Occupational skin diseases in the hairdressing trade

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Medical Reference Document

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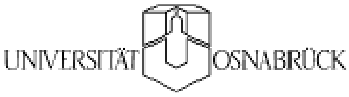

Occupational skin diseases in the hairdressing trade

(University of Osnabrück, Department of Dermatology, Environmental Medicine and Health Theory)

Contents

1 The European hairdressing trade

The current European Risk Observatory report entitled “Occupational skin diseases (OSD) and dermal exposure in the EU (EU-25)”, published in 2008 by the European Agency for Safety and Health at Work, lists skin diseases as the second most common occupational health problem in Europe. Occupational skin diseases are considered ”one of the most important emerging risks related to the exposure to chemical, physical and biological risk factors". The percentage of skin diseases among all occupational diseases is calculated at 7%. Furthermore, the report points out the high economic costs of these diseases, now calculated to be 5 billion euros per year in the EU (De Craecker et al. 2008, Wulfhorst et al. 2011).

In the European Risk Observatory Report EN8 from 2009, the problem of occupational skin diseases is once again presented as an urgent issue, with specific reference to the hairdressing trade. Besides dealing with skin irritants and allergens as the cause of skin diseases, the report also gives special attention to operational structures. Also mentioned is the particular need for action regarding implementation of worker protection systems in small and medium sized enterprises (SMEs), whose workers have a significantly higher risk for developing occupational skin diseases when handling skin-damaging substances. “SMEs have particular difficulty in implementing complex technical legislation as they often have only limited technical expertise and often lack of dedicated OSH (Occupational Safety and Health) professionals. Simple guidance is therefore needed to assist in the process of risk assessment and control“ (European Risk Observatory Report EN8, European Agency for Safety and Health at Work 2009, p.79). In addition, this report highlights an urgent need for provision of information regarding risk awareness. According to the report, employees and employers consider the risks of sudden chemical accidents to be serious, while the chronic and long-term effects of skin-damaging substances are drastically underestimated. “SMEs lack the knowledge required to identify chemical risks and to choose and implement preventive measures for workers against hazardous substances“ (ibid.).

According to the European Agency for Safety and Health at Work, there are close to 355,000 hairdressing companies and 400,000 hairdresser salons in Europe employing an estimated 940,000 hairdressers. More than 50% of them work in Germany or Italy, with an additional 29% in France and the United Kingdom.

2 Epidemiology of occupational skin diseases in the hairdressing trade

Until the present, there have not been comparable data regarding the epidemiology of occupational skin diseases in the hairdressing trade in European countries, as definitions of "occupational skin diseases" (with frequent overlapping definitions of irritant and allergic contact (hand) dermatitis) and data collection systems vary. Moreover, these data often also do not assume random sampling or relate to population (Diepgen 2003). Despite these reservations, Table 1 shows exemplary data and estimates regarding the incidence (new diagnosis rate per year of a disease) and prevalence (number of affected patients at the time of examination or number of affected patients during a period of time) of occupational skin diseases by country and by publication.

The data provide the reader with a general orientation regarding the relevance of occupational skin diseases in hairdressing. According to Diepgen (2007), the prevalence in studies has been estimated too low, and is actually 30-50 times higher than reported.

Table 1: Exemplary overview of incidence and prevalence of occupational skin diseases in the European hairdressing trade (not exhaustive)

Country	Publication	Incidence	Prevalence
Germany	Diepgen 2003 (State of Bavaria)	24 cases / 1000 persons / year	-
	Uter et al. 1998 in Diepgen et al. 2007	-	3-year prevalence during training: 23.9 cases / 2352 persons
	Dickel 2002 (North Bavaria)	97.4 cases / 10,000 persons / year	-
Denmark	Diepgen 2003	11 cases / 1000 persons / year	-
	Lysdal et al. 2011	-	Lifetime prevalence of a hairdresser: 37.6% / 2918 persons; lifetime prevalence of a former hairdresser: 48.4% / 2321 persons
	Skoet et al. 2004	estimated: 5.61 cases / 1000 persons / year	-
	Bregnhøj et al. 2011a		Trainees (N=374): point prevalence: 1.1% (4); 1-year prevalence: 5.9% (22) Lifetime prevalence: 8.0% (30)
Finland	Leino et al. 1998	-	Point prevalence: 2.8% (11/355 persons)
Sweden	Lind et al. 2007	23.8 cases / 1000 persons / year; <25 years: 37.1 cases / 1000 persons	-
Netherlands	Majoie et al. 1996	-	8-year prevalence: 51% / 51 persons
United Kingdom (UK)	Meyer et al 2000	-	6-year prevalence: 116.3 cases / 100,000 persons
France	Bruneteau et al. 2004	-	12.9-83% (highest among apprentices)

3 Structure and functions of the skin

The skin is the outermost layer of the body and has an area of approx. 2 m². After the lungs, it represents the largest organ of the human body.

As the outermost layer, it fulfills various duties that can be differentiated into protective and contact functions. The contact function includes external appearance and properties as a sensory organ. Additional functions of the skin provide protection:

- from physical conditions such as heat, cold (thermoregulation, cooling function) and radiation
- from mechanical exposure such as pressure, friction and impact
- from chemical substances, including water
- from invasion of and defense against microorganisms
- from uncontrolled loss of water (transepidermal water loss; TEWL).

In addition, the skin plays a role in absorption (transdermal application of medicines), storage (adipose tissue, depot injections) and metabolic functions (Vitamin D synthesis) (Jung/Moll 2003).

These functions correlate with the skin's structure.

3.1 Layer structure

The skin is made of three layers. From outside in, these layers include the epidermis, dermis and subcutis (see Figure 1).

