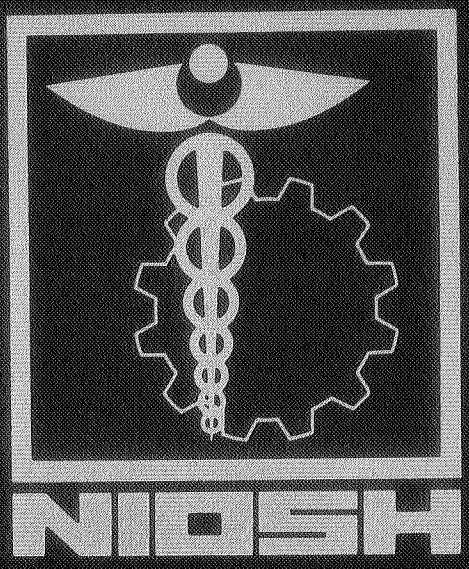

Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries

• Dermatological Conditions •

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

Proposed National Strategy for the Prevention of Dermatological Conditions

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1988

DHHS(NIOSH)Publication No. 89-136

Introduction

This document, *A Proposed National Strategy for the Prevention of Dermatological Conditions*, summarizes what actions need to be taken to prevent occupational dermatological conditions. It was developed in 1985 at a conference sponsored by the National Institute for Occupational Safety and Health (NIOSH) and The Association of Schools of Public Health (ASPH), which brought together over 50 expert panelists and 450 other occupational safety and health professionals.

In addition to the strategy for dermatological conditions, NIOSH and ASPH have published strategies for the other nine leading occupational diseases and injuries: occupational lung diseases, musculoskeletal injuries, occupational cancers, severe occupational traumatic injuries, occupational cardiovascular diseases, disorders of reproduction, neurotoxic disorders, noise-induced hearing loss, and psychological disorders.

The proposed strategies were originally published in a two volume set, *Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries, Part 1 and Part 2*. These proposed strategies are not to be considered as final statements of policy of NIOSH, The Association of Schools of Public Health, or of any agency or individual who was involved. Hopefully, they will be used in the quest to prevent disease and injury in the workplace.

To learn of the availability of the complete texts of Part 1 and Part 2, or to obtain additional copies of this or other Strategies, contact NIOSH Publications, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Telephone (513) 533-8287.

A Proposed National Strategy For the Prevention of Dermatological Conditions

I. Introduction

Occupational skin disorders are important causes of morbidity and disability in the workplace. Recognizing this importance, the U.S. Department of Labor in 1978 commissioned a Standards Advisory Committee on Cutaneous Hazards, which issued recommendations for improved surveillance, prevention, and research (*1*). In 1982, the National Institute for Occupational Safety and Health (NIOSH) included occupational skin disorders on its list of ten leading work-related diseases and injuries (*2*).

This document addresses occupational dermatological conditions resulting from workplace exposures that directly and adversely affect the structure and/or function of the skin. These conditions include both acute injuries and chronic diseases. In addition to being a target organ, the skin may serve as a route for entry of toxic chemicals through percutaneous absorption into the body. Researchers studying occupational diseases that affect other organs or systems should consider the relative contribution of dermal exposures to environmental substances to the total chemical burden of the body and the effect of skin injury and disease on the protective characteristics of the skin.

II. Background

Because large surface areas of the skin are often directly exposed to the environment, this organ is particularly vulnerable to occupational and environmental diseases and injuries (Table 1). No standard operational definitions of injury and disease exist, and any distinctions between them are occasionally arbitrary. By convention, "diseases" usually refer to conditions that result from cumulative or repetitive exposures, while "injuries" refer to conditions that result from instantaneous trauma or a single (usually brief) exposure. Some misclassification will inevitably continue to occur (e.g., classification of allergic "poison ivy" dermatitis from a single exposure to the plant as an "injury") until such time as operational criteria are more rigorously standardized.

Table 1. Structure, Function, and Occupational Disorders of the Skin

Structure	Function	Occupational Disorder
stratum corneum	barrier against chemical diffusion and microorganisms	chapping from low humidity, chemical stains, systemic toxicities following percutaneous absorption
squamous and basal cells of epidermis	cell regeneration, synthesis of stratum corneum, wound repair	infection, burns, contact dermatitis, basal and squamous cell carcinomas
melanocytes and melanin	absorption of ultraviolet radiation	toxic vitiligo, melanoma, post-inflammatory hyper- and hypopigmentation
Langerhans cells, lymphatics, dermal macrophages	immune regulation and surveillance	delayed hypersensitivity reactions, mycosis fungoides
Merkel cells, nerve tissue elements	perception of environment	toxic neuropathies
blood vessels, mast cells	thermoregulation, nutrition of tissue	heat stroke, urticaria, flushing reactions, vibration "white" finger
connective tissue	mechanical protection against trauma, wound repair	infection, burns, trauma, granulomatous reactions, solar elastosis, scars, scleroderma
eccrine sweat glands	thermoregulation, buffering of skin surface	miliaria ("prickly heat")
sebaceous glands	synthesis of skin surface lipids, chemical barrier against microorganisms	oil acne, chloracne
hair, follicles	insulation and protection, secondary sensory organs, social appearance	folliculitis, traumatic or toxic alopecia
nails	grasping and manipulation of small objects	paronychia, dystrophy, onycholysis

A. Skin Diseases

Dermatological diseases accounted for a disproportionately large percentage (approximately 34%) of all cases of chronic occupational disease identified in the Bureau of Labor Statistics (BLS) Annual Survey for 1984 (Figure 1).

The estimated number and rate of occupational skin diseases are shown in Figure 2 and Table 2. The greatest number of cases (23,017) occurs in the manufacturing division, while the highest rate occurs in the combined division of agriculture/forestry/fishing (28.5 per 10,000 full-time workers).

