

A HANDBOOK ON

OCCUPATIONAL HEALTH PRACTICE IN THE SOUTH AFRICAN MINING INDUSTRY

CHAPTER 15

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Chapter 15

Occupational Skin Disorders

This chapter covers the important topic of occupational skin disorders that have, largely, been unrecognised and underreported, much less researched, in the mining industry. The introduction summarises local and international information on skin diseases in the mining industry, and research needs are discussed. The relevant legal framework and compensation issues are briefly outlined. The clinical approach to skin diseases summarises the conditions most likely to be encountered in the industry.

The complexities of assessing skin exposure risk and the deficiencies of applying recognised exposure levels to occupational skin diseases are addressed. The skin barrier function in identifying hazards is highlighted. Personal protective equipment is discussed, with particular emphasis on skin protection. General principals relevant to all personal protective equipment are addressed, with additional sections on gloves and barrier creams. Last, the rehabilitation and accommodation of mineworkers with impairment and disability, due to skin disease, is discussed, giving a general guide to occupational skin diseases, with emphasis on those that need special consideration.

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15.1 Introduction

Any abnormality of the skin induced or aggravated by the work environment is defined as an occupational skin disease (OSD). While legislation applies particularly to the workforce involved in mining and other activities, a mine workforce also includes managerial, laboratory, administrative, maintenance, and construction personnel. All these workers are potentially exposed to skin hazards, emanating from air conditioners to solvents. This chapter will assist identification of skin diseases in any of these jobs, although conditions relating to mining are emphasised.

Identified irritants are listed in **Table 15.1** and allergens are listed in **Table 15.2**.

Table 15.1. Skin hazards relevant to mining: irritants

Shotcrete (fresh), cement
Alkaline and acid concrete accelerating agents
Concrete solutizers
Moulding agents
Wood implementing materials
Lubricants (greases, oils)
Solvents (trichloroethylene, white spirits, thinners, benzene)
Acids and alkalis
Anticorrosives
Diesel fuels, paraffin
Bitumen, tar
Polyurethane (rock strengthening)
Phenol formaldehyde resin (ground stabilisation)
Ammonium nitrate (explosives)
Dust (rock, iron pyrites, cement, wood)
Humidity
Heat
Cold
Sand, soap, detergent, hand cleaners, wet work
Hand-operated tools
Radiation – non-ionising ultraviolet (welding, open cast mining), ionising (uranium/radon gas, carbon-14)

Table 15.2. Skin hazards relevant to mining: allergens

Metals: • Nickel • Lead • Cobalt • Chromium Chemical allergens: • Epoxy resins • Acrylate glues (used in repairs/maintenance) • Textile dyes/resins (in protective clothing) • Latex (in gloves and equipment seals) Other sources: • Cutting and lubricating oils • Certain acids and alkalis used in mineral processing • Dust and particulate matter containing allergenic metals

The extent and diversity of mining operations in South Africa expose the more than 470 000 mineworkers to a wide range of environmental conditions from hot, dry, high solar-radiation open mines to hot, humid, underground mines (1). As there has been minimal research on the prevalence of skin diseases, there are no reliable data to assess the impact of OSDs on worker health and productivity.

Estimates are possible only from compensation claims and mine healthcare records, since published data on skin diseases in South African mines deal mainly with epidemics of unusual infections, such as dermatitis, fungal infection, eczema, yaws, and sporotrichosis, and extreme physical conditions, such as heat, or systemic diseases, such as systemic sclerosis (2).

Global warming has added a new complex dynamic to potential skin disorders. Several researchers hypothesise that climate change, including rising ambient temperatures, increasingly potentiates the onset of tumorigenesis. Air pollution and skin damage due to UV radiation can cause skin cancer in extended periods of exposure (3) (4) (5).

15.1.1 Skin diseases in South African mines

In the South African mining industry (SAMI), contact dermatitis, both allergic and irritant, is a common skin issue, as established in a surveillance study by the National Institute for Occupational Health (NIOH) in 2017 (6). Other skin diseases seen include fungal infections, nummular eczema, and atopic dermatitis. Allergic skin reactions like itchy rashes and urticaria are also prevalent, along with conditions like athlete's foot, heat rash (7), and lymphocutaneous sporotrichosis (8).

15.1.1.1 Dermatitis

This is a broad category, including both allergic and irritant forms. Allergic contact dermatitis occurs when the skin becomes sensitised to a substance, while irritant contact dermatitis is caused by direct irritation

from substances like chemicals or solvents. Several substances can trigger dermatitis. Metals like nickel, cobalt, and chromium are common allergens, while irritants like cutting fluids, solvents, and abrasive materials can cause irritant contact dermatitis.

15.1.1.2 Fungal infections

These can be common in moist, warm environments found in some mining operations, and can manifest as conditions like athlete's foot and sporotrichosis. Athlete's foot is a superficial fungal infection of the skin, typically on the feet, caused by dermatophytes. Sporotrichosis, also known as 'rose gardener's disease', is a subcutaneous fungal infection caused by the fungus *Sporothrix*, which usually enters the body through a cut or scrape leading to skin lesions and, potentially, systemic infection

15.1.1.3 Nummular eczema

This type of eczema is characterised by coin-shaped patches of inflammation and itching. Eczema can be triggered by metals like nickel, cobalt, and chromate, and other substances like formaldehyde and certain chemicals used in industrial processes.

15.1.1.4 Atopic dermatitis

Also known as atopic eczema, atopic dermatitis is a chronic skin condition often associated with allergies and other inflammatory conditions. Mining activities can expose individuals to various substances, some of which can trigger or worsen atopic dermatitis (eczema). These substances include metals, volatile organic substances, and solvents. Specifically, trace elements like lead, cadmium, mercury, chromium, and cobalt have been linked to dermatitis. Additionally, epoxy resins, rubber chemicals, plastic chemicals, metals, and antimicrobials found in certain mining operations can also be significant allergens.

15.1.1.5 Other skin disorders

Besides the above, miners may experience other skin problems like allergic reactions (pruritis, urticaria), abscess formation, and various types of rashes.

Skin disorders in the SAMI are reported through a combination of mine-based medical services, occupational health surveillance programmes and, potentially, compensation claims. Data collection often includes patient identifiers, disease type, treatment details, and sick leave records. Surveillance programmes play a crucial role in identifying and managing these disorders, as they help in control and planning measures

It is important to note that skin diseases in the SAMI are underreported, perhaps due to the priority of other severe diseases such as occupational lung diseases (OLDs). Even when reported, the claims tend to be delayed or declined.

15.1.2 Skin disorders in the international mining industry

Globally, skin disease is prevalent in the mining industry. In the USA, common OSDs include contact dermatitis (irritant and allergic), folliculitis, and skin cancer (9). Occupational skin diseases are reported through the mine accident, injury, and illness reports, which are managed by the Mine Safety and Health Administration (MSHA). These reports provide a comprehensive overview of the incidence of dermatitis and other skin conditions in the mining sector.

In the UK, the common skin disorders in the mining industry include contact dermatitis (both irritant and allergic), fungal infections, and skin infections (10). Dermatitis is a reportable disease in the UK, and is

managed by The Health and Occupational Research (THOR) network in a scheme known as EPIDERM (11). This requires dermatologists to report cases of skin disease. General practitioners are managed under a similar reporting scheme called THOR-GP.

In the Australian mining industry, common skin disorders include irritant contact dermatitis, allergic contact dermatitis, and skin cancer, particularly due to ultraviolet (UV) exposure (12). Irritant contact dermatitis is the most frequent, while allergic contact dermatitis is less common, but can be triggered by substances like certain metals or chemicals. Skin cancer, especially non-melanoma skin cancer, is also a significant concern due to the prolonged sun exposure many miners experience. Skin disorders are typically reported through the workers' compensation system. Employers are required to notify the compensation scheme upon receiving a claim, including a claim form and a medical certificate from the treating medical practitioner. This ensures that OSDs are recognised and managed appropriately.

Different countries, thus, report different experiences of skin diseases in miners. However, because skin disease is a rare cause of death, and is underdiagnosed and underreported, health professionals, management, and sufferers may underestimate its importance and the long-term disability it can cause. The cost of OSD in the mining sector is, thus, potentially high for the worker in respect of disability, and for the industry in days lost and medical compensation costs.

15.2 Legal Framework and Compensation Issues

As with all other occupational diseases, the management of skin disorders is embedded in sections 11 and 22 of the Mine Health and Safety Act No. 29 of 1996 (MHSA) (13).

Section 11 addresses the employer's duty to ensure the health and safety of employees by identifying, assessing, and minimising the hazards to health or safety that they may be exposed to while at work.

Section 22 addresses the duty of employees to ensure that they take reasonable care to protect their own health and safety, and that of others, by using protective clothing, and other health and safety facilities and equipment provided for their protection, health, or safety.