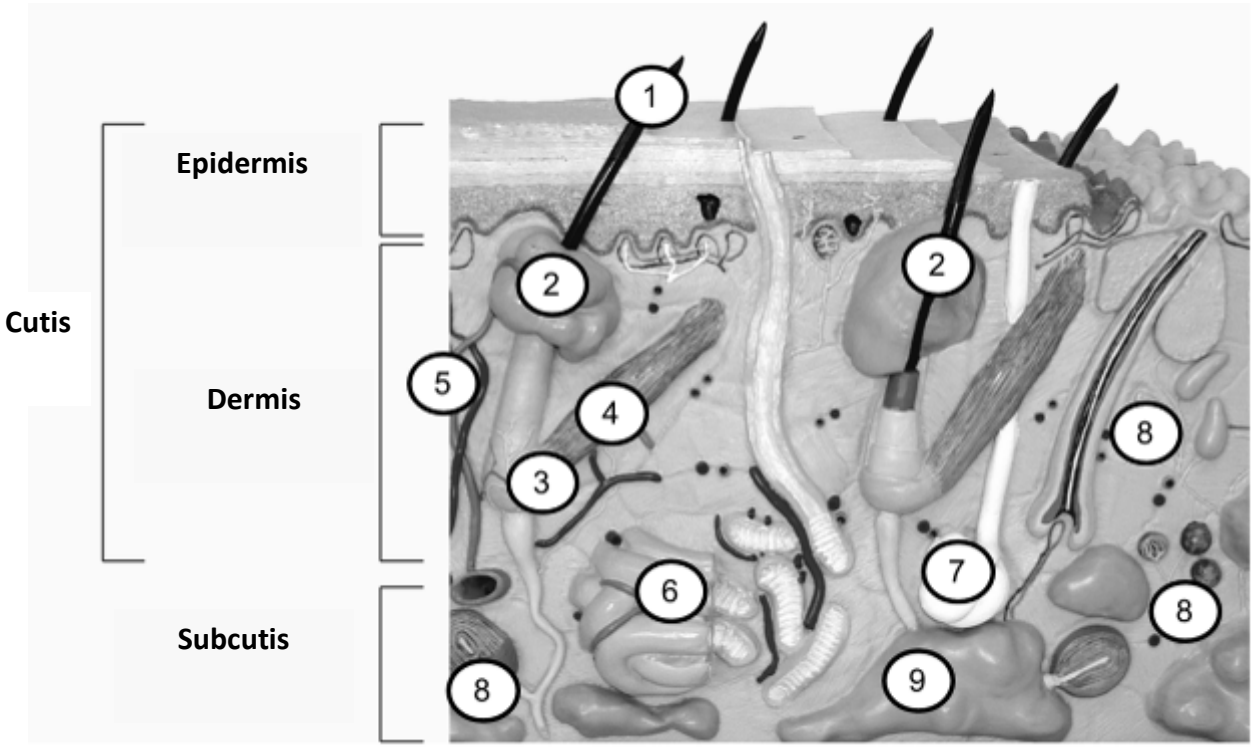

Figure 1: Structure of the skin (©iDerm Osnabrück)
1. Hair, 2. Sebaceous gland (production of fat/lipids), 3. Hair root, 4. Arrector pili muscle (goose bumps), 5. Blood vessels, 6. Sweat glands (scent glands in the genital and axillary region), 7. Sweat glands (water glands in all body regions; serve a coolant function through evaporation), 8. Nerve cells (different cells for pressure, pain, cold and heat sensors), 9. Adipose tissue.

The subcutis is mostly made of fat. It is involved in the storage and warmth-retaining functions of the skin. The fat also provides protection from mechanical influences. For example, the fat deposits under the heel provide padding for footsteps. Fat layers also protect the internal organs.

The dermis is the layer that is retained when leather is produced. It gives the skin its unique mechanical toughness and includes various structures such as sweat and sebaceous glands, nerve cells and blood vessels. By changing their diameters, blood vessels play a role in the body's heat regulation processes and supply the avascular epidermis with nutrients and oxygen.
The epidermis plays the most important role in protecting the body from chemical and physical influences, although it is the thinnest of the three skin layers with about 0.2 to 0.4 mm of thickness. It is composed of four layers, which from bottom to top are the basal cell layer (stratum basale), the spinous layer (stratum spinosum), the granular layer (stratum granulosum) and the cornified layer or horny layer (stratum corneum) (see Figure 2). The epidermis has a regenerative capacity that is otherwise only found in the liver and intestines (Kerscher et al. 2009).

3.2 Skin regeneration

The basal cell layer represents the innermost layer of the epidermis, immediately above the dermis, allowing it to be optimally supplied by nutrients from the blood. The basal cells continually undergo cell division or "germinate", which is why this layer is also called the germinative layer. In addition to basal cells, this layer also includes melanocyte cells. They create the pigment melanin, which is released to the skin cells as needed. In the skin cells, the pigments are arranged to protect the cell nuclei (Jablonski 2004, Brenner/Berking 2010). Melanin thereby serves as the natural sun protectant of the skin (tanning) and protects the living cell layers from the energy-rich sunlight, which could otherwise lead to cell mutations (skin cancer).

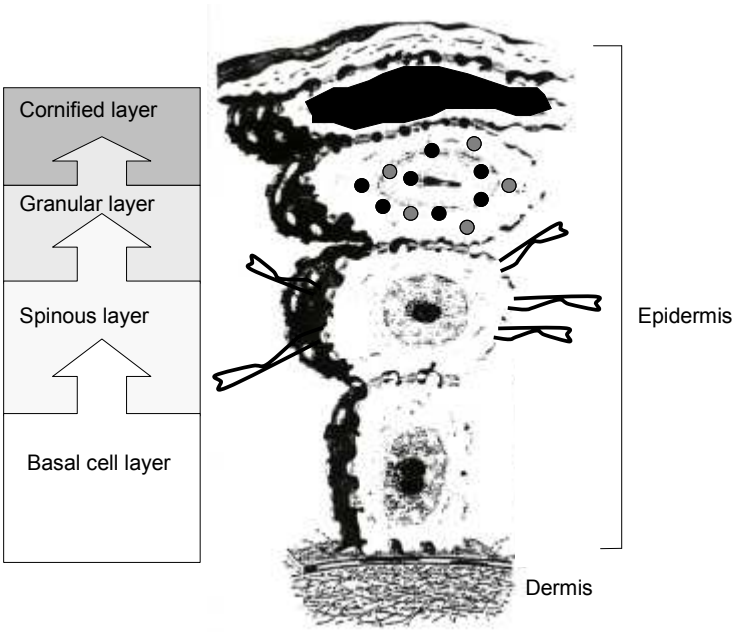

Figure 2: Structure, regeneration and developmental stages of the epidermis (©iDerm Osnabrück)

The newly formed cells in the basal cell layer are then pushed upwards by the most recently formed cells, towards the surface of the skin (Heymann 2003). While they "migrate" towards the skin's surface, they pass through various stages of development (see Figure 2). First, they create cellular appendages and cell contacts, which gives them a spinous appearance. This cell layer, immediately above the basal cell layer, is called the spinous layer for this reason. Superficial to this lies the granular layer, in which the cells form small keratin-filled granular structures and small adipose

bodies ("lamellar bodies" also called "Odland bodies"). This begins the process known as cornification. Cornification involves the cells losing their nuclei as they become stiff and immobile, until they are finally completely filled with keratin at their final position in the cornified layer. The cells are now called cornified cells (keratinocytes) and are arranged in a strictly ordered geometric pattern that has a brick wall-like appearance. The fat from the adipose bodies is released to the intercellular spaces and binds the cells like the mortar between bricks in a wall. In the cornified layer, the cornified cells (keratinocytes) are pushed further towards the skin surface. In this process, the cell connections are continually weakened until after a period of about four weeks the cells are released from the skin (desquamation). Every day, between 0.5g and 1g of dead keratinocytes are released. This means that healthy skin requires approximately four weeks to completely regenerate (Fartasch 2002).