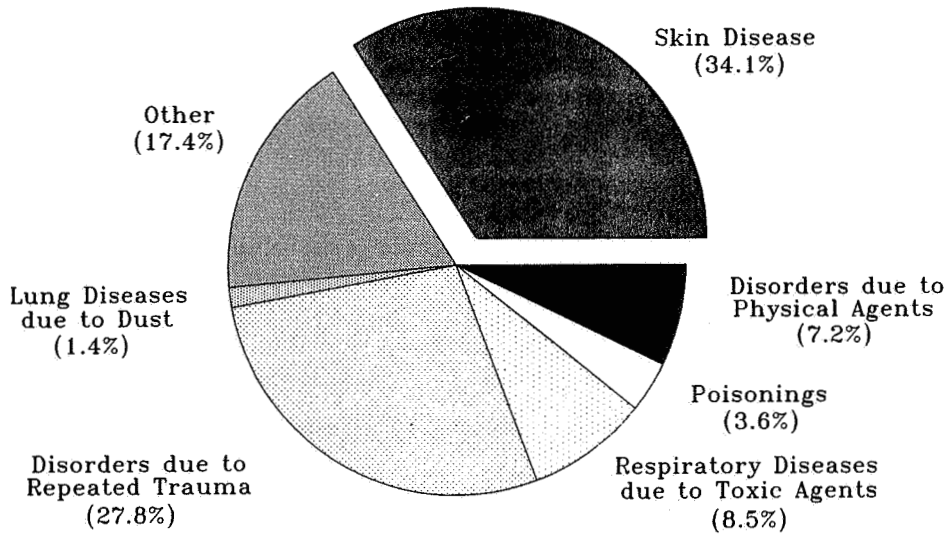

Figure 1. Occupational Illnesses by Type
BLS Annual Survey, 1984

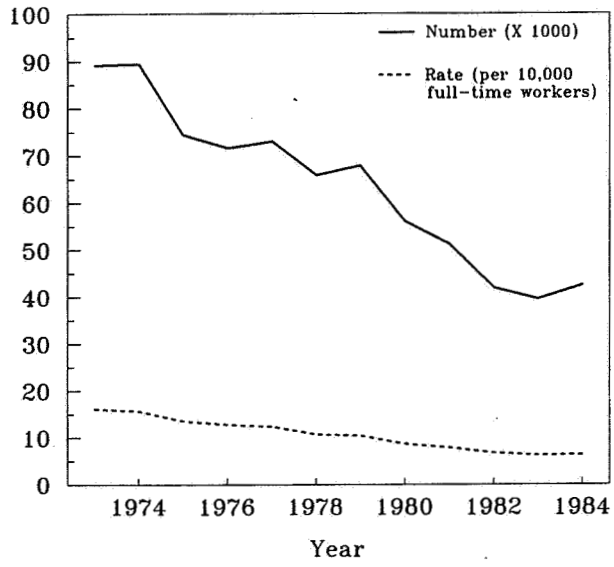

Figure 2. Numbers and Rates of Occupational Skin Diseases and Disorders, BLS (1973-1984)

Table 2. Cases and Incidence Rate of Occupational Dermatological Diseases, by Major Industrial Division — Private Sector, United States, 1984*

Industrial Division	Number	Incidence rate**
Agriculture/forestry/fishing	2,233	28.5
Manufacturing	23,017	12.3
Construction	2,456	6.6
Services	7,973	5.0
Transportation/utilities	2,114	4.3
Mining	393	4.0
Wholesale/retail trade	3,770	2.1
Finance/insurance/real estate	563	1.1
Total	42,519	6.3

* Bureau of Labor Statistics Annual Survey
** Per 10,000 full-time workers (2,000 employment hours/full-time worker/year)

The number of cases has been gradually decreasing over the last decade, reaching a low of approximately 39,540 cases in 1983. Incidence rates for occupational dermatological diseases have exhibited a similar downward trend, gradually decreasing from 17 cases per 10,000 full-time workers in 1972, to a low of 6.2 cases per 10,000 worker years in 1983. It has not been clearly determined, however, whether this steady downward trend resulted from true progress in the prevention of occupational skin disease. An increase in the estimated number and rate of cases in 1984 coincided with an estimated increase of 11.7% in the overall incidence of occupational injury and disease in the United States, as reported by the BLS in its Annual Survey. Due to underrecognition, underreporting, and misclassification, the true numbers and rates of occupational skin diseases may be 10- to 50-fold higher than reflected in the Annual Survey (*3*). Analysis of workers' compensation claims from California suggests rates on the order of 20 per 10,000 workers (*4*).

As many as 20%-25% of all persons with occupational skin disease lose an average of 11 days from work annually (*4-6*). Assuming a 10- to 50-fold underreporting (*3*), the estimated annual costs of dermatological diseases due to lost productivity, medical care, and disability payments may range between $222 million and $1 billion (*7*).

B. Skin Injuries

Injuries to the skin (cuts, lacerations, punctures, abrasions, burns) account for a substantial percentage of all occupational injuries combined, i.e., about 35% of occupational injuries treated in hospital emergency rooms and about 23% of injuries for which workers' compensation claims are filed (Table 3).

NIOSH has estimated that 1.07-1.65 million occupational skin injuries occur yearly, with an estimated annual rate of 1.4 to 2.2 cases per 100 workers (*8*). Separate estimates for lost workdays or costs are not available for skin injuries. However, given the large number of cases that occur annually, the costs attributable to lost productivity, medical payments, and disability payments are probably considerable.

Table 3. Relative Distribution of Occupational Skin Injuries Among All Injuries (eye injuries excluded)

	NEISS* (n=4,401,567)	SDS** (n=1,365,097)
Skin Injuries	34.7%	22.5%
All Other Injuries	65.3%	77.5%
Total	100.0%	100.0%

* National Electronic Injury Surveillance System, U.S. Consumer Product Safety Commission, 1985 data

** U.S. Bureau of Labor Statistics Supplementary Data System (SDS), 1983 data

C. Percutaneous Absorption

The number of cases of systemic toxic reactions (acute or chronic) attributable annually to percutaneous absorption in the workplace is unknown; most such cases probably go unrecognized. A NIOSH review of National Electronic Injury Surveillance System (NEISS) data, covering emergency room visits in a selected sample of hospitals from 1981 to 1985, found only three cases of acute systemic reactions possibly attributable to percutaneous absorption from workplace exposures (unpublished). These data are not sufficient to determine the role of percutaneous absorption in the occurrence of occupational disease.

III. Assessing the Problem

Preliminary assessment and characterization of the various dermatological conditions that may afflict workers (Table 1) is essential before rational strategies can be formulated to prevent and control these disorders. The discussion below highlights the important causal agents, risk factors, and clinical outcomes towards which effective strategies can be directed.

A. Skin Diseases

The occurrence of a cutaneous disorder is relatively easy to recognize, because changes induced by the disease process are visible. However, accurate clinical determination of the specific diagnosis of skin disease and its relationship to occupation usually require a high level of clinical skill and expertise, even among dermatologists. Definitive attribution to a particular causal agent may be limited by either a lack of specific diagnostic tests or the relative difficulty of performing them on a routine clinical basis. Thus, determination of a causal agent is often based on nothing more than a temporal association of disease with exposure and the intuitive judgment of the examining health care provider. Furthermore, the relative contributions of exposures encountered outside the usual work environment (home, secondary jobs, social and recreational activities) must be sorted out. This is frequently a difficult and complex task. For most workplace chemicals, little or no data on cutaneous toxicity are presently available to assist the health care provider in making an evaluation.

1. Contact Dermatitis

Although precise figures are not available, clinical experience from field investigations in the 1950s suggests that 80% of all cases of contact dermatitis are due to skin irritation, while 20% may be due to allergy (*9*). The influx of new and potentially allergenic chemical substances into the workplace since the 1950s may have had some new, as yet unmeasurable, impact on the proportional mix of irritation vs. allergic contact dermatoses. Indeed, claims for contact dermatitis may constitute up to 90% of workers' compensation claims for skin diseases (*4*). Contact dermatitis has been included in the list of occupational sentinel health events (SHE[0]), defined as preventable diseases the occurrence of which serves as a warning signal that the quality of preventive or therapeutic care may need to be improved (*10*).

a. Irritant Contact Dermatitis

Irritant contact dermatitis most often results from prolonged, cumulative, or repetitive exposures of the skin to chemical or physical substances that directly injure the tissue and cause inflammation. This condition is arbitrarily distinguishable from chemical burns only by the rapidity with which inflammation develops following exposure. Most cases of contact dermatitis are due to irritation caused by chemical agents. Such irritation commonly occurs on the hands, forearms, and other skin surfaces that come into direct contact with the causal agent and rarely spreads to skin surfaces that do not have obvious or frequent contact. Indirect exposure through skin contact with grossly contaminated objects, surfaces, or clothing may be important. In many instances, chemical irritation may develop through the interaction of multiple, cumulative exposures to several agents or through the combined effects of physical trauma rather than from isolated exposure to a single agent.