The MHSA does not contain a specific section that refers to 'skin' in isolation. However, the protection of skin is addressed through broader provisions, as indicated above. Other related provisions on emergency procedures for hazardous substances can be found in the Occupational Health and Safety Act No. 85 of 1993 (OHSA), under General Safety Regulation 3(9), which states (14):

"Where an employee at a workplace is exposed or can be exposed to a potential hazard of injury to or absorption through the skin as a result of sudden contact with a large amount of toxic, corrosive, high risk or similar hazardous substance, the employer concerned shall make sure that there is a fast-reacting deluge-shower with clean water or a similar facility in the immediate vicinity of the workplace of such employee and that the employee is trained in the use thereof."

Skin disorders are compensable under the Compensation for Occupational Injuries and Diseases Act No. 130 of 1993 (COIDA) (15). Schedule 3 of the COIDA lists the following compensable diseases related to skin disorders:

- Melanoma of the skin from work involving the handling or exposure to polychlorinated biphenyls
- Allergic or irritant contact dermatitis from work involving the handling or exposure to dust, liquids or other external agents or factors
- Any disease or pathological manifestations from work involving the handling or exposure to

beryllium, cadmium, phosphorus, chromium, manganese, arsenic, mercury, lead, fluorine, carbon disulfide, cyanide, halogen derivatives or aliphatic or aromatic hydrocarbons, benzene or its homologues, nitro and amino derivatives of benzene or its homologues, nitroglycerine or other nitric acid esters, hydrocarbons, trinitro-toluol, alcohols, glycols or ketones, acrylamide, or any compounds of the aforementioned substances.

Obtaining compensation for skin diseases is difficult, due to the perceived unimportance of the problem. Chances of acceptance are greatly facilitated by ensuring that all the necessary forms, including a dermatology report where indicated, are properly completed, and forwarded together at the same time.

To submit a compensation claim, these forms should be completed:

- W.Cl.1 – Employer's report of disease
- W.Cl.22 – First medical report
- W.Cl.53 – Dermatological report, with copies of relevant special investigations
- W.Cl.26 – Progress reports, as required
- W.Cl.26 – Final report

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15.3 Clinical Approach and Spectrum of Conditions

Dermatological disease, while rarely causing serious illness, causes disability and misery, and decreases worker efficiency. Workers themselves fear retrenchment and do not wish to give up bonus pay. They will work without complaint, although in much discomfort. This section attempts to provide a workable approach for recognising these problems, and should be read in conjunction with **Appendix 15.1**.

Occupational dermatoses can be the result of a single or repeated exposure to one hazard, or of the cumulative effects of a variety of different hazards, occurring simultaneously or consecutively. All four categories of causation, (i.e. mechanical, biological, chemical, and physical hazards) comprise skin irritants and sensations, with the ability to cause direct skin damage, and they can all act as hazard modifiers. For more details on specific skin diseases, see **Appendix 15.2**.

15.3.1 Mechanical hazards: trauma, friction, pressure, vibration, pounding, abrasion, and penetration

This is the largest causal category as it includes trauma to the skin surface. Mechanical hazards are irritants and result in acute damage (redness, blisters, erosions, necrosis, burns, ulcers), chronic damage (Raynaud's phenomenon, vibration syndrome, deformity, nasal perforation), or chronic adaptive skin protective reactive responses (skin thickening and hyperkeratosis as in corns, calluses and lichenification). Vibration injury is covered in Chapter 10 of this Handbook (Noise and Vibration).

15.3.2 Chemical hazards: organic and inorganic compounds

Chemical hazards are either directly toxic to cells or cause indirect injury through metabolites or immune mechanisms. The effects (irritant/toxic or allergic) are local, causing skin damage (burns, ulcers, nasal perforation, pigmentation) and disease (dermatitis, urticaria), or systemic, secondary to percutaneous absorption (trichloroethylene). Chemical allergens cause skin disease via stimulation of the immune response.

The spectrum of skin changes ranges from nothing (sub-clinical damage) or dryness, to erythema and frank eczema. Chemical irritants also include water or mild soap (known as wet work), harsh acids, alkalis, and solvents.

Heavy metals like arsenic, cadmium, chromium, lead, and mercury are known to be toxic and can cause multiple organ damage, even at low levels of exposure. Some metals, like nickel, chromium, and mercury, can also cause adverse health effects in their metallic compound forms. Some metals are common allergens that can cause contact dermatitis, while other metals can lead to systemic toxicities and various skin manifestations.

Certain metals, like nickel and chromium, can trigger an allergic reaction in the skin when they come into contact causing itching, redness, swelling, and blisters. Exposure to heavy metals like mercury, lead, or cadmium can lead to systemic toxicity, affecting the skin and causing pigmentary changes, inflammatory dermatoses, skin ulcers, and cancer.

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As there is individual variation in the sensitivity of the skin and its ability to recover, and as virtually every substance can affect the skin or be absorbed, no substance should be excluded from a risk assessment.

15.3.3 Physical hazards: temperature, radiation, electricity, humidity, airflow, and occlusion

Physical hazards often act as hazard modifiers, but they can cause direct effects.

Solar, non-ionising, ultraviolet radiation causes sunburn, skin ageing, and cancer and, in combination with certain chemicals, can precipitate phototoxic or photo-allergic reactions. Chronic exposure to artificial light sources may produce similar effects. Ionising radiation causes radio-dermatitis and cancer. Uranium oxide (alpha, beta, and minimal gamma radiation) is present in rock and is mined as a by-product of gold. The concentration varies from place to place, with the highest level being 0.5 kg/ton of ore. Workers are shielded from exposure by rock and water.

Temperature, humidity, and airflow all act as irritants, causing damage to the skin barrier. Reactions to heat include burns, miliaria, urticaria, erythema ab igne, and cancers. Cold exposure causes frostbite, chilblains, urticaria, and immersion foot. In dry environments, the stratum corneum becomes dehydrated (< 50% relative humidity is associated with < 10% horny layer hydration, the level at which skin irritation occurs), while excess hydration results in maceration of the skin.

Occlusion of the skin (rubber personal protective equipment (PPE)) may cause damage to the protective skin barrier by overhydration of the horny layer, and encourage infections (fungal foot infections). It may also lead to blocked pores, predisposing to acne (rubber masks, oils, greases) and miliaria. Additionally, occlusion and hyperhydration can affect the barrier of the skin, leading to increased permeability of the skin.

15.3.4 Biological hazards: viruses, bacteria, fungi, parasites, and insects

The range of infections manifesting in the skin varies from immediate manifestations to progressive disorders over time. The infections that manifest immediately, such as impetigo, folliculitis, boils, abscesses, candidiasis, and dermatophytes, also respond promptly to treatment. However, the more chronic, indolent forms may be difficult to recognise (lumps, chronic sores, or sinus tracts) and often need biopsy for culture and histology. Unusually severe, recurrent, and persistent infections, despite full appropriate treatment, should alert one to underlying systemic immuno-deficiency conditions.

Foot problems are especially problematic for miners. Occlusive PPE, used in hot, humid working

environments, predisposes to skin maceration and irritation, and microorganism growth. Although moist environments encourage dermatophyte fungal and yeast infections, wetness of the feet predisposes to bacterial infections characterised by malodour and athlete's foot.

Rodents, bats, mites, and cockroaches can inhabit mines. Rodent fleas and mites can result in insect bites. Bats are associated with histoplasmosis exposure that causes systemic fungal infections, especially in the immuno-compromised. Cockroaches are increasingly recognised as a cause of type I allergic reactions in the general population.

15.3.5 Pre-existing conditions

There are pre-existing conditions that pre-dispose miners to certain occupational dermatoses:

- Atopic individuals, especially those with a family or personal history of eczema, are more at risk of developing contact dermatitis, as their skin barrier function is impaired. Individuals with dry skin will also be more at risk, for the same reason.
- Individuals with fair skin are at higher risk of damage due to solar UV radiation.
- Patients who are immuno-compromised, such as diabetics and those with acquired immunodeficiency syndromes (AIDS), are more liable to develop severe skin infections.
- Patients with underlying disorders of keratinisation such as psoriasis are susceptible to disease aggravation following skin damage, or develop lesions at the sites of trauma (isomorphic or Koebner phenomenon).

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15.4 Risk Assessment of Skin Hazards

Risk assessment involves the identification of all potential hazards in the workplace, an evaluation of exposure potential for each hazard, and a ranking of occupational risk.