In most cases, the cornified layer is made up of only 10-12 cell layers (although up to 86 layers have been documented; Ya-Xian et al. 1999) and ranges from 0.02 to 4 mm thick depending on the body region and mechanical demands (Kerscher et al. 2009, Heymann 2003). This means that the cornified layer is thinner than a hair in most body regions!

As the outermost cell layer, the cornified layer is directly exposed to damaging environmental influences and serves as a functional barrier. Full functionality of this layer is, therefore, extremely important for maintaining healthy skin.

3.3 The barrier function

The structure of the cornified layer was first described in the 1980s with the brick-and-mortar model (Elias 1983). In this case, the cornified cells form the "bricks" and fatty substances (primarily ceramides) form the "mortar". The fat-containing substances released from keratinocytes in the uppermost granular layer create a watertight seal at the intercellular spaces. These fats are important for the cohesion of the cells and the seal that is created (barrier function). Just as holes can form in the joints of a wall when building a house (see Figure 3), the fatty substances can be unevenly distributed around the cornified cells. In order to protect the "wall" - in this case the skin - from environmental influences and stresses, a wall is coated or covered with plaster. This additional protection is also present in the skin, in the form of natural water-lipid film (hydrolipid film). This film is composed of a water and a lipid phase. Both phases are bound by natural emulgators in an emulsion, which is spread over the skin surface and keeps it soft. The lipids are created by sebaceous glands and skin cells; water is created in the sweat glands (perspiration) and released from the body by the skin cells (transepidermal water loss, TEWL) to and by way of the skin (Fartasch 2002, Schaefer/Redelmeier 1996, Rawlings/Harding 2004).

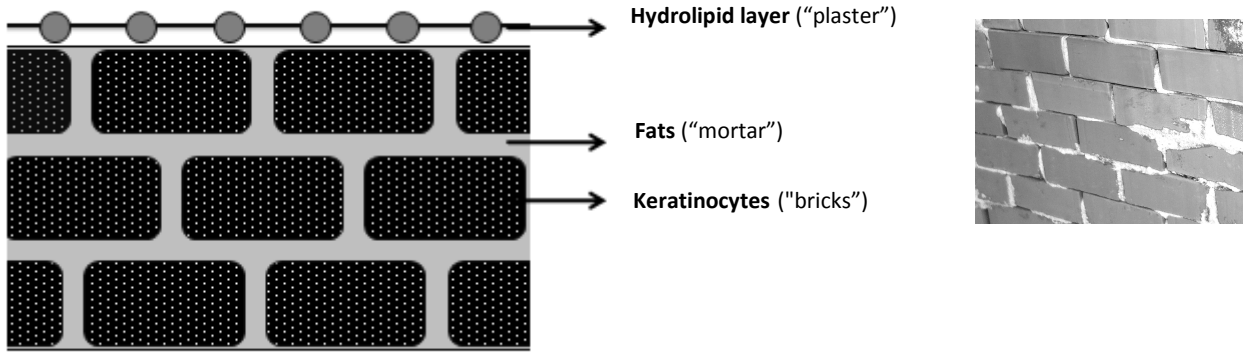

Figure 3: Brick wall as a model for the cornified layer (©iDerm Osnabrück)

In addition to protecting the body from water loss, the cornified layer and the hydrolipid layer are also capable of protecting the body from many external physical exposures. Blocking external substances is another extremely important protective function. This may represent “chemicals” of various types (such as various hairdressing chemicals), or also bacteria, fungi, viruses and other microorganisms and their metabolic products. The intact cornified layer hinders these substances from entering the living skin layers and also protects against a substantial portion of water loss from the body. Because of this, it is also known as the cornified layer barrier. Substances that are capable of crossing the cornified layer barrier represent a danger for the body.

3.3.1 PROTECTION FROM WATER AND DEHYDRATION

The specific structure of the cornified layer protects the deeper, living skin layers, creating a moist environment that is important for the maintenance of cell and tissue functionality. The lipids in the intercellular spaces and the natural moisturizing factors (NMF) in the skin reduce water evaporation from the body’s surface. Lipids repel water, preventing the water from the body from passing through the fat phase of the cornified layer and forcing it to take the route over the cells. However, the natural moisturizing factors are located here. These represent water-binding and water-attracting (hygroscopic) molecules in the cornified cells that are even able to bind water from the air if humidity is greater than 50%. One of these substances is urea (Schürer/Kresken 2000).

In summary, this means that water is both chemically bound as well as repelled by water insoluble (lipid) segments of the cornified layer, conserving it in the body. However, the body is not completely watertight! In addition to the water released from the sweat glands, approximately 300 ml of water are released daily through the skin barrier. This is the previously mentioned transepidermal water loss (=TEWL). The TEWL is an indicator for the integrity of the skin barrier. Increased TEWL shows that the skin barrier is damaged or completely destroyed and water is being released from the body in an uncontrolled fashion (Forslind et al. 1997).

This protective barrier that protects us from dehydration also works in the opposite direction. Rainwater or tap water also forms pearls on the skin surface and in addition the body does not swell like a sponge after taking a bath. However, the palms of the hand and soles of the feet do macerate. This is because the body does not have hair here and thereby does not have sebaceous glands (a sebaceous gland is always connected to a hair). The oil from the sebaceous glands, which makes up

90% of the superficial skin oils, is not present here at all. Instead, oils are only released from the cornified cells. Normally, the cornified skin layer is somewhat thicker on the palms and soles due to mechanical exposures (standing, walking, gripping, holding, etc.). These cornified cells, as is the case everywhere in the body, contain natural moisturizing factors that bind water increasingly. This combination of little fat and high levels of water-binding substances causes the skin of the palms and soles to swell more than the rest of the body and in a way that is visible to the eye. This “raisin skin” is also known as “washerwoman’s hands” (Fritsch 1990).

3.3.2 PROTECTION FROM CHEMICAL AND MICROBIAL EXPOSURES

The hydrolipid film lies at the surface of the skin. The lipid layer protects against unhindered infiltration of water and water-based chemicals (such as acids, bases, cleaning solutions), while the water-based portions in the skin provide a barrier against fats and oils.

Due to the water content within the skin and overlying the skin, the skin has a specific pH value. The superficial hydrolipid film has a pH value of about 4.5 to 5.5, which is slightly acidic (Parra/Paye 2003). Therefore, the water-fat film is also known as “acid mantle of the skin” or “acid skin mantle” (Schade/Marchionini 1928).

The acidic pH value leads to a unique, individual bacterial flora on the surface of the skin (microflora) (Parra/Paye 2003). This helps the skin to protect itself against disease-causing bacteria, viruses and fungi, which could cause skin infections. These good, “symbiotic” bacteria rely on the physiological pH value. Increases in pH value kill these bacteria. This can help microorganisms that thrive at higher pH values (>7). Unfortunately, this mostly consists of disease-causing bacteria, viruses and fungi.