There are no specific diagnostic tests for cutaneous irritation, including patch testing (*11*), and diagnosis is usually made through the intuitive judgment of the evaluating health care provider based on temporal associations with exposures, cutaneous toxicities of the exposures, and the manner in which exposures occurred.

An examination of workers' compensation data from California (*4*) suggests that the 5 categories of agents causing the largest number of reported cases of irritant contact dermatitis are:

- soaps, detergents, miscellaneous cleaning agents
- solvents
- hard, particulate dusts (e.g., fibrous glass)
- food products
- miscellaneous plastics or other resins.

Animal models have been developed to measure the irritant potential of chemical substances, but most existing data pertain only to single applications at full strength.

Risk factors that affect personal susceptibility may influence the development of contact irritation. Atopy (a personal or family history of atopic dermatitis, rhinitis/conjunctivitis, or asthma) is the single most important risk factor; the prevalence of this trait in the general population is approximately 25% (*12*). Studies suggest that for atopic individuals the relative odds of developing occupational dermatitis are increased 13-fold compared with non-atopic individuals (*5*). The risk of developing work-related hand dermatitis is greatest in persons with a personal history of childhood atopic dermatitis (*13*). As yet, no prospective studies have measured the degree of risk for developing skin irritation of an atopic individual who enters the workforce without active skin disease. Percutaneous absorption of potential irritants through the skin contributes to the risk of skin irritation and may be enhanced if protective clothing entraps or occludes the irritant against the skin. It may also be enhanced by increased hydration of the stratum corneum (the outermost protective layer), elevated temperature of the potential irritant (*11*), and contact with anatomical sites where skin permeability is greater (e.g., eyelid, face, and genital skin are more permeable and more easily irritated). Additional risk factors include virtually any pre-existing skin disease or injury (e.g., abrasions) that may be aggravated by exposure to workplace irritants, although certain dermatoses (e.g., psoriasis, atopic dermatitis) pose greater risks (*14*).

b. Allergic Contact Dermatitis

Allergic contact dermatitis, which requires sensitization and participation of the immune system (cell-mediated immunity, delayed hypersensitivity reaction), also occurs most often on those body sites where primary contact with the responsible causal agent is most frequent, usually the hands and forearms. Unlike irritant contact dermatitis, however, contact allergy can be triggered in sensitized individuals by exposures to relatively small amounts of antigenic substance. It is not unusual, therefore, for allergic contact dermatitis to develop on areas of the body remote from the primary contact. Indirect contact with objects, surfaces, or clothing contaminated with only a trace of the substance may be sufficient to trigger widespread, severe dermatitis. Diagnosis of the responsible causal agents for contact allergy may be established reliably by cutaneous patch testing. Details of this procedure have been described extensively in textbooks (*15, 16*). Definitive diagnosis of contact allergy or the specific causal agent is generally impossible in the absence of a positive patch test, with the possible exception of poison oak/ivy dermatitis, for which the clinical characteristics and history are usually sufficiently diagnostic. Because even "classic" poison ivy dermatitis can be mimicked by contact allergy to other plants (e.g., primrose, Algerian ivy), however, patch testing may be necessary to prevent misdiagnosis.

The frequency with which specific chemical substances cause allergic contact dermatitis is unknown because existing databases on occupational skin disease do not contain confirmatory data from patch tests. A review of published case reports and textbooks (*15,16*) gives some general idea of common contact allergens in the work environment. These include:

- metallic salts (nickel, chromate, cobalt, gold, mercury)

- rubber accelerators and antioxidants (thiurams, dithiocarbamates, mercapto compounds, paraphenylenediamine derivatives)
- plastics and resins (epoxies, epoxy hardeners, phenolics, acrylics, rosin)
- organic dyes (paraphenylenediamine, photographic color developers, azo dyes, numerous others)
- industrial biocides and germicides (formaldehyde, formaldehyde releasers, quaternium-15, isothiazolin-3-one derivatives)
- occasional first-aid-cabinet preparations (neomycin, thimerosal, benzocaine, mercurochrome, bacitracin).

Human and animal models have been developed to measure the sensitizing potential of various chemical substances, but dose-response data are generally unavailable (*17*).

Potential risk factors are similar to those for irritant dermatitis except for atopy, which does not predispose individuals to the development of contact allergy (*16*). In addition, pre-existing contact allergy acquired in the home (or another work) environment increases a worker's risk at the time of initial job placement if job duties involve exposure to the same allergen. Clinical observations also suggest that, in some cases, irritant contact dermatitis or other cutaneous trauma has preceded the development of contact allergy and may be a risk factor.

In general, the prognosis for contact dermatitis is surprisingly poor. Published series of cases suggest that only 25% of patients recover completely and fully, 50% improve but require intermittent treatment to maintain control, and the remaining 25% remain unchanged or worsen (*18-20*). Among workers who have their jobs changed or modified because of skin disease, 25% may continue to have chronic dermatitis despite these actions. The prognosis does not appear strikingly different for irritant or allergic contact dermatitis.

2. Skin Cancer

Relatively few epidemiologic studies have been performed on the relationship of skin cancer to various occupational exposures. Non-melanoma skin cancers (squamous and basal cell) occur more frequently among outdoor workers and occupations with skin exposure to coal tar derivatives (*21,22*). As yet unexplained clusters of malignant melanoma have occasionally been detected in occupational settings (*23,24*). Cutaneous T-cell lymphoma (CTCL, mycosis fungoides) was reported by one group to be associated with certain industrial occupations (*25*), while others report no association between CTCL and employment (*26*). Detailed study is needed to determine whether CTCL can be linked epidemiologically to occupation or industry of employment.

Considerable clinical, epidemiologic, and experimental evidence has established that ultraviolet (UV) solar radiation is the most potent and important cutaneous carcinogen causing non-melanoma (basal and squamous cell) skin cancer (*27-29*) and premalignant actinic keratoses. Other implicated causal agents include ionizing radiation, polynuclear aromatic (PNA) hydrocarbons

from petroleum refining and coal tar distillation, arsenic, and anti-neoplastic chemotherapeutic agents (*21,22,30*). The risk of non-melanoma skin and lip cancer following exposure to these agents (with the possible exception of arsenic) is increased when the effects of UV radiation are also present. The role of environmental or occupational exposures in malignant melanoma is less clear. Epidemiologic observations also suggest that UV radiation increases the risk for developing malignant melanoma, but this is not a simple dose-response relationship (*31,32*). No causal agents have yet been clearly identified in epidemiologic clusters of malignant melanoma. Cutaneous T-cell lymphoma, which has been associated with exposures to pesticides and other miscellaneous chemicals, must be studied in more detail (*33*). Virologic studies suggest that CTCL may be due in many cases to retrovirus infection (HTLV-I). Clinical evidence also suggests that, in some cases, malignant transformation could result from chronic bouts of allergic contact dermatitis and antigen stimulation (*34,35*). Although the possible role of antigenic stimulation in CTCL is intriguing, either as a primary cause or as a secondary promoter through interaction with HTLV-I infection, it remains an unproven hypothesis.

Personal susceptibility and pigmentary skin differences appear to play a significant role in the development of both non-melanoma and melanoma skin cancers induced by exposure to UV radiation. Relative risks are greater in fair-skinned Caucasians of Celtic descent who sunburn easily (*28,29*), while heavily pigmented skin is protective. Cutaneous trauma, particularly burns, may predispose to malignant transformation on rare occasions, and skin cancers have been reported arising directly within areas of cutaneous trauma (*36,37*).

