

The Chronic Effects of Mechanical Trauma to the Skin: A Review of the Literature

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This paper summarizes the findings of a NIOSH report entitled "The Chronic Effects of Repeated Mechanical Trauma to the Skin: A Description of the Problem in the Workplace" (the Trauma Report). Medical literature and U.S. health statistics (population surveys and occupational health reports) were reviewed to determine the long-range impact of repeated mechanical trauma sustained in the workplace. Trauma was rarely recognized as contributing to dermatological disorders. Conventional sources of information were found to be inadequate for precise estimation of costs. A minimal estimate of the annual cost of cutaneous disorders resulting from repeated mechanical trauma to the skin is \$15 million.

Key words: chronic mechanical trauma, occupation, dermatoses

INTRODUCTION

Chronic exposure of the skin to repeated small mechanical insults or microtraumas—such as pressure, friction, abrasion, minor punctures, and shearing—can cause a variety of skin changes, viz, corns, calluses, and other hyperkeratoses; pigment changes; urticarias; erosions and cuts; nonspecific dermatitis; and nail damage. These alterations occur mainly on the hands, feet, knees, elbows, lips and neck [Ronchese, 1945].

In the work setting, such findings are often regarded as unimportant lesions that are indicative of an individual's craft or occupation—a "badge of the trade." However, mechanical injuries may have serious consequences, often unrecognized. For the years 1969–1973, estimates of the number of awards for disability owing to corns and calluses are presented in Table I. It is noteworthy that eligibility requires a full year of disability. Thus it is highly probably that Social Security Disability Awards greatly

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TABLE I. Summary of Estimated Social Security Disability Awards for Corns and Callosities (1969-1973)*

Occupational group	Dot codes ^a	Estimated No. of awards ^b	
		Male	Female
Math and physical sciences occupations	020-029	1	0
Food and beverage preparation and service occupations	310-319	4	4
Lodging and related service occupations	320-329	0	4
Miscellaneous personal service occupations	350-359	5	0
Protective services	370-379	4	0
Building and related service occupations	380-389	4	0
Metalworking, NEC ^c	610-619	10	0
Metal fabricating	800-809	10	0
Transportation occupations, NEC	910-919	2	0
Production and distribution of utilities	950-959	5	0
Msc. jobs (classified by SSA ^d)	No Codes	23	0

*ICDA [1968].

^aDictionary of Occupational Titles [1965].

^bEligibility for award required a full year of disability.

^cNot elsewhere classified.

^dSocial Security Administration.

TABLE II. The Trauma Report: A Summary of Contents*

Occupational settings of repeated mechanical trauma to the skin
General statistical data on occupational dermatoses
Occupational skin cancer
Additional considerations
Conclusions and recommendations

*"The Chronic Effects of Repeated Mechanical Trauma to the Skin: A Description of the Problem in the Workplace" [Silver et al, 1984].

underestimate the total lost work time and the economic costs of these common lesions.

The National Institute for Occupational Safety and Health (NIOSH), as part of an initiative aimed at defining, identifying, and controlling occupational disorders resulting from repeated physical and mechanical insults, has sought to assess the extent to which mechanically induced skin lesions affect job capacity and well-being of workers. NIOSH recognized the need to characterize the types of lesions, to illuminate epidemiology and demography, with a view toward estimating the economic and social costs to the workers, their employers, and society in general. The collected information would be used by NIOSH to (a) define the problem qualitatively and quantitatively, (b) evaluate preventive strategies, and (c) make recommendations for future research.

This paper summarizes the findings and recommendations of a NIOSH report entitled "The Chronic Effects of Repeated Mechanical Trauma to the Skin: A Description of the Problem in the Workplace" (The Trauma Report) [Silver et al, 1984] (Table II).