3.3.3 PROTECTION FROM MECHANICAL EXPOSURES

The skin reacts to repetitive mechanical exposures by increasing its thickness. This causes it to form “calluses“ (in medical terminology: hyperkeratosis). Classically, calluses occur in the form of raised bumps on the palms and soles; however, they can occur on any part of the body subjected to loads.

In addition to the adaptability of the epidermis to mechanical influences, the deeper skin layers (dermis and subcutis) also serve protective functions. The dermis consists of highly-resistant collagen and elastic fibers and gives the skin strength against tension and tearing (Jung/Moll 2003). The subcutis protects the internal organs and serves as a shock absorber at the soles of the feet.

3.3.4 PROTECTION FROM UV RADIATION

The epidermis also serves as a barrier against high-energy sunlight. This is partly by way of skin tanning, as described above, and partly due to increased thickness caused by UV radiation. When the skin is exposed to the sun, more skin cells are formed and a so-called "solar keratosis" (acanthosis = thickening of the dermis, hyperkeratosis) is formed. This provides additional protection, along with skin pigmentation, which can block radiation and protect living cells from skin cancer to a certain extent (Jung/Moll 2003). Solar keratosis is often seen in people who work mostly outdoors (such as roofers) or who visit sun tanning salons frequently. These people have skin with a thick and leathery appearance. Skin peeling, seen frequently after summer vacation, does not just occur after sunburn.

It is a natural process that occurs when additional skin layers that were built up due to sun exposure are exfoliated again.

4 Occupational skin diseases

Up to 90% of occupational skin diseases are forms of (hand) dermatitis.
Dermatitis is caused by inflammation of the epidermis and the outermost dermis and is not infectious or of infectious origin. Dermatitis can present with redness, papules, blisters, weeping or scaly skin, or coarsened skin texture/fielding (lichenification; thick, overgrown epidermis, leathery appearance). Acute dermatitis is primarily characterized by weeping changes, while chronic dermatitis shows dry scale formation.
Dermatitis is most commonly found on the hands and forearms in the hairdressing industry, as these parts of the body as “daily working tools” are most frequently subjected to damaging exposures. However, the face can also be affected by airborne contact dermatitis (such as in case of an allergy against para-phenylenediamine, PPD).
The term “dermatitis” does not describe the cause and clinical course of a skin disease, but is used as a general term for many types of skin diseases.
There are many different causes of dermatitis. They can be generally divided into those with “internal” causes and those with “external” causes.
The various types of dermatitis can be categorized by causes as follows:

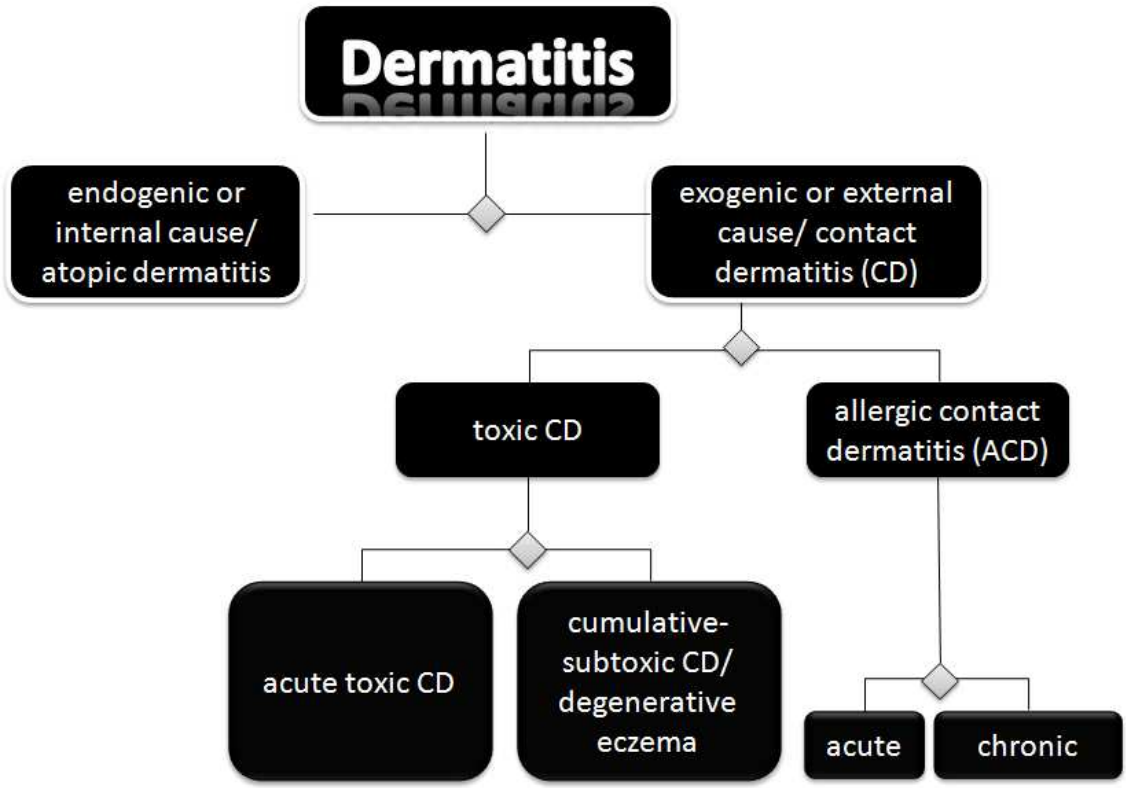

Figure 4: Causes of dermatitis

Exogenic dermatitis can be caused by occupational exposure. Endogenic dermatitis may be aggravated by activities that damage the skin.
Occupational skin diseases are explained in more detail below.

4.1 Acute-toxic contact dermatitis

This type of dermatitis is caused by short-term exposure to highly corrosive substances, such as concentrated hydrogen peroxide. It is typically caused by accidental skin exposure. Immediately after contact, the skin reacts with acute inflammation, the extent of which is dependent on the sensitivity of the skin and the concentration and exposure time of the substance in question.
Typical features of this include highly limited areas of skin changes to the area of exposure and quick recovery after removal of the causative substance (Elsner 2008). Acute-toxic contact dermatitis is generally easy to diagnose by the treating physician, as the affected patients can generally name the irritating substance.
Such skin-hazardous substances must be marked with a pictogram (see Figure 5). Some hair dyes can lead to acute irritation or even chemical burns of the skin and scalp if used improperly or at excessive concentrations (Jensen/Søsted 2006).