15.4.1 Assessing skin and surface contamination

There are several methods that can be used to assess skin and surface contamination, which help to evaluate the amount of potentially harmful substances present on the skin, work surfaces, and equipment. Some of these methods include:

- *Wipe sampling* (smear sampling) involves using a swab to collect a representative sample of material from a surface, which is then analysed in a laboratory to determine the concentration of contaminants.
- *Dermal dosimetry* uses patches or whole-body suits directly to measure the amount of material deposited on the skin. It can be helpful for evaluating exposure to substances that can penetrate the skin.
- *Direct observation* methods include skin washes and wipes, as well as the use of fluorescent tracers that can be visualised under UV light. These methods allow for direct assessment of skin contamination and the presence of specific substances.
- *Suction sampling* involves using a suction device to collect a sample of material from the skin's surface. It is often used to assess the amount of particulate matter present on the skin.
- *Direct-reading* methods use instruments like pH sticks, colorimetric pads, or mercury sniffers directly to detect the presence and concentration of certain contaminants on surfaces.
- *Contact plates* (replicate organism detection and counting (RODAC) plates) are used to sample bacteria and other microorganisms from surfaces. They are pressed onto the surface, and any contaminants are transferred to the agar medium, which is then incubated, and colonies are counted.

15.4.2 The conceptual model for assessment of dermal exposure

Schneider and his co-workers developed the estimation and assessment of substance exposure (EASE) conceptual model for dermal exposure in 1999 (16). This model outlines a structured framework for understanding and assessing dermal exposure to hazardous substances. It considers various factors that influence exposure, including the environment, clothing, and the individual's skin, to provide a more comprehensive analysis.

The model identifies the two key environmental compartments, which are air and contaminated surfaces. The clothing compartment considers the impact of clothing, specifically the inner and outer layers, as these can affect how substances interact with the skin. The skin and absorption component emphasises that hazardous substances on the skin surface are continuously taken up into the body, through the stratum corneum and epidermis.

The model acknowledges various factors that influence the uptake of substances, including the concentration gradient between the skin surface and the body, and the presence of protective clothing. The model also considers direct contact with hazardous substances from the air or contaminated surfaces, as well as potential routes of exposure through submersion in the substance.

15.4.3 Complexities of skin risk assessments

While approaches have been developed for respiratory or noise risk assessment, skin disease risk assessment is complex, owing to several practical and technical problems, including:

- The ability to recognise and diagnose skin diseases by medical personnel is generally poor.
- Knowledge among medical and occupational health personnel of skin function and the factors that affect it is inadequate, so that these factors are not addressed in occupational health programmes.
- There are few reliable incidence data of OSD amongst miners.
- Hazard effect modifiers (pre-existing skin disease, humidity, heat, dryness, occlusion, and irritants) need identification and consideration in any risk evaluation.
- Some knowledge of product chemistry is needed to identify unexpected exposures. For example, certain biocides release formalin, but formalin will not be listed on the product label as it is not added by the manufacturer. Likewise, oxidation or degradation products, such as the potent skin sensitiser formed on exposure of the degreasing agent d-limonene to air, will not be listed. Iron pyrites in gold ore produce sulphuric acid with water. Workers contaminated with the ore dust in humid, wet surroundings are exposed to this acid, as are those who sweat. Nitrous emissions from blasting dissolve in water to form nitric acid. Cross-sensitisers such as balsam of Peru, turpentine, or pine need to be identified as hazards capable of causing ongoing disease when the primary sensitiser, colophony/rosin, has been eliminated.
- The occupational exposure limits (OELs) in the MHSA are not directly prescriptive for skin, but are indirectly prescribed for the various chemicals to which individuals may be exposed. This makes compliance monitoring difficult.
- A single exposure limit is not applicable to all skin surfaces. The palms, soles, and forearms are less permeable than the scrotal area (which is highly permeable), face, and scalp. The thick horny layer of the palms and soles may, however, act as a reservoir for substances, increasing their chances of skin penetration. The nails are highly permeable to water and water-soluble compounds.
- Safety data sheets (SDSs) often list only officially recognised hazardous substances under product composition data. Skin irritants and sensitisers are not necessarily included in these lists.
- Recognised hazard and exposure limits refer to a single pure substance assessed under environmental conditions. In reality, skin exposure to a single pure substance in the workplace is unusual. It is, however, impractical to establish a set of unique hazard exposure safety limits for each

combination.

- Skin disease is often the result of accumulated multiple insults. Risk assessment generally deals with the risk of acute effects, rather than slow cumulative effects.
- Routes of skin exposure include contact with solid, liquid, and vapour forms of the substances, all of which need to be evaluated in a risk assessment.
- Skin risk assessment is time consuming, as virtually every substance present in the work environment needs identification and assessment, not only those listed in statutory Regulations. At least 20 000 chemicals are potential hazards for miners.

Skin risk assessment depends on the knowledge and experience of the assessor, allowing a subjective evaluation based on a systematic approach to ensure all potential hazards are considered.

For further guidance on dermal exposure assessment, please refer to the US Environment Protection Agency's (EPA's) exposure assessment tools by routes dermal at <https://www.epa.gov/expobox/exposure-assessment-tools-routes-dermal> and the European research project RISKDERM at <https://www.insst.es/documents/94886/679780/Toolkit+Paper+Version.pdf/58dcc79a-a6b6-423c-8cf3-500944586d6e>

15.4.4 The skin barrier function

To appreciate the complexities of risk assessment for skin exposure, an understanding of the skin barrier function is important.

The skin has developed to function effectively as a living structure at a water-air interface. The barrier function of this interface is due to a specially formulated combination of fatty substances (lipid layer), found between the specifically adapted cells (corneocytes) of the horny outer layer of the skin. A thin surface layer of oil secreted by the skin oil glands helps to maintain this barrier intact. The skin may be damaged in many ways, and often there are multiple causes contributing to skin disease.

Absorption through the skin can occur in normal skin. Substances that dissolve in organic solvents, and the solvents themselves, easily penetrate the fatty layer of the skin barrier. Although the mechanism is not well understood, water and water-soluble substances can also penetrate the normal barrier, but at a much slower rate. Areas not protected by the horny outer layer, such as the hair follicles, sweat ducts, and mucosal surfaces, offer less resistance to the penetration of most substances, especially water-soluble compounds. Safety data sheets have a skin warning for certain substances that are recognised to have significant skin absorption. Although the SDSs might be prepared by other countries supplying the goods, and not necessarily adhere to the local Standards, it is worth noting and benchmarking against such international Standards.

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Damage to the skin barrier occurs easily. The stratum corneum (outer layer of the epidermis) could be mechanically damaged with cuts, abrasions or, even, burns. The fatty layer can be removed or damaged by detergents, organic solvents, soaps, and chemicals. Too much water damages the specially adapted cells by excess hydration, while an environment that is too dry dries them out and disrupts the barrier. Once the barrier has been damaged, substances from outside can more easily penetrate the skin. This can lead to activation of the skin's immune system, potentially causing immune-related conditions such as contact dermatitis and urticaria. Alternatively, systemic absorption is markedly increased and can result in systemic toxicity. Infective organisms can also gain access into damaged skin more easily.

The skin's surface is naturally acidic due to the 'acid mantle', a thin layer of lipids, sweat, and other secretions. This acidic environment is crucial for maintaining a healthy skin microbiome, protecting against

pathogens, and promoting proper epidermal function. Skin pH imbalances, specifically an elevated pH (more alkaline), are implicated in various skin disorders. The normal skin pH range is around 4.1–5.8, and deviations from this can disrupt the skin's barrier function and microbial balance, potentially contributing to conditions like atopic dermatitis, acne, and xerosis (dry skin) (17).

Most people do not recognise that damage to the skin barrier occurs many times a day. Fortunately, the skin barrier can regenerate, but this requires time. We become aware of the damage when the skin shows changes such as dryness, cracking, and peeling. This represents early skin disease and is known as irritant dermatitis. Should damage occur faster than repair, a continuous state of disease will be evident as worsening dermatitis. Associated immune diseases, such as allergic contact dermatitis, urticaria, and infections, occur more readily with damaged barrier function and often complicate the presentation of irritant dermatitis.

15.5 Personal Protective Equipment

Common sense confirms that gloves and barrier creams are not all that are relevant to skin protection. All forms of PPE (masks, overalls, boots, gloves, helmets, goggles, ear plugs, skin guards, braces) protect against skin exposure. Because of this, and because PPE is worn in close contact with the skin, general principles applicable to PPE are discussed below.

Personal protective equipment should be used as a last resort when all other means of engineering have failed to prevent exposure. It is important to remember that the effectiveness of PPE relies on the compliance of the worker, and ineffective use of PPE could also lead to exposure. Personal protective equipment should be used only for back-up, such as splash protection. Workers should understand this principle and be fully informed of the limitations of PPE, especially as primary protection.

Before any PPE is selected, the precise task and reason for the choice must be established and discussed with the worker. This implies a complete hazard assessment of the task, including the ambient environment.