3. Infections

Workers' compensation data suggest that up to 5% of all claims for skin diseases are due to primary skin infections (*4*). Accurate data to characterize the risk of skin infection by causal agent and occupation or industry of employment are not available.

Occupational skin infections may be caused by a variety of infecting microorganisms, including bacteria, fungi, viruses, and parasites (*38*). Examples of infections that may pose unique risks for specific occupations include erysipeloid (fishermen, meat handlers), anthrax (wool handlers), atypical mycobacteria (fishermen, aquarium workers), herpes simplex (dentists, nurses, physicians), orf (sheep and goat ranchers), milker's nodule (dairymen), sporotrichosis (gardeners, nursery workers), and grain-mite itch (grain farmers).

Excessive heat and humidity may predispose workers to acquire bacterial folliculitis or superficial dermatophyte infections, particularly when work clothing is constrictive. Cuts, burns, and abrasions, especially when combined with poor skin hygiene, may become infected secondarily. The skin of atopic workers is more susceptible to bacterial infection with Staphylococcus aureus (*38*).

4. Miscellaneous Skin Diseases

Less than 5% of workers' compensation claims for skin diseases arise from disorders other than contact dermatitis or skin infections (*4*). These disorders include systemic or contact urticaria (*39,40*), cutaneous flushing (*41*), vasospastic disorders (*42*), scleroderma (*43*), toxic vitiligo (leukoderma) (*44*)

or other pigmentary disturbances, acne and chloracne (including oil acne or boils) (*45,46*), photosensitivity (*38*), and sweat retention syndromes (e.g., prickly heat). Epidemiologic studies have not been performed to compare the prevalence of these or other dermatological diseases (e.g., rosacea, psoriasis) by occupation or industry of employment with prevalence in the general population, although the National Health and Nutrition Examination Survey (NHANES I) contains prevalence data for the general population on which such comparisons could be made (*47*). Animal models have been developed to screen chemical substances for their potential to cause contact urticaria, vitiligo, acne, and photosensitivity, but these models have not been widely used for premarket screening of industrial chemicals (*17*).

B. Skin Injuries

Of all occupational skin injuries recorded among hospital emergency room cases (Figure 3) and in workers' compensation claims (Figure 4), mechanical trauma (cuts, lacerations, punctures, abrasions) accounts for 80%-90%; burns from physical agents (electrical, thermal, UV radiation, or other) make up approximately 8%-12%; and chemical burns involve less than 2.5%. Eye injuries have been excluded from this analysis, but should remain an important part of overall hazard-prevention and safety programs because the risk factors are similar.

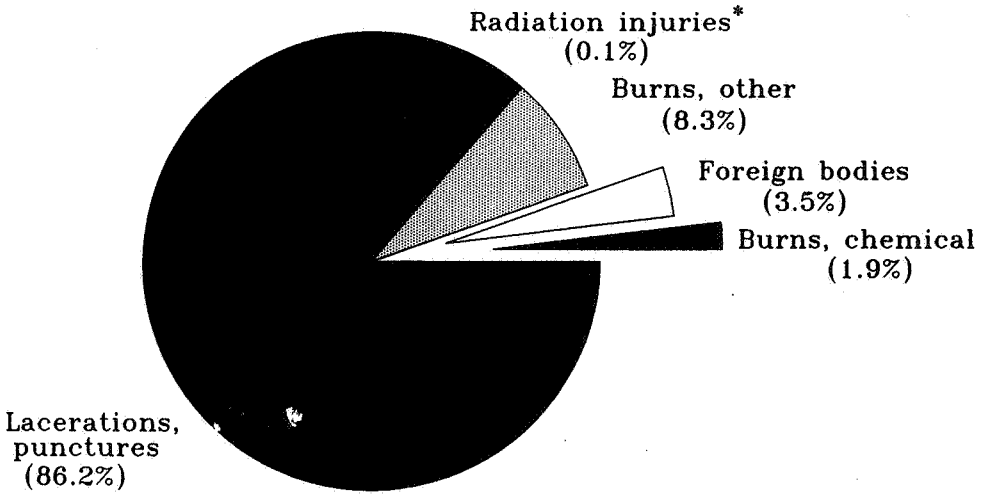

Figure 3. Occupational Skin Injuries**
by Type, NEISS 1985

* Radiation injuries primarily sunburn
** Eye injuries excluded

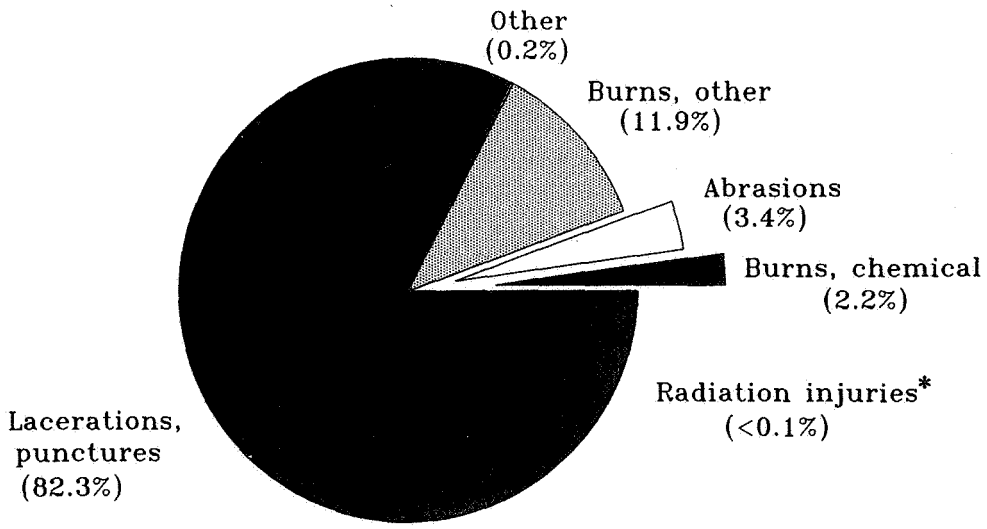

Figure 4. Occupational Skin Injuries** by Type, BLS-SDS 1983

* Radiation injuries primarily sunburn

** Eye injuries excluded

Although cutaneous occupational injuries due to repetitive trauma (e.g., painful, fissured calluses) also occur, their numbers are not known (*48*). Disorders resulting from repetitive trauma are classified in the BLS Annual Survey (Figure 1) as diseases rather than injuries (the latter resulting from "one time" occurrences), but the proportion that affects the skin cannot be ascertained.

Specific causal agents for skin injury and the occupations and industries in which they are most likely to occur have not been adequately documented in the literature. Relevant information is, however, contained in files of the Bureau of Labor Statistics' Supplementary Data System (SDS). For example, Table 4 lists the occupational groups from which the most compensation claims for injury to the skin were filed in 1983 in the 30 states participating in the SDS system. Neither incidence rates nor prevalence rates are known, however, since accurate denominator information is presently lacking.

Skin injuries may be complicated by infections, disfiguring scar formation, or even persistent pain or itching, but no data are available on the degree or frequency with which such complications occur. Assuming a complication rate as low as 0.5%, the annual number of complications in skin injury may approach the yearly number of skin diseases. The prognosis for short-term recovery from the acute effects of injury is generally excellent, but long-term prognosis may be substantially affected by complications.