Objectives

The Franklin Research Center (FRC), Philadelphia, under contract to NIOSH, was given the responsibility for obtaining information on the effects of repeated mechanical microtraumas to the skin. The final report was to summarize available knowledge, identify information gaps, and suggest future areas of research. Specific information was sought on the following: (a) job categories and worker populations at greatest risk; (b) kinds of injuries and the anatomic sites involved; (c) physical impairments affecting job function or the quality of life; (d) psychological consequences, including cosmetic concerns; and (e) a measure of economic impact, based on the number of workers affected, lost workdays, and reimbursements through compensation and other insurance programs.

Initially FRC looked into problems caused solely by "friction and pressure." Because of a paucity of relevant articles, it soon became apparent that some expansion of the definition of repeated "mechanical" trauma was necessary. The acceptable definition was expanded to include skin lesions resulting from repeated minor punctures, cuts, and chronic vibration.

Information Sources

FRC obtained information and data from the following sources:

1. The medical and experimental literature, including research reports, case histories, monographs, and books. Computerized searches were conducted on the data base systems in the National Library of Medicine, Bethesda, MD (NLM), and the Dialog Information Retrieval Service, Palo Alto, CA (DIALOG). Limited manual searching of older literature and texts was also conducted.

2. The Supplementary Data System (SDS) [Bureau of Labor Statistics, 1978], which contains information from state-supplied Workers' Compensation Reports. This system contains data on case characteristics, industry and occupation of the affected worker, and, in some cases, indemnity compensation and medical payments. A description of this system has been reported by Root and McCaffrey [1978].

3. The dermatologic reports from the U.S. National Health Survey: (a) the 1971-1974 Health and Nutrition Examination Survey (HANES) [Johnson, 1979], and (b) the 1976 Health Interview Survey (HIS) [Bonham, 1979]. The data from these surveys performed under the auspices of the National Center for Health Statistics (NCHS) were reviewed with regard to the prevalence of skin disease attributable to repeated mechanical trauma and the extent of medical impairment.

FINDINGS

Identification of Pertinent Literature

The FRC search identified approximately 600 journal articles and book titles. Approximately 350 of the titles were selected as appropriate for review based either on the title or on key words in the bibliographic citation. However, this effort produced only a limited body of useful information. Only 69 of the papers contained relevant material, and over half of these pertained to the effect of skin wounding on two-stage (initiation/promotion) carcinogenesis assays and not to job-related skin problems. An additional 58 references were collected from other sources, giving a total of 127 references. The scarcity of information was apparent from the very start.

Assessment of the Health and Economic Impact of Mechanical Skin Trauma

The literature search was useful for identifying groups of workers or jobs prone to repeated mechanical insults. The job categories were far-ranging, including musicians, athletes, meat cutters, painters, barbers, garbage collectors, jewelers, farmers, and flooring installers [Ronchese, 1945, 1948; Mills and Kligman, 1975; Warren, 1940; Freeman and Bergfeld, 1977; Donahue et al, 1978; Peachey and Matthews, 1978; Rao, 1981; Spoor, 1977; Vollum and Azadeh, 1979; Tennstedt et al, 1979; Jirasek, 1979; Asawa et al, 1980].

The body regions affected by trauma varied according to occupation. Not unexpectedly, hands and fingers were common sites of injury, although characteristic lesions were found elsewhere. The clinical descriptions were varied and often inexact. These included calluses, pigmented or scaly lichenifications, hyperkeratotic changes, erythema, papules, and vesicles. Mills and Kligman [1975] coined the term "acne mechanical" to describe a special type of friction- and pressure-induced acne form lesions. All too often, the descriptions were well below the standards of specialists in dermatology.

The literature was not very useful for assessing the physical and psychological consequences of the lesions. Rarely was there an actual indication of lost workdays due to mechanically induced skin changes. Generally patients were seen by physicians only when the lesions became infected or inflamed. Moreover, the literature was virtually without value with regard to estimating the "extent of the problem," namely, (a) persons affected and (b) economic impact.

