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Record-Based ("Passive") Surveillance for Cumulative Trauma Disorders

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I. INTRODUCTION

Surveillance means different things to different people. A formal definition of surveillance for cumulative trauma disorders (CTDs) may be stated as "the ongoing and systematic collection, analysis and interpretation of exposure and health data necessary for the planning, implementation, and evaluation of programs for prevention and control of CTDs" (From Ref. 1, with slight modification).

Surveillance is a noun derived from the verb "survey," which means "to take a general or comprehensive view of a situation" and "to view in detail in order to ascertain a condition, value, etc." Further, the word *surveillance* implies the attitude of preparedness to make appropriate responses to the surveyed situation. Therefore, in a very broad sense, surveillance is a basic survival function of any living organism. Even a small creature performs surveillance of its surroundings and responds by flight from an attacker or a dash toward food. In our current context, business organizations, both small companies and large corporations, must maintain surveillance of production, customer's needs, market trends, and employee health status to survive and maintain a healthy existence.

II. TYPES OF SURVEILLANCE FOR CTDS AND DEFINITIONS

Since there are many types of surveillance, it is worthwhile to clarify the position of this chapter in the overall surveillance scheme. In the fields of public health and epidemiology, the term *active surveillance* has been traditionally used to indicate the activities of data collection (case finding) by reaching out to, and searching through, patients' records at doctors' offices and hospitals. In contrast, *passive surveillance* has been used to mean the data collection activity of waiting for and receiving the disease reports at the public health office, usually at the Department of Health of a state or city [2].

In recent years, however, a new meaning of active and passive surveillance has been added within the discipline of CTD epidemiology [3]. In this instance, the term active surveillance is used to denote the activities of generating the data, finding cases by administering (musculoskeletal) health questionnaires and/or conducting physical examinations among workers. In contrast, the term passive surveillance is used in CTD epidemiology to denote reviewing and analyzing preexisting records such as OSHA 200 logs and workers' compensation claims, which are usually kept at the employer's office. As a result, the terms may refer to entirely different surveillance activities.

In view of the increasing public health importance of CTDs and increasing interactions between the disciplines of public health and ergonomics, it is highly desirable to avoid confusion by clarifying these terms and definitions. Therefore, I have devised more descriptive terms:

Record-based surveillance: the use of available records such as OSHA 200 logs
Data-generating surveillance: Activities such as questionnaire administration and/or health examinations

To place our topic in perspective, various types of surveillance programs that can be performed for various purposes are listed in Table 1. In this chapter, most of the discussions will focus on record-based surveillance [B.1(a), Table 1] for an in-plant ergonomic program [B.2(a)]. At the same time, readers are reminded that the entire ergonomic program in the plant, from reviews of records to the assessment of effectiveness of ergonomic intervention (feedback), can also be included in a broad sense of surveillance, as shown in Figure 1.

Depicted in the upper part of the flowchart are the surveillance activities for CTDs in a narrower sense. These begin with record-based surveillance, with a systematic review of OSHA 200 logs, workers' compensation claims, sickness and absenteeism records, and other health care records. This analysis will assist identification of high CTD risk jobs.

The results of such an analysis should be compared with the results of various other assessment activities, which are presented in the middle of the flowchart. Such activities would include examination of the awareness of ergonomic issues among management and labor, assessment of the type and degree of exposure (e.g., ergonomic walk-through), and data-generating surveillance such as musculoskeletal health questionnaires and physical examinations. These results usually corroborate one another, leading to the identification of the problem areas and jobs in the plant as illustrated later in Case Report 2.

Shown in the bottom third of the flowchart is the intervention stage, in which various ergonomics intervention measures are implemented to abate the problem. When a follow-up assessment is performed after a sufficient time period, it can be expected that the data from assessment activities will show a decreasing trend of CTDs (provided that the cause of the problem was properly identified and the intervention was correctly targeted and implemented).

In a very broad sense, all of the stages depicted in Figure 1 may be included in a comprehensive surveillance scheme.