The relative importance of risk factors that contribute to traumatic skin injury is unknown. Investigations of individual cases of occupational traumatic injuries and fatalities implicate a number of contributing causes. Cited most often

Table 4. Skin Injuries by Occupational Group, Bureau of Labor Statistics' Supplementary Data System, 1983*

Occupation	Number	% Total
Cooks	14,657	5.5
Food Service Workers	10,620	4.0
Miscellaneous Laborers	9,203	3.5
Miscellaneous Operatives	8,417	3.2
Machine Operatives	7,751	2.9
Carpenters	7,624	2.9
Construction Laborers	7,550	2.8
Automobile Mechanics	5,506	2.1

* Based on workers' compensation data from 30 states.

are the failure of management to recognize hazards and provide appropriate controls, faulty equipment or process design, faulty task design, improper work techniques, inadequate maintenance, lack of hazard recognition, inappropriate response in nonroutine or emergency situations, economic pressures, and a variety of human factors (e.g., fatigue, substance abuse, risk-taking behavior). Personal susceptibility may be increased by hyperhidrosis (increased sweating) of the palms when this is severe enough to interfere with the grasping and manipulation of tools (*49*).

C. Percutaneous Absorption

The skin may be an important route of absorption for chemical substances that can cause acute or chronic systemic toxicity. Skin exposure may occur directly from raw materials, from contaminated work surfaces, or from toxins unintentionally generated during the manufacturing process. For some substances (e.g., pesticides), the skin may be the principal or only route of exposure (*50*). Federal and state standards for occupational health, however, only set permissible levels for airborne exposures to these industrial chemicals and, therefore, are not applicable here. As new regulatory requirements go into effect to reduce permissible airborne exposure levels of potential carcinogens and toxins, percutaneous absorption will likely become a relatively more important route of exposure in terms of total body chemical burden.

Important chemicals that may produce serious systemic toxicity have been reviewed extensively (*51-53*). These include aniline (methemoglobinemia, bladder cancer), benzene (aplastic anemia, leukemia), cyanide salts (acute cellular asphyxia and death), and mercury (central nervous system intoxication, kidney failure). Of the more than 85,000 chemical substances currently listed in the Registry of Toxic Effects of Chemical Substances (RTECS) (November 1986), less than 1600 have dermal LD 50 data reported, and only 1300 have any cutaneous irritant effects reported; specific quantitative dose-response data are virtually non-existent. Numerous human, animal, and in vitro models have been developed to study both the quantitative and qualitative aspects of percutaneous absorption (*17*), but these have been used chiefly for pharmaceutical rather than industrial chemicals.

The primary determinants of percutaneous absorption reside in the specific molecule under consideration: molecular weight, size, stereochemical configuration, partition coefficients, etc. Knowledge of these factors permits a fairly accurate prediction of the potential for transdermal absorption. Factors that may promote percutaneous absorption of systemic toxins include trauma (cuts, burns, abrasions), prolonged skin contact, excessive hydration of the stratum corneum, elevated skin-surface temperature, contact with highly permeable facial or genital skin, and contact with areas of pre-existing dermatitis (*11*).

IV. Prevention Planning

Effective planning to prevent and control occupational dermatological conditions requires preliminary assessment of the following basic elements: working populations at greatest risk, available prevention/control methodologies, health care delivery practices, resources of professional health and safety manpower, and economic and material resources.

A. Targeting High-Risk Populations

Based on statistics currently available, manufacturing workers have the most cases of skin disease, while agricultural workers have the highest rate of skin disease, more than twice that of manufacturing workers (Table 2). Despite the high rate among agricultural workers, relatively little effort has been made to characterize this risk in more detail. Cooks and food service workers, laborers, and machine operators also appear to incur large numbers of traumatic injuries to the skin, although the incidence rates have not been ascertained. Outdoor workers are exposed to potentially harmful ultraviolet radiation from the sun and have an increased risk for developing skin cancer. Although precise data are not available, as many as 10% to 20% of the workforce may be exposed to solar radiation for at least part of the workday. In targeting strategies, consideration must be given to reaching small employers in industries where occupational dermatological conditions are more likely to occur.

Current risk patterns may be altered by demographic changes within the workforce. Trends projected to the year 2000 show declining work populations in agriculture, population shifts within manufacturing from heavy to light industries, increased populations in service industries, an increase in the proportion of female workers up to almost 50% of the workforce, and, as the baby-boom generation matures, an increasing proportion of middle-aged workers (age 35 to 55) with a corresponding decrease in young and old workers (NIOSH, unpublished).

B. Prevention and Control Methods

1. Engineering

The most effective control measures totally eliminate any possible skin contact with potentially harmful environmental exposures. Process engineering involves isolation, enclosure, or containment of equipment or machinery. Chemical engineering involves either elimination of harmful chemical exposure altogether, or substitution of less noxious substances. Although replacement of contact allergens with non-allergenic substances has been used successfully (*54,55*), elimination and substitution are not always viable options when a causal agent is an integral part of the production process and no substitute is available.

2. Personal Protection

Protective equipment and clothing are widely used in industry to control exposures. The chemical and physical resistance of personal protective equipment to specific causal agents for skin disease is an important consideration. Prudent selection of protective equipment depends on data generated by standard test methods about chemical and physical resistance. To date, the F23 Protective Clothing Committee of the American Society for Testing and Materials (ASTM) has developed several consensus procedures for testing chemical and physical resistance; several others are in draft. Although some data have already accumulated on the resistance of specific protective materials to pure (neat) forms of many chemical agents (*56*), these pure chemicals are typically compounded, formulated, or mixed in the workplace with other materials. Breakthrough values for pure liquids do not correlate with breakthrough times for binary mixtures (*57*), and variations in the composition, thickness, and quality of protective materials translate into variations in their chemical resistance. Therefore, in selecting chemical protective clothing (CPC) specific CPC materials should be tested against the actual chemicals or chemical mixtures used in the workplace. The effectiveness of procedures to decontaminate CPC is largely unknown, and toxic substances that have permeated CPC may remain there and pose a theoretical risk of accidental exposure during reuse. Thus, contaminated CPC should not be reused unless evidence specifically indicates that the decontamination method is efficient and does not degrade the CPC.

Small amounts of chemical substances that permeate CPC may be an important factor in allergic contact dermatitis (*58*), skin cancer, or systemic toxicity through percutaneous absorption. Currently, no evidence is available to suggest that permeation can occur in amounts sufficient to cause skin irritation without also causing gross, visible damage to CPC (*58*).

The need for CPC is often apparent, but whether it is always used when needed is not clear. Although data relating dermatological conditions to the non-use or improper use of CPC are not currently available, BLS has conducted in-depth analyses of selected types of injuries and the corresponding use of personal protective equipment (PPE). For example, data indicate that only 1% of workers suffering facial injuries and 17% of workers sustaining head injuries were wearing appropriate PPE at the time of injury (*59,60*). A survey on the use of CPC might reveal a similar pattern.

CPC may cause or aggravate dermatitis as a result of: 1) non-specific irritation from secondary sweat entrapment and friction of the clothing against the skin; 2) accidental entrapment and occlusion of chemical substances against the skin; or 3) the development of contact allergy to CPC (e.g., chemical additives in rubber gloves). Protective equipment can also contribute to the risk of traumatic injury or heat stress if it retards movement or prevents dissipation of body heat.