15.5.1 Correct use of personal protective equipment

Personal protective equipment must not worsen or aggravate the exposure:

- Any piece of apparel worn in close contact to the skin, which does not allow the free exchange or absorption of water vapour, leads to skin maceration and irritant contact dermatitis (such as rubber boots).
- Any ill-fitting piece of PPE lessens the ability of the worker to function adequately because it is cumbersome, restricts movement, causes pain, or leads to corns, calluses, or mechanical skin trauma (including boots and gloves).
- Where possible, PPE should be personalised. The fit should be correct, and the items must be used by one worker only. This prevents the spread of skin infections, such as fungi (dermatophytes, yeasts), bacteria (staphylococcus), and viruses (warts), from worker to worker that may occur with communal use. The potential spread of infections via body secretions should also be considered, especially in the event of undiagnosed dermatitis. The use of disinfectants and cleansers to overcome these problems is not reliable, owing to human error and the lack of a universal product prevents damage to the equipment or dermatitis in the worker. Personalised PPE can be cleaned in accordance with the manufacturer's instructions for each individual item.
- Failed PPE can lead to skin disease. An example of this is when gloves are used for mechanical protection in wet environments. When water penetrates the gloves and the gloves are kept on, an environment similar to that of working with the hands immersed in water is created, leading to maceration and loss of barrier function. When soiled gloves are used, the soiling is kept in occlusive

contact with the skin, increasing penetration and toxic possibilities. This also occurs when damaged gloves are used.

Dirty or contaminated skin should never be covered by PPE (for example dirty hands placed inside of gloves), as this will increase the potential for absorption

Use of damaged PPE, especially gloves (torn, leaking, structurally altered, beyond the breakthrough time), is a work hazard.

Gloves that are inappropriately used, such as latex rubber gloves for organic solvents, give a false sense of security. Although the gloves are believed to be protective, they are not. Certain solvents and chemicals penetrate the gloves easily and build up within the gloves, without damage to the glove being obvious (known as the breakthrough time). This leads to a higher concentration of the solvent and solutes inside the gloves, which come into direct contact with a moist, macerated stratum corneum, increasing skin penetration and toxic effects. Any reputable supplier of PPE should be able to provide the breakthrough time for a variety of solvents for each specific glove, for example.

Alternatively, the solvents or chemicals cause structural damage to the glove material, altering its performance characteristics. The manufacturer should also provide the list of chemicals and solvents for which a glove can be safely used. Personal protective equipment can itself cause skin disease, and it should be tested in the given environment due to mixture of exposures. A good example of this is when allergies develop to rubber in facemasks, rubber boots, skin protectors, and a variety of different gloves, or in natural rubber latex, causing latex allergies.

Cleansing products used for PPE can lead to dermatitis; for example, allergies to chlorhexidine in disinfectants or irritant reactions to soap products in incorrectly maintained equipment.

15.5.2 Personal protective equipment management programme

It is crucial that a well-structured PPE management programme should be in place, ensuring workers have the appropriate equipment to mitigate workplace hazards. Programme components should include hazard assessment, selecting of appropriate PPE, fitting procedures, maintaining, and replacing PPE, as well as thorough education and training, management support, and programme maintenance and auditing. A well-managed PPE programme is critical for workplace safety and compliance with occupational health and safety (OHS) Regulations.

The programme should entail thorough assessment of the workplace, identifying potential hazards and the risks they pose to workers. The selection should include engineering, administrative, and PPE controls to minimise or eliminate hazards.

The chosen PPE should be specifically designed to protect against the identified hazards, considering factors like fit, comfort, and ease of use. Additionally, the PPE should be properly fitted and worn by employees, following manufacturer instructions and best practices.

The programme should provide comprehensive training to employees on how to use PPE correctly, when it is required, its limitations, and proper maintenance and disposal. Securing commitment and support from management for the PPE programme is pertinent to its success, including providing resources and ensuring its implementation is effective.

Once PPE is in use, the programme should implement procedures for storage and regular inspection, cleaning, replacement, and maintenance of PPE, to ensure its effectiveness and longevity.

It is important that the PPE management programme specifies periodic reviews and audits to assess its effectiveness, identify areas for improvement, and make necessary adjustments.

There is no single item of PPE that is applicable to every task or every exposure.

15.5.3 Barrier creams

Barrier creams are topical preparations that are marketed as rub-on exposure protectors. They create a greater sense of false security. Given the limitations of all physical means of protection, obviously barrier creams offer little skin protection. They are *not* the universal, cheap solution for skin protection sought by management and occupational healthcare workers.

The main function of barrier creams is to maintain skin hydration and preserve skin barrier function. The addition of chemicals to inactivate or bind specific substances, such as metals like nickel, to prevent their interaction with the skin, may have specific application. However, barrier creams themselves may aid penetration of chemicals by allowing the chemicals to dissolve in the vehicle of the barrier cream, thereby increasing the contact reservoir and the toxic and penetration effects.

The constituents of barrier creams (fragrances, preservatives, antibacterial agents, and colourants) can also cause allergic dermatitis. Furthermore, there is the risk of not applying the barrier cream correctly (dose and coverage) or applying it to contaminated skin, causing occlusion.

15.5.4 Solar radiation protection

Employers must assess the potential for worker exposure to solar UV radiation and implement control measures to minimise the risk. Protecting workers from solar radiation involves a multi-pronged approach, focusing on minimising exposure and providing appropriate PPE. This includes encouraging workers to seek shade, wear protective clothing, apply sunscreen, and wear sunglasses, all while providing education and training on the risks of overexposure.

Where feasible, employers should implement engineering controls, such as shade structures or reflective surfaces to reduce UV exposure, administrative controls, including scheduling work during periods of lower UV intensity (e.g. early mornings and late afternoons), and work practices that minimise outdoor exposure.

Workers need to be educated about the risks of UV exposure, how to protect themselves, and the importance of adhering to sun safety protocols. Employers should regularly monitor the effectiveness of their sun protection measures and adjust, as needed.

15.6 Rehabilitation and Accommodation of Mineworkers

The aims of rehabilitation and accommodation policies are to give the worker with skin disease a chance to recover from the disorder, and to restore barrier function while investigating and eliminating the risk, pending the worker's return to the job.

Rehabilitation and accommodation depend on the type of skin disease, its appropriate management, and the ongoing risk of exposure. Apart from the guarded prognosis of contact dermatitis, most skin problems

should resolve with minimum impairment and disability after appropriate treatment, allowing full return to work.

15

Several general principles apply to most skin diseases:

- *Make facilities with warm water and bland cleansers readily available to all workers to remove soiling, as needed. Skin hygiene is essential for preventing many skin diseases.*
- *Keep the skin clean, healthy, and supple with regular bland moisturisers.*
- *Protect the skin from unnecessary exposure to irritants.*
- *Ensure PPE is appropriate for the task, maintained, and kept clean for personal use only.*
- *Train workers properly in the use and limitations of PPE, to prevent skin contamination caused by the improper use of PPE.*

15.6.1 Mechanical skin disorders

Mitigating exposures to mechanical skin disorders include:

- Trauma (cuts, abrasions, lacerations, penetration) or friction and pressure (corns, calluses) cause most of these disorders, and they should resolve with removal of the irritant.
- Vibration injury from pneumatic tools is reversible, if recognised early and the worker is given time to recover. It is advisable to use light-weight tools where vibration frequencies are minimised.
- Limiting work in cold, wet environments should prevent recurrences of Raynaud's phenomenon and vibration injury, but susceptible individuals should be accommodated where they will not be exposed regularly.

15.6.2 Skin infections

Treatment, management and prevention of skin infections:

- Most infections will respond to treatment appropriate for the organism identified clinically, by taking scraping, swabs, and biopsies for microscopy and culture.
- The worker can continue with the same work once the acute symptoms have settled, without impairment and disability.
- Prophylactic measures need to be put in place to prevent re-infection and to discourage organism growth. These measures include education about the precautions needed to prevent dissemination of the infection (walking barefoot in communal areas with fungal or wart foot infections), treatment or elimination of the organism reservoir (wood for sporotrichosis, stagnant water for pseudomonas, nasal carriage for staphylococcus), and the need for dry, hygienic, non-occlusive environments (use of absorbent bland powders and clean cotton socks daily, cotton glove liners, vapour-permeable overalls, air-conditioning).

15.6.3 Contact eczema/dermatitis

Treatment and management of contact eczema/dermatitis:

- This disorder will respond to removal of skin from contact with the responsible agents (irritants and allergens), combined with appropriate treatment for eczema (usually topical steroids) and secondary complications, such as infections.
- Prognosis is guarded for patients with contact dermatitis, as ongoing exposure to irritants and unidentified sources of allergen or cross-reacting substances is difficult to control.