Table 1 Types and Definitions of Surveillance for CTDs

A. Exposure variables (measured in ergonomics surveys). Repetition of task, force, posture, duration of work/rest periods, vibration, workstation design, etc. (discussed elsewhere in this book)
B. Outcome variables. Health/morbidity status of workers
   1. Source of surveillance data
      (a) Record-based surveillance (passive surveillance[a])—the analysis of existing records and/or data
      (b) Data-generating surveillance (active surveillance[a])—the generation of data by use of questionnaires, medical examinations, etc. (discussed in Chapter 23)
   2. Scope of surveillance
      (a) In-plant surveillance—private industrial effort
      (b) Public health surveillance—governmental effort

[a]In this chapter, the author has avoided using the terms "active" or "passive" surveillance because they may be confusing or misleading to readers coming from different disciplines.

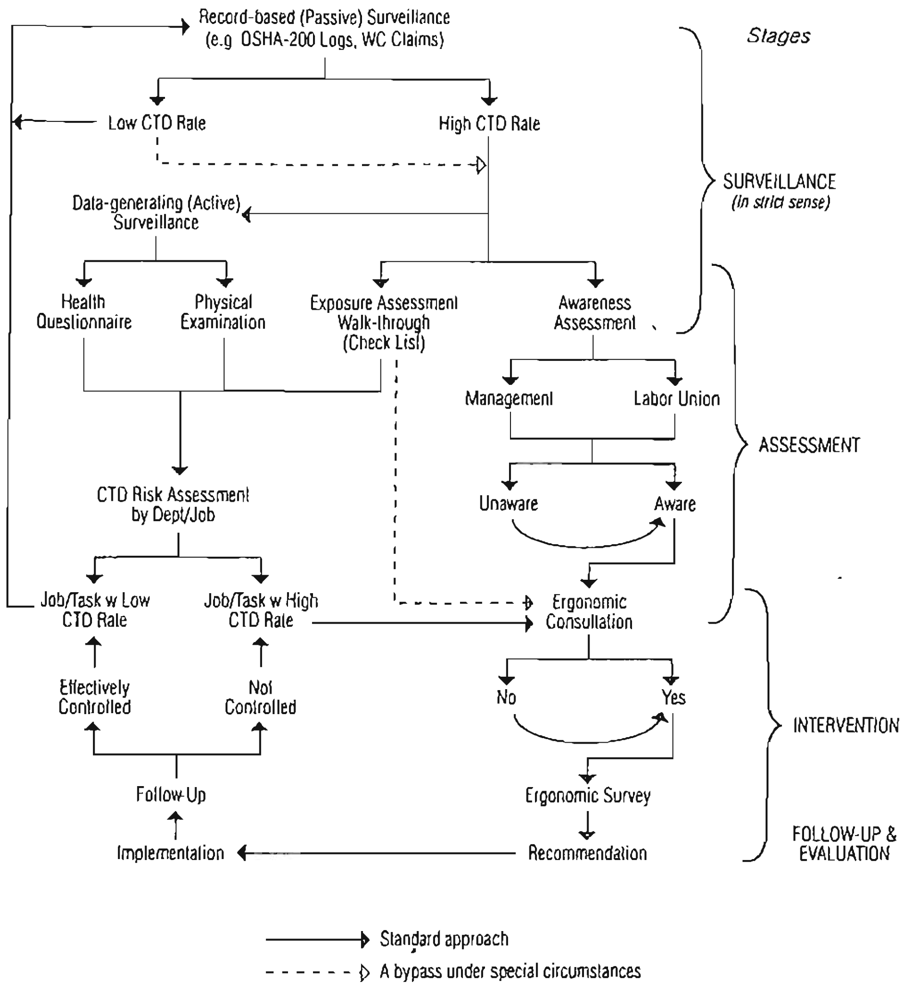

Figure 1 A flowchart of comprehensive CTD surveillance in industry (Solid arrow: standard approach. Dashed arrow: a bypass under special circumstances.)

III. BACKGROUND AND SIGNIFICANCE TO OCCUPATIONAL ERGONOMICS

Surveillance activities should provide the backbone of any ergonomics program. However, for people who are not familiar with ergonomics, it is not necessarily easy to understand and conceptualize the CTD surveillance functions in a plantwide ergonomics program. People who have been well trained in industrial hygiene, epidemiology, or occupational medicine may find that their learned principles and techniques are not quite suitable for dealing with CTDs in the workplace. The reasons for this may be illustrated by comparing surveillance methods for lead exposure and its health effects with those for CTDs (Table 2).