On the basis of the index titles contained in SDS, it was anticipated that this data base would provide information for estimating costs and for identifying causes of skin injuries. The category Rubbed or Abraded, UNS, included six subcategories, five of which provided data that pertained to chronic skin trauma: By Leaning, Kneeling, etc; By Objects Handled; By Vibrating Objects; By Repetition of Pressure; and Undefined.

The latest data in SDS from two states—New York (1979 data) [Anon., 1982] and Wisconsin (1978 data) [Anon. 1981]—were reviewed. New York and Wisconsin were selected because their records contained a modest amount of compensation data, a wide variety of industries/occupations, and were thought to reflect occupational populations in the United States. Unfortunately, problems of data comparability limited the usefulness of the SDS. There were differences between the two states with respect to eligibility requirements for compensation, compensation information, and the way in which the information was interpreted. The process of deriving a cost estimate for job-related mechanical trauma had to be crude but was undertaken nonetheless.

Compensation costs owing to job-related repeated mechanical trauma were estimated to have a national economic impact of at least \$14–17 million. This figure is certain to be an underestimation because it did not include (a) the cost of illnesses that are uncompensated because of waiting time requirements, (b) the costs of skin diseases that are not recognized by physicians or workers as having a mechanical trauma factor in their etiology, (c) the estimate that occupational dermatoses may be 10–50 times under-reported [Standards Advisory Committee on Cutaneous Hazards (SACCH), 1978], and (d) the fact that 14% of the civilian, wage, and salary work force are not covered by Workers' Compensation [Price, 1984].

Another approach for estimating the extent of the problem was to evaluate skin disease data for the general population and determine, where possible, the prevalence and severity of skin problems owing to mechanical trauma among the working-age population. Data from HANES and HIS were reviewed for this purpose [See Johnson and Roberts, this volume].

HANES [Johnson, 1979] provided estimates of skin disease based on findings from interviews and standard dermatological examinations among a national probability sample of civilian, noninstitutionalized populations, aged 1 to 74 years. In the HANES report, the only category that appeared to be directly relevant to the topic was Corns and Callosities. For this category, HANES reported a total prevalence rate of 156.9 per 1,000; of these only 3.2 per 1,000 of the corns and callosities were judged by the examining dermatologist to be "significant" (ie, conditions that should be seen at least once by a physician). Only 0.6 persons per 1,000 of those judged to have "significant" corns or callosities expressed concern or complained about their condition. HANES did not provide age-distribution data sufficient to derive the prevalence for corns and callosities among working-age populations or the "handicap" associated with various skin disorders.

With regard to all skin diseases, it was noted that nearly one-fourth (approximately 24%) of adults 18-74 years of age with significant lesions had job exposures to chemicals or conditions that could have contributed to the disorder (HANES). Usually, a causal relationship of exposure could not be explicitly defined.

HIS [Bonham, 1978] contained data on the prevalence of chronic skin and musculoskeletal conditions based on data collected in household interviews by the U.S. Bureau of the Census for the NCHS. The prevalence rate reported for corns and callosities among the civilian noninstitutionalized population (all ages) was 26.5 per 1,000 (5.583 million persons). Ninety-nine percent of those affected were in age groups that might suggest a work-related cause.

Prevalence rates were higher among nonwhites and females and increased with increasing age. A decrease in prevalence was observed as family income increased. Although the rate of 26.5 per 1,000 was less than the 41.5 per 1,000 reported in the 1969 HIS, the number of "restricted activity" days owing to corns and callosities (all ages) actually increased from 0.4 in 1969 to 2.5 days per year in 1976. Data were also given for the degree and frequency of "bother" and the number of physician visits because of various skin disorders including corns and callosities; however, these latter data were for respondents of all ages; no age distribution figures were given.

DISCUSSION

During the literature-search phase it quickly became evident that chronic repetitive microtraumas to the skin were seldom described as distinct categories except for passing reference in some texts and general reviews [eg, Schwartz et al, 1947; Adams, 1983]. Case histories of skin disorders (eg, infections, contact dermatitis) rarely addressed the potential contribution of mechanical traumas, and those that did generally included only an isolated sentence or two in the discussion section. Words such as "friction," "pressure," "abrasion," etc, were rarely emphasized in bibliographic citations—ie, the key words and titles—of clinical reports concerning job-related dermatological problems.