The effectiveness of chemical "barrier creams" remains controversial and unproven (*61*). Claims of their clinical efficacy come largely from the manufacturers of such creams based on in vitro data, but these are usually unsubstantiated by controlled clinical trials. Anecdotal benefits may in fact derive from a simple lubricating effect on the skin, improved personal hygiene, or a reduced need for skin washing (e.g., dirt, oil, or grease stains are easier to wash off), rather than from actual formation of a "chemical barrier." Bar-

rier creams that provide some protection against specific chemical substances are still possible, at least in theory, and Orchard et al have demonstrated that a barrier cream containing a polyamine salt of a linoleic acid dimer suppresses positive patch tests to poison ivy resin in sensitive individuals (*62*). Barrier creams may, however, aggravate existing dermatitis and should only be used on normal noninflamed skin. On the other hand, sunscreens with high solar-protection factors (SPF 15 or greater) are extremely effective barriers against ultraviolet radiation. They not only protect against sunburn (*63*), but have prevented the formation of skin cancer in animal models (*64*).

3. Hygiene

Hygiene controls may be directed at either the skin or the work environment. Nonspecific measures include good housekeeping, dust suppression, and waste elimination. Several highly specific protocols exist for environmental decontamination of various chemical substances and may have limited application where trace contamination of the work environment can provoke skin disease (e.g., allergic contact dermatitis, chloracne). Although copious flushing with water alone is usually sufficient following skin contact with acids and alkalis, specific protocols for decontaminating the skin have been recommended to prevent chemical burns from hydrofluoric acid (*65*), phenol (*66*), alkyl mercury compounds (*67*), white phosphorus (*68*), and chromic acid (*69*).

The use of nonspecific skin cleaning measures should be tempered with the knowledge that overuse or incorrect use of soaps, abrasives, or waterless cleansers may be more irritating to the skin than the substances they are intended to remove, particularly when they are used to clean areas with preexisting dermatitis (*70*).

C. Health Care Delivery

Adequate treatment for most dermatological conditions of occupational origin depends in large measure on the diagnostic and therapeutic competence of the health care provider. Although dermatologists should intuitively possess the highest levels of skill in this regard, their relative contribution to current health care delivery for occupational dermatological conditions is unknown because existing patterns of health care delivery (e.g., private dermatologists, family practitioners, company physicians and nurses, occupational medicine specialists and clinics) have not been assessed adequately. Results of the National Health and Nutrition Examination Survey (NHANES I) conducted by the National Center for Health Statistics (NCHS) suggest that the level of care for skin disease in the general U.S. population is inadequate and could be improved substantially if dermatologists were involved in treatment promptly (*47*).

First-aid cabinets in most workplaces usually contain preparations for treating minor skin injuries, infections, or dermatitis. Such first-aid preparations are usually of dubious value, and enthusiasm should be tempered with the knowledge that many of these preparations contain common contact allergens (e.g., neomycin, benzocaine) to which injured workers occasionally become sensitized. Oral hyposensitization therapy has been effective in preventing poison oak/ivy dermatitis in controlled laboratory settings (*71*). Clinical consensus, however, has held that the commercial desensitization kits currently

available are usually not effective in clinical practice. Hyposensitization for other forms of contact allergy appears technically feasible but has not yet been successfully developed.

D. Human Resources

Although no statistics are available, there is an apparent shortage of skilled professionals in critical disciplines (dermatologists, occupational medical specialists, occupational health nurses, industrial hygienists, safety engineers) who have had sufficient training in occupational dermatological conditions. No residency programs in either dermatology or occupational medicine currently require any training in occupational dermatological conditions for board certification. Similarly, programs in industrial hygiene and occupational nursing provide only minimal training in occupational skin disorders. An increased pool of occupational health and safety professionals who have sufficient knowledge and skills to address dermatological problems will be required before any comprehensive strategy is likely to have a large scale impact.

E. Economic/Material Resources

No single entity or agency by itself is currently equipped with the economic or material resources to run a national program for preventing occupational dermatological conditions. In FY 1986, NIOSH was able to fund only 5 extramural grants relating to occupational skin conditions, with total funds of $470,000. Given these limited resources, cooperative and collaborative efforts will inevitably be required from federal, state, and local agencies, universities, and professional organizations and societies.

V. Implementation

Five principal approaches are available for implementing an effective strategy: education and training of workers and management, dissemination of information on health hazards and safe work practices, corporate employment policies and practices, motivation of workers and management to maintain safe and healthy work environments, and regulation of workplace exposures.

A. Education

The effectiveness of educational activities directed at workers or management rests on the assumption that ignorance of safety and health hazards is a principal determinant of injury and disease. Adequate training for both workers and management in the job safety and health aspects of dermatological conditions, risks, and risk factors should help reduce the incidence. Educational activities should be appropriately aimed at the education and literacy level of the targeted workers. The addition of skin-disclosing agents (e.g., fluorescent tracers) to industrial substances has been an effective educational tool that enhances worker awareness of poor hygiene practices (72).

B. Dissemination of Information

An effective network is needed to promptly disseminate information on cutaneous health and safety hazards. Within the NIOSH Division of Standards Development and Technology Transfer is an Information Dissemination Section that maintains up-to-date information on all human health hazards, cutaneous or otherwise, based on published medical and toxicologic data and provides such

information upon request. NIOSH itself publishes criteria documents and reports of Health Hazard Evaluations (HHE) and disseminates these to health professionals through mailing lists or upon request. The BLS publishes annual statistical data that include overall rates and numbers of skin-disease cases, but does not publish separate data on lost workdays or risks by industry of employment.

C. Employment Policies and Practices

Organizations with strong commitments to worker well-being and strong and viable supervisory chains of command and responsibility have traditionally been thought to provide a safeguard against occupational injury and disease. In the past decade, a substantial increase has occurred in the number of industries with in-house medical facilities and trained safety personnel. Dermatologists, however, do not appear to play a substantial current role in the medical evaluation or treatment policies of most companies.

Pre-placement screening of workers may be useful when unique personal susceptibility is an important risk factor, but unless a true risk for development of occupational skin disease is known with certainty, moral and ethical dilemmas preclude such screening of healthy workers. Although diseased skin may easily be aggravated by specific workplace exposures, pre-placement physical examinations for pre-existing cutaneous diseases (e.g., atopic dermatitis and psoriasis) are seldom performed (*14*). Routine pre-placement patch testing for work duties involving exposure to potential allergens is not recommended except when personal history suggests prior sensitization to the allergen. Attempts to correlate personal susceptibility to irritation through research with indirect measurements that indicate impaired function of the normal cutaneous barrier (e.g., increased transepidermal water loss, decreased electrical impedance) have not yet met with widespread success.

D. Motivation

Preventive measures are more likely to be effective if employers and workers are motivated to use and support them. Motivational techniques, such as incentives (prizes, awards) or disincentives (fines, litigation, insurance costs), have been used. Although the costs of workers' compensation should influence employers to commit more resources to prevention, such costs may continue to be written off as business costs until they are prohibitive. Whenever lifestyle contributes to the occurrence of injury or disease, motivational techniques should be used to change lifestyle habits as well as specific work practices.