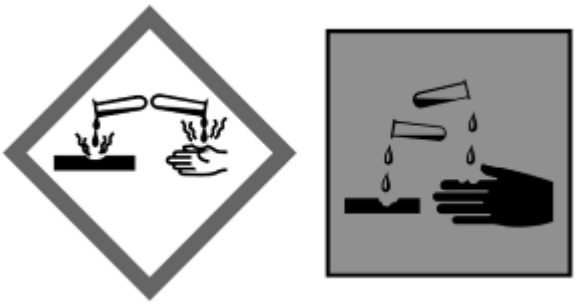

Figure 5: New and old risk pictogram indicating "corrosivity" substances
(left: new label from 2009, right: old label until 2009)

4.2 Cumulative-subtoxic contact dermatitis

Cumulative-subtoxic contact dermatitis is the most common occupational type of dermatitis. This represents the chronic form of contact dermatitis and is the result of cumulative (=repetitive) skin irritation with an irritant substance (Frosch/John 2011, Skudlik/Schwanitz 2003). Skin irritants must be marked with the following pictograms (see Figure 6).

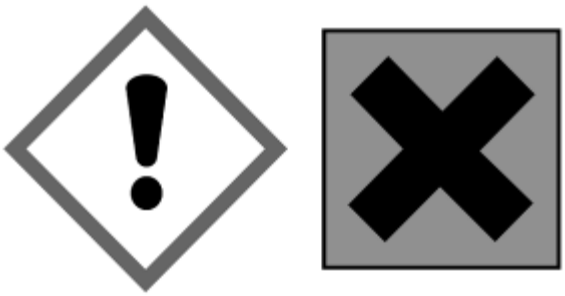

Figure 6: New and old risk pictogram indicating "irritant" substances
(left: new label from 2009, right: old label until 2009)

There are some exceptions, e.g. water, shampoo and skin cleaning agents, which not need to be labeled, although repeated skin contact may also cause irritation.

4.2.1 ETIOLOGY

Cumulative-subtoxic dermatitis develops in three phases due to the long-term or repetitive exposure of one or more irritants. Due to chronic skin irritation, various repair mechanisms of the epidermis and dermis are overwhelmed.
In the first phase, the hydrolipid film (acid protection layer) is removed (such as by washing the hands a single time), which causes the cornified layer to be exposed. The skin stretches and feels "dull". Regeneration of the natural acid protection layer takes approx. 1.5 to 3 hours.
New irritations cause cumulative damage and, in the second phase, the natural fats of the cornified layer are removed from the deeper cell layers. The cornified layer can then be infiltrated by various substances used at work.
In the third phase, external irritating substances (see Table 2) cause an inflammatory reaction of the skin.

4.2.2 TYPES OF CLINICAL MANIFESTATION

The skin changes that occur have a wide variety of clinical manifestations. Depending on the concentration and duration of contact to hazardous substances (see Table 2), they often are limited to low-grade redness and scaling with small fissures of the skin. They usually have unclear borders. It is typical to begin in between the fingers, as the skin here is particularly sensitive. Moisture and other substances can also collect between the fingers and underneath hand jewelry (finger rings, bracelets, watches).

4.2.3 CONSEQUENCES

Even early signs of cumulative-subtoxic dermatitis should be taken seriously! Some eczematous skin changes seen in hairdressing may appear mild, but none are harmless and innocent. In initial stages of the disease, cumulative-subtoxic dermatitis can often be treated easily and is healed by limiting skin exposure and performing persistent skin care (skincare product) in combination with adequate skin protection (skin protection cream and gloves). However, if no changes are made, cumulative-subtoxic dermatitis can take on a chronic course and become difficult to treat even without skin exposure, last for extended periods or have massive recurrences with only minimal irritation.

With cumulative-subtoxic dermatitis, the damaged cornified layer barrier is subjected to risk of infection or sensitization (development of an allergy) to occupational and/or non-occupational substances. Chronic cumulative-subtoxic dermatitis usually forms the precondition for the development of allergic contact dermatitis (see next chapter). Cumulative-subtoxic dermatitis must be carefully allowed to heal. Recurrences often occur due to repetitive exposure of the skin prior to full recovery of the epidermis, as the skin may appear externally intact.

4.3 Allergic contact dermatitis

In some cases, the skin reacts to external substances that are normally well tolerated with dermatitis. This reaction is known as an allergy (=different response/reaction) because the body and immune system react in a different or hypersensitive way. The purpose of the immune system is to clear away foreign substances that have entered the body. In the case of allergies, these immune mechanisms

overshoot their target. Almost all substances, including occupational substances or hair and skin cosmetic products can cause an allergic reaction. Allergies should not be confused with acute-toxic dermatitis. Every person's skin will react to concentrated acids (such as hydrogen peroxide) with skin inflammation or irritation.

The actual purpose of the immune system is to protect the body. With allergies, the immune system fights fiercely against harmless substances, so-called “allergens”, without a clear reason as to why. The associated and subsequent reactions such as inflammation and tissue damage, e.g. symptoms of skin dermatitis, are types of hypersensitivity reactions.

4.3.1 ETIOLOGY

For an allergic reaction to occur, there must first be sensitization to a specific substance, the allergen. With allergic contact dermatitis, two phases of development are described.
In the first phase (sensitization phase), the body is introduced to the allergen. Contact allergens represent haptenes (semi-allergens), which are too small to have an immunogenic effect. They can only be processed by the immune cells in the dermis or mucous membranes (Langerhans cells) after being bound to carrier proteins. After a Langerhans cell presents the immune system with the allergen that has entered the body (antigen presentation), the immune system creates matching defensive cells based on the lock-and-key principle. This sensitization phase is not noticeable and is not predictable. It requires at least 5-7 days, but may also last for years (Jung/Moll 2003). After the sensitization phase, the immune system will recognize the allergen until the end of life.
The second phase is known as the reactive phase. The immune system is now sensitized to a certain substance (allergen = antigen). In case of repeated contact with the allergen, it is recognized as an antigen and an inflammatory reaction (defense reaction) is induced (Jung/Moll 2003).
Almost any substance, even if tolerated well for years, can suddenly cause an allergy.

Whether or not and when a person develops an allergy cannot be predicted and depends on several factors, such as the duration and intensity of contact, the sensitization potential of the allergen, genetic disposition and skin condition (Jung/Moll 2003). However, it is certain that cumulative-subtoxic dermatitis often precedes allergic contact dermatitis. Damage to the cornified layer barrier makes it easier for allergens to invade into the skin.

4.3.2 TYPES OF SKIN MANIFESTATION

Manifestation of symptoms is similar to clinic symptoms of cumulative-subtoxic contact dermatitis. To determine the cause of disease, dermatologists can perform allergy testing (patch tests).
Allergic contact dermatitis represents a so-called “delayed type” allergic reaction. Signs of inflammation are first visible after approx. 24-48 hours from contact. Skin reactions that first occur after 48, 72 or 96 hours following allergen contact can also be observed. This is a reason why the allergen is sometimes difficult to pinpoint. The affected persons often cannot remember what substances were in contact with their skin 1-3 days ago. Another reason is that the number of substances that can cause allergies is now so high that the physician and patient will need detective-like skills to track down the allergen. Allergic contact dermatitis can only be diagnosed if all potential allergens are tested. Because of this, cumulative-subtoxic hand dermatitis can only be diagnosed if an allergy is ruled out with certainty; in medical terms, cumulative-subtoxic dermatitis is considered a diagnosis of exclusion.