Lead has been known for many centuries to be toxic to humans. In the past several decades, much has been elucidated about the biochemical and toxicological details of lead poisoning. As a result, we now know how much exposure to lead can cause what toxic effects, and standards have been developed to control the exposure by setting the maximum limit for atmospheric lead as well as the blood lead level. Also, several biochemical indicators of

Table 2 Comparison of Exposure/Effect Assessments for Lead Poisoning and Cumulative Trauma Disorders

	Lead poisoning	CTDs
Exposure agent	Lead, lead compounds	Physical stress (force, repetition, posture, duration/lack of rest)
Assessment methodology	Established and specific (lead in air or blood)	Being developed but not established (e.g., ergonomic checklist)
Quantification	Precise	Difficult (except for repetition and duration)
Nonoccupational exposure	Identifiable and distinguishable	Identifiable but not easily distinguishable
Outcome/effect indicators	Nerve damage; kidney damage	Local fatigue, pain, discomfort (e.g., health questionnaire)
Diagnosis	If suspected, usually simple and definitive	Fairly simple for presumptive diagnosis; tests such as EMG, NCV are costly[a]
Technology for prevention	Known and available	Still much unknown or under development

[a]EMG = electromyography; NCV = nerve conduction velocity.

lead exposure and absorption have been identified and used as exposure-monitoring tools. Today, a very effective surveillance for occupational lead exposure and absorption can be conducted by using these refined methodologies to monitor lead levels in atmospheric and biological samples [4].

In contrast, the state of our current monitoring capability in medical surveillance for CTDs does not have the advantage of sensitive and accurate measures. This situation is analogous to that of several decades back in history when we had to wait until the manifestation of frank symptoms of lead poisoning such as lead colic and radial nerve paralysis or signs such as "lead lines" on the gum or in skeletal radiographs. Now we have sensitive tools to monitor exposure to lead. In contrast, this is not the case for CTDs. For example, despite the fact that carpal tunnel syndrome (CTS) is probably the most studied CTD and criteria for its surveillance have been developed [5], medical evaluation of CTS is still largely subjective. Although the measurement of nerve conduction velocity (NCV) is available as an objective method to test dysfunction of the median nerve [6], its high cost (due to the need for skilled technicians and professional interpretations) is rather prohibitive for the routine use of NCV measurement as an industrial screening tool.

Furthermore, the technology for the ergonomic assessment of exposure factors is still in its developmental stage, although some noteworthy advances have been made in recent years [7]. There have been a few documented success stories in which epidemiological and ergonomic investigations have led to some definitive intervention strategies [8]. These cases typically involved specific and obvious physical stresses such as the use of the knee kicker by carpet layers to stretch carpet [9,10]. However, to date, most epidemiological attempts to simply establish certain occupations or jobs as the cause of certain CTDs (e.g., CTS) have been unsuccessful [11]. Such failures are not surprising when one realizes that the causative agents are not the occupations or jobs per se but rather the physical stresses demanded by the job and how the job or task is performed. In other words, almost any manual job can lead to CTS or tendinitis depending on how the task is performed, while even meat packing jobs that have been known for their severe musculoskeletal stresses [12] could be performed, theoretically, without incurring a CTD if appropriate ergonomic practices were put into effect.

Therefore, we have to come to the realization that these difficulties are inherent in the medical and ergonomic surveillance of CTDs. Nonetheless, we must use currently available methodologies to perform the needed quantitative assessment and hope for technological advancements in coming years. It is not difficult for an epidemiological study to identify occupations or industries with an elevated risk of CTDs. However, epidemiological techniques alone cannot determine what exposure factors in the work are really causing the problem and how these can be controlled. Thus, cooperative and coordinated efforts of both ergonomists and epidemiologists are much needed to achieve this goal [13].