E. Regulation

Regulatory controls for specific causal agents fall into three main areas: bans, exposure limits, and labels or warnings. The OSHA Hazard Communication Standard (29 CFR 1910.1200) is an example of the latter approach. Promulgated regulations controlling exposure to causal agents should ideally be based on objective data for dose-response toxicity, but practical difficulties for measuring cutaneous exposures in the workplace severely limit this approach. Indeed, establishing standards for skin exposures is difficult because simultaneous exposures to several different agents may result in interactions that produce skin irritation and personal susceptibility factors may play an important role. Clearly, innovative approaches are needed.

VI. Evaluation

The effectiveness of prevention and control strategies aimed at occupational skin conditions should be monitored and evaluated following implementation.

A. General Monitoring

The Annual OSHA 200 Log Survey of the BLS currently monitors national incidence rates of occupational skin diseases and injuries passively in a randomly selected sample of private-sector U.S. businesses. Although this survey has never been validated as an accurate indicator of true incidence rates, NIOSH has in the past linked its institutional goals and objectives for reducing occupational diseases and injuries to the annual results of this survey. Current evidence suggests that occupational diseases may be underrecognized and underreported on the OSHA 200 logs (the source of case data for the Annual Survey) (*3*), or even deliberately misclassified as injuries to avoid reporting cases without lost work time (*73*). As yet, no alternative surveillance methods have been developed and used.

B. Specific Monitoring

Specific surveillance for the effectiveness of prevention efforts can be accomplished by monitoring either the occurrence of dermatological conditions or the levels of exposure within targeted working populations. At present, follow-up epidemiologic surveys are seldom performed on the occurrence of disease or injury after controls are implemented, and effectiveness becomes largely anecdotal.

Process monitoring may be aimed at detecting exposure levels to specific causal agents in the work environment. Exposure to dusts, mists, residues, and vapors can be monitored using the existing sampling and analytic methods of industrial hygiene. Airborne exposures (e.g., vapors), however, are infrequent causes of skin disease — except for particulates (e.g., fibrous glass) and heavy mists — and monitoring of work surfaces contaminated with liquids or solids is more important.

Several techniques to detect skin contamination from a variety of chemical substances have been developed, including the lightpipe luminoscope for measuring ultraviolet excitation and fluorescence of chemical substances (*74*) and the video microcomputer for fluorescent tracer analysis (*72*). These methods, however, simply monitor cutaneous exposure but provide no information on the actual extent of percutaneous absorption.

If accurate analytic methods are available, biologic monitoring may be performed on body fluids or tissue samples to evaluate the effectiveness of controls aimed at minimizing skin exposure and percutaneous absorption.

VII. Recommendations

A. Assessing the Problem

The recommendations given below represent the minimum effort required for effective prevention of occupational skin disorders at a significant national level. These recommendations have arbitrarily been divided into two groups: those likely to have the most immediate and measurable impact ("Now") and those with a pos-

sibly delayed impact ("Later"). The distinction was based solely on current knowledge, feasibility, and available resources and should not imply any priority of needs.

1. General Needs

   a. Now

      - Increased use is needed of existing databases that contain information on occupational skin conditions, both in the United States (e.g., OSHA 200 Log, SDS, NEISS) and abroad, to identify high-risk working populations and to generate hypotheses for research. These efforts should include attempts to link observations in different databases, including international sources.

      - Techniques of investigative epidemiology (e.g., standardized questionnaires and morbidity ratios) should be applied increasingly not only to test specific research hypotheses but to detect previously unrecognized clusters of dermatological conditions within different working populations compared with the general population. The NHANES I Dermatology Survey contains detailed information on disease prevalence in the general population and may be useful in this regard.

      - The list of occupational sentinel health events (SHE [0]) should be expanded to include outcomes other than contact dermatitis. This may serve to trigger earlier recognition and reporting.

      - The maintenance of OSHA 101 logs, which contain supplementary data on types of skin conditions, causal agents, occupation, age, and sex is required by law. These logs could be collected along with the OSHA 200 log survey, and analyzed separately to provide better data for characterizing occupational dermatological conditions.

      - To characterize dose-response relationships of cutaneous exposures, research should be performed with existing models (animal or in vitro) for cutaneous toxicology to provide more accurate estimates of actual risk, to assist health care providers in their diagnoses of probable causal agents, and to facilitate the future establishment of cutaneous exposure standards.

   b. Later

      - Changes must be made in existing surveys or new surveys must be developed to provide the information required to characterize risk, risk factors, and causal agents in greater detail. State files of workers' compensation claims could be used to attain this goal.

      - New toxicology models should be developed that more accurately predict risk.

      - Centralized databases must be developed that contain detailed information on occupational skin diseases, injuries, and cutaneous toxicology.

2. Specific Needs

a. Now

More information must be obtained about the cutaneous and systemic toxicity of newly-developed chemical substances before they are widely introduced into workplaces.

- The important factors and causal agents responsible for high rates of occupational skin conditions in agriculture must be characterized more accurately.

- The poor prognosis of workers with contact dermatitis requires further explanation and study. Factors contributing to the persistence or chronicity of dermatological conditions (including misdiagnosis and inappropriate treatment by health care providers) should be evaluated.

- The actual frequencies with which specific chemical substances cause occupational allergic contact dermatitis in workers at highest risk (e.g., machinists, agricultural workers) should be ascertained in well-controlled epidemiologic studies. The cutaneous patch testing required in such studies could be accomplished through contractual arrangements with dermatologists skilled in this procedure. (A similar contractual arrangement with FDA successfully delineated the frequencies of contact dermatitis from allergens in cosmetics.)

- Epidemiologic and toxicologic studies should be pursued in unexplained clusters of occupational malignant melanoma, cutaneous T-cell lymphoma, or other skin disorders.

- The true incidence of occupational skin infections should be established, and the infectious agents should be accurately identified.

- Priorities for research on percutaneous absorption should be linked to a priority list of causes for systemic occupational diseases (e.g., carcinogens, mutagens, teratogens). Research should investigate the potential influence of vehicles on absorption.

- Existing databases should be analyzed and epidemiologic studies performed to identify the most important types of occupational skin injuries, along with their risk factors, causal agents, incidence, and prevalence of complications.

- A survey should be conducted in targeted populations to determine whether CPC is being used when needed.

b. Later

- Accurate techniques and methods, both clinical and instrumental, should be developed through prospective studies to reliably predict the actual risk of future injury or disease in healthy but high-risk workers (e.g., atopic workers).

- Specific case studies should be undertaken to compare the costs incurred by employers as a result of occupational dermatological conditions with the costs and effectiveness of implementing preventive efforts.

B. Prevention Planning

1. Targeted Populations

a. Now

- Based on available data, prevention strategies and methods will have the greatest immediate impact if aimed at work forces in agriculture, manufacturing, and construction — where the highest rates of cases occur — and at the large outdoor work force — with its specific risk of skin cancer. These prevention strategies must include provisions to reach small employers within these industries where the risk is disproportionately greater.

b. Later

- New surveillance and recognition methods must be developed to detect specific worksites at greatest risk, where intervention will have an obvious and immediately measurable impact. State claims for workers' compensation or OSHA inspection reports that specifically identify worksites may be useful for this.

- The targeting of working populations for future intervention must take into account changing demographics and shifts of workers into different sectors of the work force because this will undoubtedly influence the number of cases occurring in various industrial divisions.

2. Prevention and Control Methods

a. Now

- Based on current knowledge, available prevention and control methodologies should emphasize that:

  - Process engineering (isolation, containment) is the best solution wherever it is technically feasible.