4.3.3 CONSEQUENCES

Once acquired, contact sensitization against occupational substances that already caused symptoms cannot be cured and often forces affected patients to give up their occupation. Course and severity of allergic hand eczema are more severe and more protracted than in irritant hand dermatitis and correlate with more frequent job loss (Meding et al. 2005, Cahill et al. 2004, Diepgen 2003). It remains for the rest of the patient's life. Hyposensitization cannot be performed for allergic contact dermatitis. The only way to keep the skin healthy is to consistently avoid an allergen by changing products or using appropriate protective gloves.

4.3.3.1 Patch testing as a work qualifying test for hairdressers

Performing patch testing before choosing a career and thus before entering the profession to exclude possible work-related allergies is not a reasonable strategy from a dermatological perspective. A Danish study showed the current mean age at which apprentices in hairdressing had their hair dyed for the first time to be 12.1 (2-19) years with the control group at 13.5 years; in addition, 30.1% of the control group and 48.1% of the hairdressers in training had had a Henna tattoo (Bregnhøj et al. 2011b), factors which could have led to sensitizing skin contact with chemicals used in hairdressing. Despite this, a patch test would only identify isolated cases with a contact allergy that had already become manifest. However, it should be noted that allergies to hairdressing chemicals develop later among non-hairdressers than among hairdressers. In a study by Uter et al. (2007), the average age of patch testing for diagnosis of sensitization to hairdressing cosmetics was 26 years old for hairdressers, while it was 49 years old for hairdressing customers or self-users of hairdressing products. These results show that patch testing as a work qualifying test for future hairdressers (at an average age of 16 years old) is of little informational value. In unfortunate cases, some allergies may even be caused by the test, which is why international allergology societies strictly advise against such predictive tests. Amendments to the EU cosmetics guidelines (76/768/EEC) with "Directive 2009/134/EG of the Commission, 28 October 2009" and "Directive 2010/4/EU of the Commission, 8 February 2010" stipulate that hair dyes containing substances with high sensitization potential should be marked with a label after 1 November 2011 indicating that "this product is not intended for persons under 16 years of age". Because of this, the use of patch testing as a work qualifying test is even more senseless, as contact to sensitizing hairdressing substances prior to starting work at 16 years old will be very limited.
Furthermore, it can be assumed that persons with known skin incompatibility reactions to cosmetic products will choose other occupations of their own accord. Bregnhøj et al. (2011a) were able to demonstrate a "healthy worker effect" among hairdressing apprentices in Denmark. This means that the incidence of dermatitis of the hand, wrist or forearm or the presence of atopic disposition is relatively low among hairdresser apprentices compared to a control group.
In general, patch tests cannot be used to predict whether a person will develop a future contact allergy. On the contrary, the usage of a patch test should be considered with caution, as undesired side effects such as sensitization caused by the test itself can result (Schnuch et al. 2008).

4.3.3.2 Self-testing with hair dyes

Cosmetics Europe (formerly COLIPA, "The European Cosmetics Association") recommends performing a self-test by the user (e.g. for 48 hours) against potential product allergies prior to using hair dye products (SCCS 2010). This has been put into practice by various manufacturers (SCCS 2012, Mildau 2010). The Scientific Committee on Consumer Safety (SCCS) has warned against self-tests due

to the risk of false-negative results and the risk of causing sensitization. Hair dyes are also not approved as a “leave-on” skin product based on the cosmetics guideline (SCCS 2010).

5 Activity-related risk factors and hazardous substances in the hairdressing trade

5.1 Wet work as primary risk factor

The extent of occupational skin diseases in the hairdresser trade caused by frequent contact with water is often underestimated.

Prolonged contact to water or moisture leads to swelling of the keratinocytes. Keratinocytes can bind a great deal of water with natural moisturizing factors (NMF). After contact with water (wet work), the swelling leads to dehydration of the skin. The water that has been taken up evaporates and the cells shrink. With this, the intercellular spaces (see Figure 7) enlarge and allow more water to escape. In addition, potential irritants and allergens (see Table 2) can now more easily pass through the cornified layer into deeper layers and cause inflammation or sensitization.

The skin is particularly permeable immediately after taking off impermeable protective gloves (if sweating occurs in the gloves) or after handwashing (such as after washing hair without protection and/or performing cleaning or disinfection).

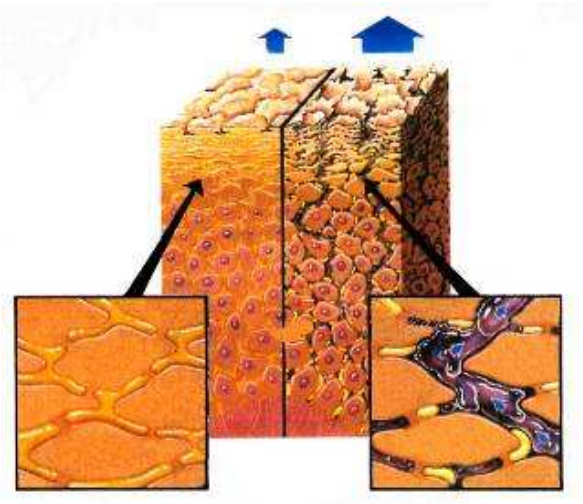

Figure 7: Influence of wet work or extended glove wear (sweating in watertight gloves; source: Bundesverband Hautschutz e.V. 2007, modified)
Left: Healthy group of cells. Right: Loosened group of cells with enlarged intercellular spaces after extended contact with moisture or glove wear.

Constant contact with water is one of the most important risk factors with regard to formation of hand dermatitis. It has been proven that workers in “wet work occupations” (such as hairdressers) suffer much more frequently from contact dermatitis than persons with occupations that do not involve water contact.

In Germany, “wet work” is a clearly defined topic. According to the Technical Rule for Hazardous Substances (TRGS) 401 (2008, number 3.3.4, 2), this includes “activities where the workers

1. perform the work for a major portion of their working time, i.e. regularly more than two hours per day, with their hand in a wet environment or
2. have to wash their hands frequently or intensively or
3. wear protective gloves with occlusion effects (accumulation of heat and moisture) for a corresponding period. The liquid-tight effect of protective gloves prevents the dissipation of perspiration to the outside and so the skin swells up as the time the gloves are worn increases, which lessens their barrier effect. Because the skin is predamaged in this way, it becomes easier for irritants, potentially allergenic (sensitising) substances or infectious agents to penetrate.”