A recently published case illustrates why the role of trauma is difficult to detect. As part of a follow-up for articles that may have been missed during the preparation of the Trauma Report or appeared after its completion, a computer search of MEDLINE revealed the title "Hyperkeratotic Lesions of the Palms" [Hersle and Moberg, 1982]. Neither the abstract nor key word sections of the bibliographic citation mentioned trauma or occupation or contained information suggesting that the article was relevant to the topic. However, on reviewing the text, it was found that the authors had discussed the possible role of mechanical trauma in the development of the skin lesions. They wrote, "Since almost half of the study patients did hard manual work at the time of onset . . . it is conceivable that chronic mechanical trauma contributes to the pathology."

In contrast, a recent paper by Menne [1983] represents a rare instance in which mechanical trauma is discussed as a key factor in the development of a job-related skin disorder. The word "friction" appeared in the title and "occupational dermatitis" was among the key words. The paper describes a post office worker with a case of palmar dermatitis resulting from constant friction on the palm with a rough-surfaced tabletop. Although Menne [1983] noted that frictional dermatitis was probably not uncommon, he also noted that friction-induced skin problems were not often reported. Indeed, the under-reporting of occupational disease, in general, and more specifically, job-related dermatological conditions, has been recognized by others [SACCH, 1978].

SUMMARY AND CONCLUSIONS

1. Corns, calluses, and other hyperkeratotic manifestations that are indirectly attributable to repeated mechanical insults are a relatively small part of the problem measurable by workdays lost and the accompanying costs. No doubt, repeated mechanical trauma contributes significantly in certain occupations to the development of skin infection and chemically induced dermatitis.

2. Reporting requirements are presently too imprecise and too loosely interpreted to provide accurate quantitative information on the impact of job-related repeated mechanical trauma to the skin. However, if the definitions were clarified and made uniform for all states, mechanical trauma as a category could be precisely identified as a cause or contributing factor. This would not involve an increase in SDS manpower or funding.

3. Except for the "degree of bother" noted in HIS, little information was located on psychological complications that may arise because of mechanically induced lesions. Only a paper by Russell [1975] addressed the emotional aspects of skin disease in general. However, it may be appropriate to add to this category such lesions as "Fiddler's Neck" [Tennstedt et al, 1979], which have relatively little clinical importance but are often of cosmetic concern. Additional literature on the psychological and psychosocial impact of skin disorders and disfigurement may not lie in the dermatology literature but may be located elsewhere, such as the psychiatric or social science literature.

4. While a few references were located on trauma-induced skin disorders of the feet, the Trauma Report did not address this issue. Injuries to the forefoot caused by ready-made safety shoes are, according to Varzos [1970], probably not uncommon. Safety shoes, while offering protection from acute trauma (dropped items, penetration by sharp articles, etc), can create frictional problems. The resulting corns, calluses,

etc, if bothersome, may result in physician visits and restricted workdays. If not properly cared for, the condition may lead to accidents and injuries.

RECOMMENDATIONS

The Trauma Report recommended two types of prospective studies:

1. a broad survey of representative occupations for the purpose of defining relationships between job tasks and the prevalence of various types of repeated mechanical trauma; and

2. an in-depth pilot program of specified industries, conducted by qualified medical and other personnel to help clarify the relationship of repeated mechanical trauma to infections and contact dermatitis, to identify the source and kind of chronic mechanical traumas associated with specific job tasks, and to assess the feasibility and cost effectiveness of potential control measures.

The poultry-dressing and meat-packing industries were suggested for the above pilot programs. These two industries were recommended because SACCH [1978] listed them as having the highest risk with respect to occupational dermatoses and because many of the tasks performed by workers in those industries involve repeated mechanical trauma.

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