitization to fragrances and methyldibromo glutaronitrile in liquid soaps, hand creams, and various other materials [103–105]. Relevant allergens not detected by the standard series include, most importantly, glutaraldehyde (endoscopic and dental cold sterilant, X-ray developing systems) and (meth)acrylates (orthopedic and dental reconstruction) [106–108]. Glutaraldehyde, as well as chlorhexidine-containing and povidone-iodine-containing skin cleansers, often cause ICD rather than ACD [109]. Individual drugs – some of which, such as propacetamol [110], can cause airborne ACD – may also need to be tested for, as indicated by the history.

39.12.13 Laboratory

Hand washing and cleaning equipment commonly causes chronic ICD. This is another occupational group at risk of type-I NRL allergy and in whom ACD

Fig. 10a, b. Occupational allergic contact dermatitis from gloves in a female surgeon (a). She was patch test positive to thiuram mix and the glove’s manufacturer confirmed the presence of a thiuram derivative. Note that the dermatitis is the most severe on the back of the hands and least so on the palms (b)
from rubber-processing chemicals also occurs [111]. The standard series will usefully pick up allergens such as epoxy resin, which, recently, caused an epidemic of ACD from its addition to a microscopy immersion oil [112]. Innumerable other allergens are used in laboratories [113], and many may require individual patch and/or prick testing.

### 39.12.14 Metalworking

It is the metalworking fluids (MWFs) (Fig. 11), rather than the metals, that are a major problem for these workers, with ICD being more common than ACD, though sensitization occurs particularly from water-based MWFs [114, 115] (Fig. 12). Oil-based MWFs (neat oils) can be patch tested at from 1% (low viscosity) to 25% (high viscosity), while the concentrates of water-based MWFs (soluble oils) require ideally a 10%, 5%, 2.5% serial dilution. Recently, a German working party on allergy diagnostics in the metals branch has published guidelines for testing with fresh and used samples of the patients’ MWFs [116]. Fresh concentrate of the water-based MWF should be tested at 5% aq., which is an average workplace concentration. Used water-based MWF can be patch tested as is, provided that the concentration at the work-place is ≤8%. In the case of higher workplace concentrations, further dilution to an end concentration of 4–8% is recommended. As a rule of thumb, this can be achieved by a 1:1 aqueous dilution of the water-based MWF. Neat oils should be tested 50% in olive oils according to this report [116]. It is often the biocides that are the sensitizers in water-based MWFs, and additional series (Table 1) are helpful in identifying these. Alkanolamine borate corrosion inhibitors may sensitize and are difficult to patch test with, a buffered dilution series being recommended [117]. The standard series will identify colophonium-positive individuals who may have been sensitized by chemically related tall-oil-based emulsifiers in water-based MWFs. Mercaptobenzothiazole and ethylenediamine [118] may also be present in water-based MWFs. Fragrances are often added to MWF in order to mask the odor. This explains the higher prevalence of sensitization to the fragrance mix in metal workers ([115] and Chap. 33). Unless they occur in electroplaters, reactions to nickel, cobalt, and chromate require careful assessment as to their relevance, and can be incidental. Degreasing solvents are another common cause of ICD and are usually best left untested.

### 39.12.15 Office

Office workers are another group who may experience itchy skins from low-humidity environments. Carbonless copy paper and visual display terminals have now largely been exonerated as dermatological hazards. Carbonless paper may contain colophonium and, thus, cause very circumscribed lesions on the hands that have come into contact with the paper [119]. Multiple factors, not all of them medical, may
conspire to produce outbreaks of symptoms misinterpreted as insect bites in such workers [120]. Individual instances of ACD from standard allergens such as nickel and rubber chemicals [121] occur in the office environment. ACD as well as ICD from computer mice and/or the mouse pad have been reported [122–124]. Skin lesions may also consist of blanchable erythematous patches with telangiectases on the ulnar aspect of the palms or eczematous lesions with fissures on the fingertips (“mouse fingers”) [125–127]. Although reactions to plastic materials are rare in comparison to the extensive contacts in virtually every occupation, occupational contact dermatitis from headphones containing diethylhexyl phthalate has recently been described [128].

39.12.16 Petroleum Recovery

Drillers are at considerable risk of ICD from drilling “muds,” acids, detergents, and organic solvents. ACD has also been reported from polyamines in the emulsifiers of oil-based muds [129]. Further details about this industry are to be found in Rycroft [130].

39.12.17 Photographic

Even with increasing automation, contact sensitization still occurs from both black-and-white and color processing [131]. Additional series (Table 1) are extremely useful and are usually adequate for patch testing. A recent update [132] included formaldehyde and methylchloroisothiazolinone/methylisothiazolinone in the standard series as allergens relevant to color processing.

39.12.18 Printing

The organic solvents used for cleaning down machinery remain a major cause of chronic ICD. Allergens in conventional printing technology are largely covered by the standard series, including formaldehyde, methylchloroisothiazolinone/methylisothiazolinone, chromate, and cobalt [133, 134], whereas UV-curing printing systems [135] require the addition of a (meth)acrylate series (Table 1). Frequent hand washing may sometimes cause ACD from preservatives (e.g., methylidibromo glutaronitrile), as well as more commonly, ICD [136].

39.12.19 Veterinary, Slaughtering, and Butchery

This somewhat anomalous grouping of occupations is prompted by their overlapping sources of ICD and CU/PCD, with ICD arising from animal fluids and entrails [137] and disinfectants, and CU/PCD from animal tissues/meats, obstetric fluids, animal hair, and dander [62], as well as NRL in rubber gloves. ACD [138] is caused mainly by rubber gloves, and by veterinary medicaments [139] and sterilants.

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