  - Elimination of hazardous chemical substances, or substitution of less noxious substances (e.g., allergen replacement) may be effective in selected situations.

  - Selection of chemical protective clothing should be based on not only performance and physical properties but also data on chemical permeability when available. CPC should not be reused wherever allergic reactions or systemic toxicity are a concern.

  - Manufacturers of CPC should develop products with wider size ranges, improved comfort, and better functional and protective characteristics to encourage increased voluntary use by workers.

- Although controlled clinical trials have never validated the effectiveness of chemical barrier creams, the possible skin-lubricating effects and improved personal hygiene associated with use of these creams warrant their consideration. They should not, however, be used on skin with preexisting dermatitis. Commercially available sunscreens with an SPF of 15 or greater have proven effective in preventing skin cancer.

- Approaches involving environmental hygiene should place more emphasis on the importance of contaminated work surfaces.

- The risks of secondary dermatitis from overuse of skin cleaners or inappropriate use of solvents should be considered in all approaches to personal hygiene (skin cleaning). Industrial skin cleaners should not be used on skin with preexisting dermatitis. When specific procedures exist to decontaminate skin from selected substances, their use should be encouraged.

b. Later

- Research must continue on new or more effective prevention and control methods, and these methods must undergo experimental validation before they are implemented. Specific future research considerations should include:

  - better approaches to process and chemical engineering

  - expanded testing of CPC for permeability against high-priority hazardous substances, e.g., allergens, carcinogens, or other potential systemic toxins

  - development and evaluation of substance-specific protocols for decontaminating both surfaces and skin

  - development of new instruments and methods for monitoring contamination of skin and surfaces

  - clinical and experimental studies on the efficacy of chemical barrier creams

- Databases must be developed and maintained with information on effective prevention and control methodologies.

3. Health Care Delivery

a. Now

- To determine whether optimum care is being provided and to identify and correct deficiencies, existing patterns of health care delivery to working populations should be assessed. The specific involvement of dermatologists should be encouraged among primary health care providers and other occupational health professionals for the diagnosis and treatment of occupational dermatological conditions.

b. Later

- Studies should be conducted that assess the efficiency and effectiveness of various health care provider schemes (e.g., private practice, HMO's, occupational medicine specialty clinics) for occupational dermatological conditions to determine which approach provides optimum benefit within the various schemes.

4. Manpower

a. Now

- Because there is a shortage of health care providers with special expertise in occupational dermatological conditions, efforts should be continued through traditional educational channels — such as seminars, symposia, professional society meetings, and publications — to increase the skills of dermatologists, physicians, and other occupational health professionals who already provide care for these disorders.

- NIOSH personnel must play a leadership role in developing strategies and setting priorities so that the limited manpower available can be directed most effectively at common goals.

b. Later

- To increase the future pool of health care specialists with sufficient skills in clinical diagnosis, treatment, and epidemiologic investigation of occupational skin conditions, core curriculum requirements should be established within respective health professional training programs (e.g., schools of medicine, nursing, and pharmacy; industrial hygiene and engineering programs; dermatology and occupational medicine residency programs) for specific training in the recognition, investigation, and treatment of these disorders.

5. Economic/Material Resources

a. Now

- There is immediate need of increased funding for research at the federal, state, and local levels of government and in private sector organizations.

- Increased cooperation is needed between federal, state, and local agencies to share available resources and reduce the burden of cost. The Surveillance Cooperative Agreement between NIOSH and States (SCANS) is an initial step in this direction.

b. Later

- Projections of cost analysis are required to ensure adequate long-term funding.

C. Implementation

1. Education

a. Now

- Educational campaigns designed to increase awareness of important designated health and safety issues should be directed immediately toward workers and management in targeted populations. These campaigns should include increased use of the mass media as well as traditional information pamphlets and brochures. Educational materials should be geared to the educational levels and ethnic backgrounds of the targeted work force. The principal issues requiring heightened awareness include:

  - identification of specific hazardous substances and exposures

  - effective prevention techniques; e.g., sunscreens for preventing skin cancer

  - risk of dermatitis from inappropriate or excessive skin cleansing and from poor practices of personal hygiene

- More research should be conducted on the potential usefulness of skin-disclosing agents as an educational tool to identify poor practices of personal hygiene.

b. Later

- Educational campaigns using the mass media should be directed to increasing overall awareness in the general public of occupational health and safety issues.

- Concerns about occupational health and safety should be incorporated into existing health curriculum programs in high schools, vocational schools, and colleges to reach workers before they enter the labor market.

2. Dissemination of Information

a. Now

- NIOSH should develop and disseminate two guidance manuals:

  - a manual for workers and employers on preventing occupational dermatological disorders; and

  - a manual for occupational safety and health professionals on evaluating, controlling, and preventing hazards for occupational dermatological disorders.

- NIOSH should analyze statistics on occupational skin conditions collected annually by the BLS, SDS, and NEISS surveys and publish them regularly in the MMWR or other appropriate publications.

- NIOSH should publish annual collective summaries of HHEs involving skin complaints.

- NIOSH should promote increased awareness of the Information Dissemination Section in the Technology Information Branch of its Division of Standards Development and Technology Transfer. This Section may be used to disseminate available information on cutaneous hazards.

b. Later

- A central clearinghouse should be developed through computerized link-up of pertinent databases to disseminate information on cutaneous hazards, effective prevention methodologies, and standardized test data on the chemical and physical resistance of CPC.

3. Employment Policies and Practices

a. Now

- Training programs should be developed within high-risk industries to increase not only job skills but also safe work practices.

- Pre-placement examinations should be advocated to screen for pre-existing dermatological conditions that may be aggravated by work exposures.

b. Later

- Methods that accurately identify susceptible workers (who do not have pre-existing dermatological conditions) and predict the true risk should be developed for potential use in pre-placement screening.

4. Motivation

a. Now

- Research on motivational techniques should be encouraged, and effective techniques should be incorporated into education and training programs directed at workers and management.

b. Later

- Motivational techniques designed to change high-risk lifestyle activities (e.g., suntanning) that may contribute to occupational skin injuries or diseases should be directed at the general public.

5. Regulation

a. Now

- Material safety data sheets (MSDS) should contain more complete and accurate data on cutaneous toxicology (e.g., Draize test irritation scores) where available, and the presence of known allergens should be identified irrespective of their concentration levels. Examples of effective protective clothing should be listed if test data are available.

- Recommended standards should be adopted for uniform testing of chemical protective clothing.

b. Later

- Standards for skin exposure to hazardous substances should continue to be developed and established. This may require innovative approaches to measure exposures other than concentrations.

D. Evaluation

1. General Monitoring

a. Now

- The annual OSHA 200 Log Survey must be examined critically to establish whether it is a valid monitor of national progress in preventing occupational skin conditions.

b. Later

- Appropriate changes should be made in the OSHA 200 Log, OSHA 101 Form, SDS, or NEISS surveys, or in adapting other annual surveys that collect vital health statistics (e.g., Health Interview Survey), if necessary, to provide a more suitable vehicle for monitoring national progress. If this fails, a new survey must be developed.

2. Specific Monitoring

a. Now

- Specific demonstration projects should be conducted to determine whether hazardous exposures or the incidence of dermatological conditions have actually been reduced by implementing specific preventive methods, educational efforts, or information dissemination.

b. Later

- New methods should be developed for biologic or process monitoring of high-risk cutaneous exposures.

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