IV. RECORD-BASED SURVEILLANCE

In-plant record-based surveillance ("passive" surveillance) for CTDs involves reviewing and analyzing existing records or data systems that are normally kept by the employer [14]. Typically, available records would include OSHA 200 logs and workers' compensation (WC) claims, which will be the main subjects of discussion in this chapter. Record keeping of OSHA 200 logs is required by law for the purpose of surveillance, and the details are described in official publications [15]. In contrast, the use of WC claims for this purpose is for convenience, because the WC system was not created for surveillance purposes. Some companies keep so-called sickness and accident (S&A) records from which data for CTDs can be extracted. Medical records may be kept at the company's health unit or at the health care provider's office. Also, the health insurance records of employees have been used for CTD surveillance [16]. More detailed medical information is usually available from these health care record systems than from OSHA 200 logs or WC claims. However, routine extraction of necessary data from health insurance records is not always easy or simple unless the data are computerized and suitably coded. The insurance carriers are usually reluctant to release the data owing to the confidentiality issue and the proprietary nature of information.

For the purpose of basic CTD surveillance at the place of employment, periodic (preferably monthly) review of OSHA 200 logs and WC claims is recommended and should be effective as long as the information is recorded honestly and without bias or interference. Equally important are the keen sense and ability of the person in charge of surveillance to recognize workers' physical complaints or remarks, to detect abnormal trends, and to respond appropriately (see Sec. VII, Case Report 1).

The quality and usefulness of a record system for the purpose of CTD surveillance will depend on various factors. To calculate incidence (i.e., number of new cases) rates, the record should include, at a minimum, date of occurrence, personal identifier, department, job title, part of the body affected, and preferably the diagnosis. Conditions reportable in column 7-f of OSHA 200 logs are defined as "disorders associated with repeated trauma (DART)" with examples such as carpal tunnel syndrome, synovitis, tenosynovitis, bursitis, Raynaud's phenomenon, and noise-induced hearing loss [15]. Also, the denominator data, such as the number of workers by department and hours worked, should be available for calculation of incidence rates. The record should be easily accessible to and retrievable by authorized personnel for the purpose of conducting surveillance. Computerized data processing would make the analysis fast and simple.

An incidence rate (IR) per 100 full-time employees of illnesses may be computed by using the formulas [15]

$$IR = \frac{\text{Number of illnesses} \times 200,000}{\text{Employee hours worked}}$$

and

200,000 hr worked per year = 100 full-time employees (FTE)

In this calculation, only new cases are counted for a given time period. If one worker experienced the same CTD more than once during the reporting period, the occurrences are counted separately as long as there was a period of complete recovery in between. The severity or duration of the disorder is not considered in incidence rate.

The incidence rate should be computed for the entire company or plant, for each department, and for each section if within a large department. It may sometimes happen that only a small number of workers are performing highly repetitive manual work within a large company or department. In such a situation, the incidence rate for the company or department may not be high, and the CTD hazard for the small group of exposed workers can be overlooked (a dilution effect). Calculation by job/task groups, combined with an ergonomic evaluation, should be able to point out the problem areas (see Sec. VII, Case Report 2).

The calculation of the total hours worked can be obtained from computerized payroll data in most companies. If the number of hours worked is not computerized, it must be hand calculated using a calculator. For the purpose of obtaining a rough estimate, the average or usual number of workers may be used instead of hours worked, as long as the number of employees remained fairly stable during the year. (For example, if a lathe operator quit after working 6 months and was replaced by another lathe operator who worked the remaining 6 months of the year, they can be counted as 1 person-year.) However, it should be kept in mind that this rough estimation tends to underestimate the incidence rate if each worker did not work a full 2000 hr a year due to part-time work, vacation, illness, layoff, etc.

For official reporting purposes, annual incidence rates are required by OSHA. However, for the purpose of maintaining an effective in-plant ergonomics surveillance program, it is not recommended to wait for 12 months if one wants to detect an upsurge of CTDs at the earliest possible stage. Therefore, in addition to being in compliance with the OSHA requirement, examination of the current data and trend should be performed at least on a quarterly, and preferably on a monthly, basis.

In addition to the incidence rate, which considers the number of new cases in a set time period, the prevalence (rate) is sometimes used. The prevalence measures the frequency of all current cases of a disease, both new and old (continuing from a previous period), at a given point in time (point prevalence) or for a prescribed period of time (period prevalence). Thus,

$$\text{Point prevalence} = \frac{\text{number of new and old cases at a given point in time}}{\text{number of workers at the same point in time}}$$

$$\text{Period prevalence} = \frac{\text{number of new and old cases during a given time period}}{\text{number of workers at the mid-interval in the same time period}}$$

Period prevalence is of limited usefulness [17], as it does not distinguish new cases from old ones nor does it count repeated episodes of the same disease of the same person occurring in the time period.