- The worker can continue with the same job, provided that management and medical personnel recognise that the problem will recur with re-exposure, especially if insufficient time has been allowed for full recovery of the skin barrier function.
- If the worker is to continue in the same work, then the work environment (macro or micro) must be engineered to prevent ongoing exposure. This does not have to be high-tech or expensive, but includes the use of water-absorbent socks, the choice of appropriate gloves, the provision of adequate ablution facilities, or the use of simple tools to prevent direct skin contact.
- As stipulated in the duties of employees for health and safety in the MHSA, it is important that the workers be trained to ensure that they know how to protect their skin.
- The appropriate PPE may be issued for use as back-up protection against skin hazards only, or under exceptional controlled circumstances for those situations where exposure cannot be avoided.
- The necessary prophylactic measures need to be put in place to prevent other workers from being exposed.
- In the event of ongoing skin disease, despite adequate protection, the worker will need to be accommodated in alternative work situations. This can only be achieved successfully if ongoing exposure from unsuspected sources (such as formaldehyde-releasing preservatives in hydraulic and cutting oils, detergents, and topical creams) is excluded. This requires a thorough knowledge of the sources of exposure to particular agents.

15.6.4 Physical skin disorders

Mitigation of physical skin disorder hazards:

- Control of, or removal and protection from, extremes of temperature, humidity, and airflow should result in resolution of the condition caused or aggravated to the skin, unless permanent damage has already occurred (frostbite, burns).
- Radiation damage is, essentially, irreversible. Removal or protection from ongoing exposure will prevent worsening and may delay cancer development.

Prevention should be the aim of any occupational health programme. The best philosophy to adopt is to focus more effort on the occupation and process changes needed to prevent skin contact, and less on the treatment of the skin.

The findings from any case of OSD should be used to engineer alterations in the work environment, so that the problem does not recur.

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15.7 Impairment and Disability

Impairment is the clinical assessment of loss or abnormality of physiological, psychological, immunological, or anatomical structure or function.

Disability refers to an incapacity to earn the wage previously earned by the worker, because of injury or disease. It depends on the job and the worker's ability to compete in the open market.

Impairment is a medical term dealing with health status, and does not necessarily imply disability, which is a social or vocational term dealing with the ability to meet the demands of life.

Handicap refers to impairment, or a history of such an impairment that limits life activities. A worker with contact dermatitis is considered handicapped, even though the symptoms of the condition are resolved away from exposure and would, thus, have neither an impairment nor disability rating.

Because of the wide range of conditions that are considered work-related skin diseases, it is not possible to discuss the assessment of impairment and disability in each case. Work-related skin diseases affect predominantly the hands, feet, and face. Thus, they limit the ability to work and, because skin diseases are visible, they affect social contacts. Disability is determined by limitation of manual skills, risk of spread of infections, negative psychological image, colleague acceptance, and the job involved.

Most work-related skin diseases can be managed without the need to remove the worker from their job permanently. Apart from those conditions where permanent damage to the skin occurs (burns, vibration syndrome and scleroderma), the only condition that has a guarded prognosis is allergic contact eczema. Although the worker recovers away from the workplace and exposure to the substance, the impairment to the immune system is permanent, resulting in handicap and disability.

There are no simple rules that allow one to quantify OSD impairment and disability.

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Appendix 15.1. Clinical Approach to an Occupational Skin Disease

This section is a guide to evaluating a worker with a skin complaint, and identifying risk factors involved for suspected occupational skin disease.

Step 1 Occupational history

Take a detailed chronological employment history. This often requires a personal knowledge of the type of work being done, and may include an evaluation of the work environment to establish the occupational connection and all possible aetiological agents.

Note when the skin problem started and its relationship to work.

Relate symptoms to activities of daily living including work, hobbies, sport, and the home environment. Record in detail the facilities and products used for skin hygiene, in both the home and the workplace.

Include a detailed history of PPE, its use, and maintenance. Note whether it is for own or general use. Document cleaning methods and the products used. Check that the PPE is appropriate for the exposure for which it has been chosen. Check the workers' understanding of the use and maintenance of the equipment. Personal protective equipment may be the cause of the skin problem or may be aggravating the condition, such as dust trapped in gloves or occlusion causing skin maceration and promoting growth of skin bacterial and fungal infections.

Step 2 Medical symptoms

Describe the skin problem fully. Remember that there are a wide range of skin conditions that are considered occupational.

Note any past dermatological problems, especially atopic eczema, psoriasis, or previous skin allergies.

Take a full and detailed history of all treatments used, systemic and topical. Note medications given by alternative healers, self-medication, and those used prophylactically.

Step 3 List of hazards

List all potential hazards, not only those in statutory lists of hazardous chemicals. These should include dusts, environmental and climatic conditions, physical (vibration, radiation, and temperature), and chemical exposures. The composition of the chemicals and dusts should be ascertained and, where appropriate, the manufacturers noted, and SDSs obtained. This information allows one to identify substances that could cause skin disease.

Step 4 Examination

Identify the skin lesions. Describe in detail the various morphologies present, and the distribution of the lesions relative to each other and on the body.

Try to establish a relationship between the distribution of the lesions and exposure to materials at work, by doing a complete skin examination. The area of greatest disease is often the area of greatest contact with the offending product. Occasionally, this is not immediately obvious, such

as with the transfer of airborne agents (volatile chemicals or dusts) to exposed skin surfaces, or via direct hand contact to more susceptible areas of skin such as the eyelids and genitalia.

Cutaneous absorption may lead to systemic toxicity. Examine any patient with suspected systemic toxicity for signs of skin exposure.

The clinical manifestations of the more commonly encountered skin problems in the mining industry are detailed in **Appendix 15.2**.

Step 5 Assessment

In many cases, a clinical history and examination are all that is needed to confirm a diagnosis of OSD.

Occasionally, infective organisms may need to be identified and cultured, or special investigation (patch tests (**Appendix 15.3**), biopsy and histology) required. Each case must be judged on merit.

Clinical criteria for OSD:

- Is the clinical appearance consistent with occupational dermatoses?
- Are there workplace exposures to explain the skin disease?
- Is the distribution of the skin disease consistent with cutaneous exposure in the job?
- Is the relationship between exposure and the skin disease onset consistent with occupational exposure?
- Do special investigations identify and confirm probable causative agents from the workplace?

Step 6 Treatment

This is unique to each disease and specific details are given in **Appendix 15.2**.

Appendix 15.2. Skin Conditions and Their Management

Corns and calluses

Calluses and corns result from exposure to excessive and continuous pressure to the skin.



A callus appears as a yellowish thickening of the skin over an area exposed to pressure, commonly the ball and heel of the foot and the palms in those exposed to manual labour.



A corn results from a more concentrated pressure producing a central hard core in the thickened skin, usually on the upper surfaces of the toes.

Soft corns are painful white thickenings of the foot web spaces, the result of lateral pressure from footwear.

Treatment:

1. Remove the cause and relieve pressure to the area:
 - Advise on appropriate footwear or gloves
 - Refer to an orthopedist, for prosthetic devices to correct foot abnormalities
 - Use foam rubber between the toes to relieve lateral pressure
2. Remove thickened skin (treatment by a chiropodist is preferable):
 - Apply salicylic acid 10% (keratolytic) and occlude with plaster for 24 hours
 - Soften lesions by soaking in warm water
 - Remove softened skin with a scalpel blade or abrasive such as pumice or scraper
 - Repeat above process daily, as required

Eczema/dermatitis

There are many causes of eczema, but the clinical picture is essentially the same. The main complication of eczema is secondary infection with either bacteria, particularly *Staphylococcus aureus*, or viruses such as herpes simplex. These infections aggravate the eczema.



Acute eczema

- Itchy
- Vesicles, weeping and crusts (dry serum)
- Erythema and swelling
- Excoriations (skin lesions caused by picking, scratching, or rubbing the skin) and secondary infections may complicate the presentation (by causing a range of problems, including infections, scarring, and even life-threatening injuries)



Chronic eczema – lichenification (a thickened, hardened, and leathery appearance of the skin, often caused by chronic irritation or scratching)

- Itchy
- Thickened, dry, leathery skin
- Accentuated skin markings
- Pigment change (increased pigmentation usually)
- Excoriations, secondary infection, and features of acute eczema may complicate the presentation

Contact eczema may be irritant or allergic. Irritant dermatitis does not involve an immune response, but occurs following a single or repetitive cumulative damage by the same or multiple different

irritants encountered in all activities of daily living. Irritants can be physical (hot, cold, dry, humid environments), mechanical (dust or fabric abrasion, occlusion), or chemical (water, detergents, soaps, solvents, alkalis, and acids).

Skin lesions are initially confined to the sites of contact, but spread to adjacent skin with time. Eczema may become generalised, sometimes quite suddenly (irritant dermatitis reaction). The initial site of involvement on the body may provide a clue as to the aetiology. Patch testing may help to identify specific allergen triggers.