“The times of working in a wet environment and the times for which liquid-tight gloves are worn must be added together if no effective measures are taken to regenerate the skin.” (TRGS 401 2008, 3.3.4, 3)
According to this definition, professional hairdressing is a typical wet work occupation. How to deal with wet work is explained in Chapter 6. Further information can be found in “TRGS 530” (2007), the “Declaration of Dresden” (2010) and in the “European framework agreement on the prevention of health risks in the hairdressing sector” (2010).

5.2 Irritants and allergens

Hairdressers have skin contact with a wide range of irritating or allergenic substances in the course of their occupation. Table 2 provides an overview and lists activity-specific potential allergens and irritants.
Washing-active substances such as syndets, soaps and shampoos cause natural oils in the skin to be washed away and cause damage to cell membranes (Effendy/Maibach 1995, Tupker 1996).
Due to these influences, the barrier function is damaged, which often represents the beginning of a severe skin disease. The affected persons may not even notice the disease or may not take it seriously.
Dry, raw skin is often an early sign of reduced functionality of the skin’s intrinsic defense mechanisms. Such a damaged skin barrier allows easy penetration of irritants and allergens.

Table 2: Selected activity-related allergens and irritants in the hairdressing industry (as in Brans/Merk 2009, expanded)

Activity	Products	Exemplary contact substances [INCI]	Irrita-tion	Sensitiza-tion	Protective measures
hairwashing, hair care, hair styling	shampoo, cream rinse, conditioner, hair spray, hair gel, hair wax	tensides (such as cocamidopropyl betaine)	+	+	**long cuff single use gloves**
		preservatives (such as methyldibromo glutaronitrile [MDBGN][1], methylchloroisothiazolinone MCI / methylisothiazolone MI)	+	+	
		perfumes (such as cinnamal, eugenol [phenylpropene], hydroxyisohexyl 3-cyclohexene carboxaldehyde [lyral, MPCC])	+	+	
		water	+		
		phenols	+[2]		
		selenium disulfide	+[2]		
		formaldehyde[3]	+	+	
		parabens	+[2]	+[2]	
		dichloromethane (in hair lacquer)	+[2]		
coloring agents	oxidation colors	p-phenylenediamine (PPD) [4]	+	+	**single use gloves**
		toluene-2,5-diamine (PTD), o-,m-toluylendiamine[4,5]			
		m-toluylendiamine[6]			
		o-aminophenol[7]			
		p-, m-aminophenol[4]	+	+	
		p-methylaminophenol[4]	+	+	
		2-methyl-5-hydroxyethylaminophenol[4]	+	+	
		m-phenylendiamine[7]		+	
		1-naphtol	+		
		resorcinol	+		

[1] no longer permitted in cosmetic products (SCCP opinion on methyldibromo glutaronitrile, 2005)
[2] Bruneteau et al. 2004
[3] since 2004, officially considered carcinogenic by the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO). According to the *EU Cosmetics Directive 76/768/EWG* and to *EU Cosmetic Regulation (EG) No 1223/2009* the amount of formaldehyde is limited; as a preservative up to a maximum of 0.2% (Annex V) and in nail hardening products up to 5% (Annex III)
[4] products with this ingredient have required identification as follows since 1st of November 2011: "This product is not intended for use on persons under the age of 16."
[5] according to the *EU Cosmetics Directive 76/768/EWG* and to *EU Cosmetic Regulation (EG) No 1223/2009* permitted with limitations, except of m-phenylenediamine, which is banned
[6] according to the *EU Cosmetics Directive 76/768/EWG* and to *EU Cosmetic Regulation (EG) No 1223/2009*, m-phenylenediamine and its salts are banned
[7] prohibited by the *EU Cosmetics Directive 76/768/EWG* and to *EU Cosmetic Regulation (EG) No 1223/2009*.

Activity	Products	Exemplary contact substances [INCI]	Irrita-tion	Sensitiza-tion	Protective measures
coloring agents	oxidation agents, bleaches	hydrogen peroxide	+		
		hydrochinone	+	+	
		kalium persulfate	+[2]	+[2]	
		sodium persulfate	+	+[2]	
	blonding agents	ammonium persulfate	+	+	
perms	perming fluid	e.g. ammonium thioglycolate, glyceryl monothioglycolate (GMTG/GMT)[8], cysteaminehydrochloride	+	+	**single use gloves**
hair straightening (Kratz et al. 2010)	brazilian straightening [9]	formaldehyde[3] and/or methylene glycol (= reversible product of formaldehyde in water)	+	+	**avoidance (airborne; carcino-genic)**
		sodium hydroxide	irritant[2]		**nitrile single use gloves**
		potassium hydroxide	irritant[2]		
		lithium hydroxide	irritant[2]		
cleaning	cleaning agents, disinfection agents	e.g. formaldehyde[3], glutaral, perfumes, tensides, preservatives	+	+	**reusable gloves**
contact with occupational tools	e.g. scissors	nickel		+	**Nickel-free material**
skin protection	protective gloves	latex, mercaptobenzothiazoles, thiurames, dithiocarbamates, phthalates[10], formaldehyde[3,11]		+	**gloves without latex, phtalates and accelerator free gloves**
	skin protection agents	Preservatives, lotion bases, perfumes	+	+	**hypo-allergenic products without color, fragrance and preser-vatives**

[8] in 1995, the manufacturer of hair cosmetics and the (German) barber guilds decided not to use GMT in perm (Berger et al. 2005: 13)
[9] prohibited based on EU-Cosmetics Directive 76/768/EWG, as the formaldehyde concentration significantly exceeds the limit of 0.2% (Kratz et al. 2010)
[10] Geier et al. 2003
[11] Pontén 2006

Activity	Products	Exemplary contact substances [INCI]	Irrita-tion	Sensitiza-tion	Protective measures
haircutting (Füeßl 2011)	hair		+[12]	(+)[13]	**arm protectors, closed shoes**

Further information on the sensitization potential of hair dyes can be found at Søsted et al. (2004). According to Brans/Merk (2009), hairdressers should be patch tested by using standardized DKG patch test series, especially the one for “hairdresser”as well as the “standard", “externa contents” and “preservatives and disinfectants” test series.

6 Skin protection in the hairdressing trade

6.1 Work organization

Wet work should be reduced if possible or spread among multiple employees to minimize individual exposure. Workflows should allow for switching between moist and dry activities (TRGS 401, Declaration of Dresden).

6.2 Three column model

Skin protection has a three column model, consisting of the following:

- Skin protection *during* work
- Skin cleaning and
- Skin care *after* work

These methods have been shown to be particularly effective when combined (Winkler et al. 2009, Kütting et al. 2010).
The following paragraphs explore the three columns in more detail.

6.2.1 Skin protection

Methods for skin protection include both protective gloves and skin protection products.
Skin protection products should be tailored to the activities performed by the hairdresser. They may protect primarily against moisture and water or can reduce the tendency to sweat under watertight gloves. The protective effect is discussed in the literature with controversy. Bock et al. (2001) were able to show an anti-transpirant effect of an aluminum chlorohydrate skin protection product, which was applied under impermeable protective gloves. Fartasch et al. 2010 did not demonstrate such an effect with short-term occlusion.
It should be remarked again that frequent use of a skin protection product in the context of the three column model can work preventively against the development of occupational skin diseases (as previously explained).