For the purpose of estimating the overall seriousness of CTDs by departments or disorder and for setting the intervention priority, the severity index may be useful. The severity index (SI) may be calculated for all CTD cases or by diagnosis, or by part of the body affected, using the following formula:

$$SI = \frac{\text{Total number of workdays lost due to the defined disorder(s)}}{\text{Total number of workers or hours worked in a time period}}$$

However, it must be kept in mind that the severity index may be influenced by such factors as the type (conservative or invasive) of medical management [18], sickness benefit, and opportunity for transfer to less stressful jobs. It may also be skewed by unusually long illnesses experienced by a small number of employees.

V. ADVANTAGES AND DISADVANTAGES OF RECORD-BASED SURVEILLANCE

Major advantages of record-based surveillance using OSHA 200 logs or workers' compensation claims are its low cost and easy accessibility. Since the employer is required to collect and maintain the record, the reviewer's main task is to tabulate and analyze the data. This effort is small compared to the data-generating surveillance, which involves administration of a health questionnaire and/or physical examinations, and subsequent data analysis [3].

A major shortcoming of record-based surveillance is said to be its underreporting. Fine and others [3] estimated that record-based surveillance detected only one-seventh of potential CTD cases that were uncovered by data-generating surveillance. There are several reasons for this underestimation. First, the mere presence of pain or other symptoms is neither reportable in OSHA 200 logs nor sufficient for filing a WC claim. Second, some employers may be reluctant to list all reportable cases in the OSHA 200 logs. There were well-publicized cases of deliberate underreporting by some meat packing companies in the mid-1980s. After OSHA started imposing large fines for such neglect or concealment, the number of reported cases started to increase. Third, employees may hesitate to report their symptoms or illnesses to their supervisor, particularly at a time when jobs are scarce.

In contrast, musculoskeletal questionnaires or physical examinations of data-generating surveillance (described in more detail in Chapter 23) typically elicit reports of symptoms and signs in various body parts in a confidential manner. Pains and discomfort above certain levels and lasting more than a certain number of days are counted as positive cases. Therefore, it is not surprising that data-generating surveillance (particularly for research purposes) can detect many times more cases than record-based surveillance.

Worker's compensation (WC) claims are filed under specific rules and regulations that vary from state to state. Therefore, record-based surveillance using these databases may be subject to an equal or higher degree of underestimation compared to the review of OSHA 200 logs. On the other hand, WC claims usually contain a wealth of information related to each CTD claim, including the body part affected and diagnosis [19]. Under special circumstances such as for research, health insurance records can be obtained and analyzed for detection of potential CTDs [16]. However, widespread or routine use of health insurance records as a surveillance tool may not always be feasible or practical, particularly for small companies.

The primary objective of conducting an in-plant CTD surveillance is early detection and intervention. For this purpose, the concept of Sentinel Health Event—Occupational (SHE-O), which was first proposed by Rutstein and others [20], can be applied. For investigation of various occupational diseases, including CTDs, a single case could trigger more focused examinations of the health status of coworkers and the work area where the index case was detected [21]. Even if record-based surveillance may detect only a small portion of CTD cases, it can be said that one case detected by record-based surveillance may lead to several times as many unreported cases.

VI. CRITICAL REVIEW OF CURRENT STATUS AND FUTURE CONCERNS

As presented in the above, record-based surveillance for in-plant monitoring of CTDs can be conducted fairly rapidly and easily once the system is in place and managed by a knowledgeable and responsible individual. With the support of responsive management, this person can play an important role for timely intervention and control of CTD problems in the plant. At the plant level, disorders associated with repetitive trauma (DART) conditions reportable in column 7-f of OSHA 200 logs seem to be specific enough to include the part of the body in the data.

Nationwide surveillance for CTDs is very important for making effective policy decisions for prevention but difficult to conduct for various reasons. As discussed in the beginning of this chapter, record-based CTD surveillance is plagued by the ill-defined nature of the disorders and the difficulty of exposure assessment. The current OSHA-required record-keeping system (which is the basis of the BLS' annual report) has been criticized for its tendency to understimate the incidence of CTDs [3]. Also, when the data were compiled by BLS to prepare the annual report, all of the DART conditions were lumped together. This process reduced its usefulness as a nationwide surveillance tool, although DART accounted for 56% of the total cases of occupational illnesses reported by private industry in 1990.