Atopic eczema

Occurs in individuals who tend to produce IgE antibody responses. There is usually a personal or family history of asthma, hay fever, or eczema. Stress, secondary infection, super-imposed allergic contact dermatitis, and exposure to irritants aggravate the condition. Dietary intolerance plays little role. Common sites of involvement are the face and the limb flexures. The course is chronic with acute exacerbations. Skin lesions often start in infancy or childhood and improve at puberty, but some patients continue into adult life with skin problems.

Seborrhoeic eczema

This is common, but the cause is unknown. It may be related to sebaceous gland activity, and is aggravated by stress and, possibly, yeast infections of the hair follicles. It occurs in all age groups and is recurrent. Greasy, scaly, red, poorly defined lesions are found in areas with large numbers of sebaceous glands like the scalp, central face, eyelids, central chest, and body folds. The sudden appearance of severe seborrhoeic dermatitis in adult life may be a marker of early human immunodeficiency virus (HIV) infection.

Nummular eczema

This is a persistent patchy eczema of unknown aetiology. Some patients have associated atopic or contact eczema. Bacterial infection may play a role in aggravating the condition. Well-rounded discrete patches of wet, crusted eczema are commonly seen on the limbs. The condition runs a relapsing course, with a tendency to slow deterioration without adequate treatment, usually potent topical steroids, and anti-bacterial measures.

Stasis eczema

This is usually seen on the lower legs in relationship to chronic venous stasis of the affected area. Any dependent area of the body can be affected, especially if immobility, oedema, or venous and lymphatic drainage impairment aggravates dependency. Increased pigmentation of the affected area often results, secondary to blood leaking into the skin. With chronic stasis, fibrosis of the area presents as tightly bound down skin.

Treatment

1. General measures:
 - Suppress itch with systemic antihistamines, topical steroids, and wet wraps.
 - Avoid irritants and trigger factors like heat, dryness, woolen and synthetic clothes, soaps, detergents, and solvents.
 - Advise on use of appropriate PPE for the task involved.
2. Topical eczema care:
 - Hygiene:
 - Wash daily to remove old ointment, necrotic tissue, crust, and bacteria.
 - Use a soap substitute to limit the irritant effect of detergent.
 - Acute eczema phase:
 - Use potent steroids to control the eczema.
 - Chronic eczema phase:
 - Wean to less potent or diluted steroids, tars, or emollients.
 - Moisturise:
 - Apply appropriate, acceptable emollient, liberally.
 - Specific measures:
 - Formal patch testing may be needed to identify specific allergens.
 - Treat secondary infections as per identified organisms.
 - Control stasis oedema with elevation, exercise, and pressure garments.

Folliculitis

This is a common, inflammatory condition of any hair follicle. Infection is usually due to *Staphylococcus aureus*. Less commonly, gram-negative bacteria or fungi may be involved. Occlusion, pressure, or friction of the skin, adhesive dressings, high humidity, and contact with tar or oils are all contributing factors. When due to these effects, the pustules may be sterile.



Treatment:

1. Keep the affected area clean and dry.
2. Remove or control predisposing factors, if possible, such as vapour-impermeable PPE, humidity, tar, and oil exposure.
3. Treat infections identified by pus culture with appropriate oral or topical therapy, dependent on the severity of the folliculitis.
4. Eliminate reservoirs of infection. Advise on anti-staphylococcal measures to eliminate a *Staphylococcus* carrier state and pseudomonas in stagnant water, if there are frequent recurrences.

Foot Problems in mineworkers



According to miners, feet problems are extremely common. Workers report that because of heat, humidity, heavy physical work, occlusive footwear, excessive sweating, and prolonged open, wet conditions underground, their feet are wet throughout their shifts. Excess moisture causes softening of the horny layer of the skin, which appears soggy and white. The process favours microorganism growth and loss of skin barrier function.



1. Fungal infections (yeasts and dermatophytes) thrive especially in the moist web spaces.



2. Bacterial infections of the hydrated, macerated soles cause a pitted, worm-eaten appearance and/or superficial erosions (pitted keratolysis). This is usually asymptomatic, but may cause burning and discomfort. Salmon pink fluorescence is seen with UV light examination.

Malodorous, 'smelly' feet are a consequence of the microorganism overgrowth. Loss of the skin barrier predisposes to irritant and allergic contact dermatitis. Ill-fitting boots cause corns and calluses.

Treatment:

1. The aim of treatment is to reduce overhydration and remove pressure.
2. The feet should be well dried after washing, and dusted with a bland, absorbent powder.
3. Clean absorbent socks (preferably cotton), used daily, will reduce the effects of occlusive boots.
4. Specific complications are treated, as they arise.

Erythromycin (lotion or systemic) is the treatment of choice for pitted keratolysis.

Fungal infections

Tinea corporis (body), tinea cruris (groin), tinea faciei (face), tinea capitis (scalp hair), tinea manuum (hands), tinea pedis (foot), tinea unguium (nail)



Fungal Infections

- Itchy
- Scaly
- Vesicles and blisters may occur on active edge
- Secondary infection may complicate the presentation



These common conditions are caused by infection of the scaly layer of the skin by dermatophyte fungi. They may infect any area of the body and itching is variable, occurring predominantly with inflammatory presentations. The characteristic feature of the skin lesion is the well-demarcated active edge, erythema, papules, vesicles, pustules, erosions, scaling, or hair loss. Central healing may occur, although on the palms, soles, and scalp there may be diffuse, fine scaling. The skin lesions tend to be asymmetrical in distribution. Infection of the groin area may present with symmetrical, well-defined patches on both thighs, but seldom involves the scrotum.

Fungal infections of the nail start at the edge of the nail, causing it to become deformed, crumbly, thickened, and yellow-to-white in colour. Superficial infection of the nail presents as crumbly, white irregular areas on the nail surface.

Sweating, high humidity, and tight or synthetic clothing and PPE may predispose the individual to fungal infections and promote recurrences. Repeated re-infection from reservoirs such as toenails is common. Consider predisposing causes such as diabetes, steroid therapy, or immunodeficiency states for resistant, severe, multiple fungal infections.

Without treatment, fungal infections are chronic and slowly progressive. With optimal treatment, the lesions disappear promptly, but recurrence may occur, even in the absence of obvious predisposing factors.

Confirm the diagnosis

It is best to confirm the diagnosis before starting treatment. This is done by scraping broken hairs or scales from the active edge or crumbly nail onto a glass slide. After adding a drop of 20% potassium hydroxide, the preparation is covered with a coverslip and heated gently. This dissolves the scale, allowing branching hyphae (seen in the dermatophyte skin and nail infections) and spores (found in the broken-off hair infections) to be seen under the microscope.

Treatment:

1. General:

- Eliminate predisposing factors and prevent spread of infection between workers. Communal ablutions predispose to inter-worker spread. Advise workers not to walk barefoot, especially in public places.
- Keep skin clean and dry. Promote good foot care. Advise the use of cotton socks and open shoes, where possible, for feet infections. Socks may be sterilised by boiling.
- Do not share PPE.

The choice of footwear and the worker's lifestyle are probably responsible for many recurrences of infection in the workplace.

2. Specific:

Topical agents:

- A variety of topical agents are available, including undecanoate, imidazoles and allylamines. The choice is determined by the area of the body involved and the cost. The newer antifungals are more effective and come in a wide variety of formulations, but they are more expensive.
- Nail infections: Combine nail avulsion and antifungal treatment.
Chemical avulsion: Apply 40% urea and occlude with plaster for 24 hours. Scrape off loose debris, wash well, and re-apply. Repeat daily, until the abnormal nail area has been removed. Topical nail antifungal (limited infections): amorolfine, bifonazole, and tioconazole.
- Hair infections: Only oral therapy is acceptable.

Oral agents:

- Griseofulvin 10 mg/kg/day, itraconazole 200-400 mg/day, terbinafine 250 mg/day
- Treatment period depends on the area of the body involved and the response to treatment

The nails tend to act as a reservoir for the dermatophyte fungi, giving rise to infections at other sites.

Deep fungal infections

Sporotrichosis

The fungus that causes this condition is found in organic material and is an occupational hazard of gardeners and farm workers. However, in older mine workings, props of contaminated timber may still be found. In the 1940s, thousands of mineworkers developed sporotrichosis. Since then, wood has been properly decontaminated. Miners are warned not to touch underground timber.

The infection starts as a red asymptomatic swelling at the site of inoculation. This gradually enlarges and the infection spreads up the lymphatics, causing similar lesions. The diagnosis is made by biopsy and culture of tissue. Systemic antifungals are used for treatment.