[12] Danger of pilonidal sinus (Füeßl 2011)
[13] The hair itself does not cause sensitization. However, only 80-90% of hair dye is washed out after coloring hair (Nohynek et al. 2004), meaning that hair dye in freshly-dyed hair can have a sensitizing effect (Søsted 2011).

Protective gloves in the hairdressing agency must fulfill the European Norm 374 (EN), "Protective gloves for chemicals and microorganisms". For all typical hairdresser activities (coloring hair, etc.), single use gloves made from nitrile rubber or polyvinyl chloride ("vinyl") are appropriate with adequate normation. They are to be disposed after single use. In general, nitrile rubber has a higher level of protection compared to polyvinyl chloride, so that single use gloves made from this material are preferable (Bundesverband Hautschutz e.V. 2009). If used repeatedly, the gloves may no longer be able to carry out their protective function due to the thinness of the material. For cleaning and disinfection work, reusable chemical gloves with high thickness (>0.3 mm) are to be used. For known sensitizations to rubber accelerators (such as mercaptobenzothiazoles, dithiocarbamates, thiurames), which may be contained in protective gloves made from natural or synthetic rubber, special accelerator-free protective gloves are available (Diepgen et al. 2008, Zuther et al. 2007). The same applies to disposable vinyl gloves, which potentially contain plasticizers (phthalates).
Wearing protective watertight gloves often leads to a blockade of moisture and heat. To reduce this, gloves can be changed frequently, cotton undergloves can be worn that are changed after becoming moist (Ramsing/Agner 1996) or a sweat-reducing skin protection cream can be applied (Bock et al. 2001). In the hairdressing trade, wearing gloves when cutting hair is not well accepted, as this is often associated with reduced fine motor skills. Single use gloves in combination with cotton undergloves to prevent occlusion effects are even less accepted and used. Fingertipless cotton undergloves represent an alternative.
As previously mentioned in Chapter 5.2, occlusion of moisture with watertight protective gloves causes the cornified layer barrier to become more easily permeable. This increases the irritability of the skin. Exposure to occupational substances or other skin hazards at home after wearing gloves, should be avoided (Fartasch et al 2011, Wulfhorst et al. 2011).

6.2.2 SKIN CLEANING

When cleaning the skin, the following rule should be followed: "As little as possible, as often as needed". This means that the hands need not be cleaned with skin cleansers, if not dirty, discolored, or contaminated with bacteria, such as after wearing gloves.
When using skin cleansers in hairdressing, the following points should be observed:

- the pH value should be neutral to the skin (approx. pH 5.5; important for maintaining the acid protection layer of the skin) (Schmid/ Korting 1995)
- the product should be free of dyes, perfumes and preservatives (potential allergens)
- the product should contain mild tensides
- the product should be free of solvents (Klotz et al. 2002, Stolz 2005)
- the product should be free of abrasives (Löffler et al. 2000)

For skin cleaning, lukewarm water should be used. After washing, the hands should be carefully patted dry with single use paper towels as soft and gentle as possible. Under no circumstances towels that have previously been used in direct contact with the customers should be used for drying the hands as they might contain the remains of hair colors or shampoo. These substances could penetrate more easily through the by cleaning induced hyper-hydrated skin (see chapter 5.1) at the hands and may cause irritation or even sensitization. Forceful rubbing can cause abrasion of the superficial skin layers and can damage or destroy the skin barrier even more.

6.2.3 SKIN CARE

After work, appropriate skin care products should be used for regeneration of the skin. When needed, lotion can be generously applied to the hands and covered in cotton gloves overnight to promote healing.

7 The European hair dye strategy - consumer protection

Hairdressing products such as hair dyes, finishing products and shampoo are considered cosmetics in a legal sense and, like all cosmetic substances, are subject to Regulation (EC) No. 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products (Cosmetics Regulation, in force since mid-January 2010, in effect starting 11 July 2013). This regulation simplifies and replaces the Cosmetics Directive (76/768/EEC), which has been modified, expanded and corrected multiple times since its passage in 1976.

Several studies describe the effects of hair cosmetics, particularly hair dyes, including sensitizing potential (Leino et al. 1998, Lind et al. 2007, Majoie et al. 1996, Schnuch et al. 2008, Guerra, Bardazzi et al. 1992, Guerra, Tosti et al. 1992, Uter et al. 2003) or even carcinogenic potential for bladder cancer or leukemia (Rauscher et al. 2004, Andrew et al. 2004, Gago-Dominguez et al. 2001). This led to approval of the so-called hair dye strategy by the European Commission in May 2003, with the goal of creating a positive list of hair dyes in the EU by 2010. Manufacturers of hair dyes were instructed to provide product dossiers for risk assessment to the independent scientific council for the European Commission. Substances for which a product dossier was not provided or that did not pass scientific testing were prohibited (SCCS 2010). The goal of this was consumer product safety. Hair dye substances were tested for sensitizing, mutagenic, genotoxic, reproductive-toxic, irritative and oral-toxic (90 days oral toxicity) properties as well as dermal absorption characteristics and the correlating potential effects on humans of systemic intake (Pauweis et al. 2009).

Appendix II, Part 1 of the Commission Directive 76/768/EEC regarding cosmetics lists substances that may be contained in cosmetics if certain limitations and other requirements (e.g. amount limits) are met. The second part of this Appendix lists substances that have preliminary approval. These substances have not yet been given a final assessment by the SCCS. Appendix II of the Commission Directive regarding cosmetics lists all substances and materials that are prohibited in cosmetics.

Due to the consumer safety panel's recognition "that contact allergies caused by hair dye products are an increasingly important health problem for consumers and society" (amendment to the EU Cosmetics Directive 76/768/EEC by Directive 2009/134/EC of the Commission, 28 October 2009, Part 1), the labels of hair dyes containing highly sensitizing materials (Directive 2009/134/EC of the Commission, 28 October 2009, Directive 2010/4/EU of the Commission, 8 February 2010) should include, among other things, the following notice after 1 November 2011: "Hair colorants can cause severe allergic reactions" and "This product is not intended for use on persons under the age of 16." Products without this label may no longer be sold after 1 November 2012. This age limitation has caused confusion amongst hairdressers across Europe. The German Cosmetic, Toiletry, Perfumery and Detergent Association (*Industrieverband Körperpflege und Waschmittel e.v.; IKW*) explains the legal limitation by arguing that this will ensure responsible decision-making. The EU directive does not generally prohibit dyeing for persons under 16 years old, but according to the IKW, liability of the hairdresser cannot be ruled out (IKW 2011).

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