Histoplasmosis

Bats may nest in caves and shallow, old mines. Their droppings contain spores that may be inhaled to cause fungal lung infections. Occasionally, skin nodules will develop as a result of generalisation of the disease.

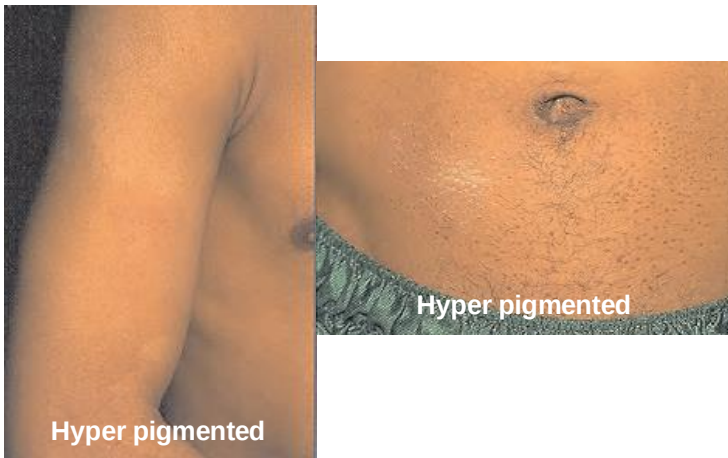
Skin lesions may take various forms, including nodules and papules with a central umbilication. The diagnosis is made by biopsy and culture of tissue. Systemic antifungals are used for treatment.

Tinea versicolor (pityriasis versicolor)

This condition is caused by *Pityrosporum orbiculare*, a yeast commensal. The rash occurs typically on the trunk, may be itchy, but is usually asymptomatic. Active infection is suggested by the presence of scale, which may be accentuated if the skin is stretched. High humidity and diseases associated with increased

sweating are predisposing factors.

Tinea versicolor



- Increased or decreased colour
- Fine scale

Investigation: Microscopy of skin scrapings reveals short unbranched hyphae and spores.

Treatment:

1. Selenium sulphide application to whole body overnight, weekly x three weeks
2. Topical: imidazole preparations
3. Oral: imidazoles for severe or persistent infection

Griseofulvin is not effective.

Re-pigmentation may not occur immediately after eradication of the organism. The absence of scale indicates adequate treatment.

Miliaria (obstruction of the outlet of the sweat gland)

Miliaria is due to obstruction of the sweat gland ducts with sweat retention and duct rupture. They occur as a direct result of heat and humidity, often after prolonged exposure. The level of rupture determines the clinical picture. Heat tolerance can be compromised due to decreased sweating, and can lead to heat exhaustion and collapse, especially with widespread involvement and miliaria profunda. Individual susceptibility varies. Predisposing factors include poor acclimatisation, obesity, underlying dermatitis (especially seborrhoeic dermatitis), and tight non-porous clothing.

Miliaria



- Pinhead vesicles on normal skin – miliaria crystalline.
- Pinhead vesicles, itch, and redness – miliaria rubra.
- Skin colored papules – miliaria profunda.

Treatment:

1. Treatment is symptomatic and preventative.
2. Cooling is the aim of acute management.
3. Topical steroids lotions may control itch and inflammation.
4. Removal of the obstruction of the sweat duct occurs with natural desquamation, which may take several days or weeks (miliariaprofunda).
5. Environmental controls, acclimatisation, non-occlusive clothing, and good hygiene are preventative measures.

Pigmentation changes

Changes in skin colour are caused by many different mechanisms.

Following inflammation of the skin, due to any cause, the colour of the skin may darken, especially in dark-skinned people, and become brown-black in appearance (post-inflammatory hyperpigmentation). A decrease in pigmentation (post-inflammatory hypo pigmentation) or total loss of colour (post-inflammatory depigmentation/acquired vitiligo) can also occur.

If chemicals such as alkyl phenols (para tertiary amylphenol, para tertiary butylphenol, and monobenzyl ether of hydroquinine) come into contact with the skin, as fumes or as a liquid, then they may cause a loss of pigmentation (acquired vitiligo).

Some metals cause specific skin discolouration. A green colour to the tongue may be due to vanadium. Infections with pseudomonas can also appear green. A slate-grey colour could be due to argyria (silver) or gold. Black could be due to coal dust, tar, or foreign body tattoos (secondary to skin penetration).

Scleroderma

This has been reported in mineworkers who are exposed to silica dust and who have silicosis. Underground workers on gold and coal mines, workers involved in sandblasting, and quarrymen are susceptible. The lungs and kidneys are primarily affected, but the skin, especially of the face and hands, can also be involved. Affected workers find that their hands become white and painful in the cold.

Patients should be removed from exposure and referred to a physician for specific management.



- Pigment loss or increase
- Thickened bound down shiny smooth skin

Urticaria

Urticaria can be acute (lasts less than six weeks) or chronic (lasts more than six weeks). The cause of the acute attack may be identified from the history, but in chronic urticaria it is difficult to identify the cause. An itchy recurring condition, due to an allergy to insect bites, including fleas, mosquitoes, midges, mites, and bed bugs, is known as papular urticaria.

Platinosis is a well-recognised allergy-like reaction, including symptoms such as asthma, other respiratory issues, and urticaria/eczema caused by exposure to platinum salts.

Urticaria (hives)



- Itch
- Erythema and swelling
- Transient (lesions come and go in hours)
- Annular or geographic outline

Urticaria can be triggered by allergic reactions to foods, medications, insect bites, or plants (all common culprits). Physical stimuli like heat, cold, pressure, or sunlight can also induce hives. Additionally, infections, stress, or certain medical conditions like lupus can contribute to urticaria.

Varying numbers of lesions occur all over the body, changing shape and position, but never leaving scars. Swelling of the lips, tongue, or mucosal lining of the respiratory tract may occur, causing breathing problems.

Urticaria can be made worse by stress, certain medication (codeine derivatives, aspirin, and non-steroidal anti-inflammatories), certain food (salicylate or histamine-containing), and environmental agents.



Papular urticaria

- Grouped or linear urticarial papules
- Central red mark (bite site) or vesicle
- Scabs, increased or decreased pigmentation
- Crops of lesions

Papular urticaria is caused by insect bites and the lesions may be seasonal, related to the life cycle and habits of the insect. Scratching of the skin causes erosions, crusts, or scabs and secondary infection. Healing leaves dark or white spots and/or scars, depending on the degree of infection and trauma related to scratching. The condition tends to settle spontaneously with time, but it may recur on exposure to insects in a new environment (after moving house, visiting a friend, going on holiday, changing work environment).

Treatment:

Urticaria

1. Regular antihistamines will control most urticarias. The antihistamines may need to be varied or used in combination, before control is achieved.

2. Manage any problem with breathing as an emergency.
3. Stop all non-essential medications and simplify activities of daily living to bland essentials.
4. A diary of all activities of daily living may help identify precipitants in cases of chronic urticaria.
5. Extensive investigations, especially allergy tests, are not indicated in most patients.

Papular urticarial/insect bite allergy

1. Eliminate ongoing exposure and contact with the insect (fumigation). Insect repellents (DEET, tar, thiamine 50 mg and/or garlic daily) are sometimes helpful.
2. Topical steroids are used on acute itchy lesions for a few days, weaning to weaker preparations.
3. Treat secondary infections.

Appendix 15.3. Patch Testing

Patch tests are used to identify substances causing allergic contact dermatitis. The need for patch testing should be judged on the merits of each case. Patch tests have no relevance in obvious cases of irritant contact dermatitis, unless an element of concomitant allergic contact dermatitis is suspected.

While standardised commercial allergens are easy to use, the reading, interpretation, and evaluation of the results require expertise. If non-standardised allergens need evaluation, then knowledge of the substances being tested, how they must be diluted (vehicle, concentration, and pH-neutralisation), and the appropriate method for testing can only be done by an expert. This will prevent irritant reactions and burns from being interpreted as allergic reactions.

Because of the paucity of experts in South Africa, patch testing is a skill that may need to be developed by occupational health workers in consultation with the local expert in their area.

Guidelines for patch testing:

- Never test in the setting of acute or severe dermatitis.
- Do not test patients taking systemic steroids, as the allergic reactions are suppressed.
- Systemic antihistamines do not suppress the reaction.
- Topical steroid use in the test area must have been discontinued at least 48 hours prior to testing, preferably longer, if potent products have been used.
- Avoid patch testing in patients who give a history of an immediate urticarial type of skin reaction.
- Never test unnamed or unidentified substances.
- Control testing, to rule out an irritant effect, is essential for non-standard allergens giving a positive reaction.

Standard allergen testing methodology

Allergens are applied to the upper back or upper arms, provided these areas are free of disease. The areas of allergen contact with the skin are marked on the skin to allow allergen identification. Any non-irritant marker can be used, provided it remains visible for several days after being applied.

The area of allergen application must be kept dry. Limit sweating, excess steam exposure, or immersion until the results have been read.

Each reaction should be evaluated for clinical and occupational relevance. Is it relevant to the current presentation or a manifestation of a past problem? Is it related to occupational exposure or due to some other activity of daily living?

Application method

The application method is dependent on the substance to be tested. Occlusive methods use aluminum or plastic chambers affixed to hypoallergenic tape as allergen containers. Semi-occlusive testing requires that the allergen is applied to the skin and covered with a semi-permeable tape. Open testing requires that the substance be applied to the same area of skin for a specific time. Occlusive tests are suitable for standard allergen preparations, or own products prepared in such a way as to exclude irritant reactions. The other two methods are more appropriate for own product testing.

Application time

This is dependent on the allergen. Most standard allergens are kept in contact with the skin for 48 hours.

Reading the patch test

The tests are read after 48, 72, and 96 hours of skin contact, dependent on the allergen and the ability of the patient to return for repeat visits. If only a single reading is possible, then 72 hours is chosen, otherwise the tests are read after 48 and 96 hours of occlusion. Morphology, interpretation, and diagnosis of patch test reactions is shown in **Table A15.3. a**.

Table A15.3. a. Morphology, interpretation, and diagnosis of patch test reactions

Morphology	Interpretation	Diagnosis
+/- Macular erythema	Doubtful	Unknown allergy
1+ Oedematous, non-vesicular erythema	Weak	Allergy
2+ Erythema, oedema, and vesicles	Strong	Allergy
3+ Spreading erythema, oedema, and vesicles, progressing to bullae/ulceration	Extreme Irritation	Irritation
IR Glazed, burned, pustular, or purpuric reactions	Negative	Negative

IR: irritant reaction

A negative patch does not necessarily mean that no allergy exists. The test could have failed because of improper antigen selection, testing at too low a concentration, use of an inappropriate vehicle, incorrect testing techniques, or the presence of confounders such as steroid use.

A positive patch test does not necessarily imply allergy. An irritant reaction may be misinterpreted as a positive result.

A positive patch test does not necessarily imply clinical relevance, as it may relate to a prior problem or represent cross-reactivity.

It is important to establish the causal effect of the irritant reaction (IR) in order to apply the appropriate prognosis.

While the process of patch testing is relatively simple, the interpretation of the results and the ability to advise workers appropriately requires an in-depth knowledge of the allergens and where they are found, skin management principles, and associated aggravating factors.

Appendix 15.4. Formulary

Topical therapy principles

Topical therapy is the mainstay of dermatology treatment. It must be used in the correct way and for the appropriate indications for the best results.

1. The patient's preferences, work, and home circumstances determine treatment choice.
 - Choose the most appropriate preparation for the body area and skin disease to be treated.
 - Strongly smelling preparations are often unacceptable to patients.
 - Laborious treatments are unsuitable for those who work long hours with limited ablution facilities.
2. Explain why the topical application is to be used and advise on side effects.
 - Preservatives (found in water-based formulations) may cause allergic reactions.
3. Wash regularly with bland soap or soap substitutes to remove old topical applications, body secretions, crusts, and colonising or infecting organisms.
4. Explain exactly how topical applications are done. Ideally, the method of application for each preparation should be demonstrated by the caregiver.
5. Adequate quantities of topical medication (about 250 g per week for the whole body) are essential.

Table A15.4.a shows suggested topical therapy vehicles for different skin types.

Table A15.4.a. Skin type and suggested vehicle for topical therapy

Skin type	Suggested vehicle
Wet, eroded	Lotion or cream
Dry, lichenified	Ointment
Face	Cream or lotion
Hairy areas	Lotion or gel
Body folds	Lotion or cream

Give adequate quantities of ointment, cream, or lotion.

Antihistamines

Antihistamines, used principally for acute and chronic urticaria, fall into four chemical groups. If the condition fails to improve with one agent, then a drug from another group, or a combination of the two, can

be tried. These agents only treat the symptoms of urticaria; the cause and aggravating factors need to be identified and avoided for long-term remission. The sedating property of some antihistamines is useful in treating severe atopic eczema. One of the newer, less sedating agents is preferable for those who need to be alert to drive and operate machines. **Table A15.4.b** shows examples of antihistamines.

Table A15.4.b. Examples of antihistamines

Examples of antihistamines	
Group	Generic name
Alkylamines	Chlorpheniramine Dexchlorpheniramine
Aminoalkyl ethers	Clemastine
Ethylenediamines	Mepyramine
Phenothiazines	Alimenazine/trimeprazine Promethazine
Piperazines	Cetirizine/hydroxyzine Oxatomide
Other	*Acrivastine Azatadine Cyproheptadine *Ebastine *Fexofenadine *Loratadine *Terfenadine

*Non-sedating antihistamines

Topical steroid therapy

The choice of a topical steroid preparation depends on the severity of the skin disease and the area to be treated.

Very potent steroids should not be used on the face or in the body folds.

A good practical tip, when using topical steroids, is to start with a potent steroid to suppress inflammation. Once this has been achieved, remission should be maintained by weaning to a weak or diluted preparation or emollient. **Table A15.4.c** shows comparative potencies of topical steroids.

Table A15.4.c. Comparative potencies of topical steroids

COMPARATIVE POTENCIES OF TOPICAL STEROIDS	
Group I WEAK Hydrocortisone 0.5% Hydrocortisone 1%	Cutaderm®, Dilucort®, Skincalm®, Biocort®, Mylocort®, Procutan®, Stopitch®
Group II MODERATELY POTENT Alclometasone Betamethasone Clobetasone	Aclosone®, Betnovate ½ strength®, Celestoderm-V ½ strength®, Eumovate®
Group III POTENT Betamethasone dipropionate Betamethasone valerate Diflucortolone Fluocinolone acetonide Fluticasone Hydrocortisone butyrate Methylprednisolone Mometasone	Diprosone®, Adco-betamethasone®, Betnovate®, Celestoderm-V®, Lenovate®, Persivate®, Topivate®, Nerisone®, Cortoderm®, Snyalar®, Cutivate®, Locoid®, Advantan®, Elocon®, Elomet®, Elica®
Group IV VERY POTENT Betamethasone dipropionate (in propylene glycol) Clobetasol Diflucortolone	Diprolene®

Prolonged use of (especially potent steroids) may cause any of the following side-effects: atrophy, acne, hypo pigmentation, increased skin fragility and bruising, masking/promotion of fungal and bacterial infection, perioral dermatitis, rosacea, striae, telangiectasia, vasodilatation, and systemic absorption with suppression of the hypothalamic pituitary adrenal axis.

In an adult, 15 g of topical product is needed for a single, full body application. Topical steroids diluted in an appropriate ointment, cream, or lotion base (vehicle) that will not interfere with the active ingredient, provide larger quantities of the steroid at a reasonable price, and improve the ease of topical applications.

Sun protection

Sun exposure should be avoided as far as possible, including protecting the eyes from the sun.

Physical sun protection methods

- Outdoor activities should be limited, when possible, to early morning and late afternoon.
- Clothing (cotton gloves, large brimmed hats, overalls, and sunglasses) that does not allow penetration of the sun's rays, but is comfortable and cool is preferable.

Topical sun protection methods

The sun protection factor (SPF), water resistance, and the specific wavelength protection offered determine

the choice of sun protection used under any set of conditions. The SPF refers to the increased time a person can spend in the sun before burning. If one burns after 30 minutes of sun exposure then, theoretically, using an SPF 15 topical cream should enable one to spend 30×15 minutes in the sun before burning. Products' SPF rating should be verified by a Standards surveillance body. Many of the topical preparations are not water-resistant, thus, repeated applications may be necessary with sweating and water immersion to ensure sun protection, irrespective of the SPF rating. Broad-spectrum wavelength (UVA and UVB) protection is important for chronic daily sun exposure. Topical preparations should be used to supplement sun avoidance measures. These can be divided into two groups:

- a) **Physical sun blocks** contain zinc, titanium and, sometimes, iron. They act as physical barriers to light penetration. They protect against a broad spectrum of wavelengths. Sometimes, patients find them cosmetically unsuitable, as they leave a fine film on the surface of the skin.
- b) **Sunscreens or filters** contain chemicals that absorb light at specific wavelengths. Thus, they filter the light reaching the skin. The chemicals are used in combination to give a broad spectrum of protection, but may cause irritant, allergic, or photo-allergic reactions.

Combinations of physical and chemical filters are often used. They provide a broad spectrum of wavelength protection.

Oral sun protection agents

These are not of any significant clinical value, although beta-carotene has been used for the management of porphyria, with some success.

For patients with photosensitivity disorders or skin which burns easily, a minimum sun protection factor of 15 is advisable.