Since 1992, BLS has been using a redesigned occupational injury and illness surveillance program to collect more detailed information such as the demographics of the affected workers and the cirumstances of the incident for lost workday cases. This new method has generated information that is more useful toward prevention of CTDs, which was not available under the old reporting system [22].

Also, at the time of this writing, OSHA's effort to propose an ergonomic protection standard for general industries is stalled in a political process. Detailed methods of surveillance for exposure to musculoskeletal stress and health effects are described in the proposed draft [23]. Whether or not such a standard is eventually promulgated, the surveillance methods described in the OSHA draft are very useful for implementation of an in-plant ergonomics program on a voluntary basis. I am also confident that the basic aspects of record-based CTD surveillance described in this chapter would be applicable regardless of the type of standard or guidelines that might be finalized by OSHA.

VII. CASE REPORTS

Two cases have been selected to illustrate some of the points made in this chapter.

A. Case Report 1

This case is based on a paper by Luopajärvi et al. [24] reporting on a food (unspecified) production factory where approximately 200 female workers performed packing tasks on assembly lines in the 1970s. As shown in Table 3, the number of cases of occupational hand

Table 3 A Surveillance Record of a Food Packing Company (Case Report 1)

Year	Number of cases	Lost workdays	Hindsight remarks
1972	1	42	Something happened here, but no intervention?
1973	12	1117	
1974	16	1446	Many of these cases could have been prevented if problem had been identified and intervention begun in 1973.
1975	46	3670	
1976	51	5288	
1977	20	840	
1978	5	201	
1979	1	24	
1980	0	0	

Source: Data from Ref. 24 by permission.

disease in 1972 was only 1 with 42 lost workdays. In 1973, this jumped to 12 cases with 1117 lost days, and over the following years the numbers continued to increase. In 1976, the situation had become so serious that a project was started to deal with the problem with seven working groups directed by a multiprofessional leadership. The epidemic was eventually brought under control by 1979. However, during the 6-year span 1973–1978, a total of 150 cases and 12,562 lost workdays due to hand disorders were recorded.

Although the intent of the paper was to report on the effectiveness of various intervention measures to contain the epidemic, it seems to present a very interesting case study for surveillance. First, there was at least a basic surveillance system in this plant to record occupational illnesses and lost workdays. Through 1972, the packaging was probably done by a slow, old-fashioned method. Although it was not described in the paper, something happened during the year 1973. A likely scenario might be that a new company policy was implemented to increase the production rate by way of increased quota, possibly accompanied by the introduction of partial automation. Workers had to adjust the speed of manual work to that of the machine, but obviously it was far beyond their physical capacity.

The sudden increase of morbidity must have caught the eye of plant management in 1973. Strangely, however, nothing was done to deal with the surge of new cases until 1976. By hindsight, if the intervention effort had been initiated in 1973, they could possibly have prevented up to 130 cases and 11,000 lost workdays. This case amply illustrates that the failure of early detection of the problem by surveillance and resultant lack of timely intervention allowed the problem to continue and even increase in size for several years.

The moral of this case would be that an increased rate of CTDs must be examined to determine the reason for the increase and dealt with promptly to prevent an epidemic, which can be very costly.

B. Case Report 2

This case is based on my own experience at the National Institute for Occupational Safety and Health (NIOSH). In a joint surveillance project by NIOSH and Ohio Bureau of Workers' Compensation (BWC), WC claims were analyzed for "inflammation or irritation of joints, tendons, or muscles" resulting from "overexertion occurring over a protracted time period" for various parts of the body [19]. As a result, we were able to identify companies with a high incidence rate of such cases for the hand/wrist including carpal tunnel syndrome. (Before 1985, Ohio BWC did not include a separate code for CTS.) Subsequent telephone con-

Table 4 Comparison of Crude Incidence Rates of Carpal Tunnel Syndrome (CTS) and Related Disorders by Various Surveillance Methods at a Hose Manufacturing Plant (Case Report 2)[a]

Dept.	Number of workers	WC claims	From OSHA 200 logs: CTS or like	From OSHA 200 logs: Sprains/ strains	From questionnaire: Neck/ Arm	From questionnaire: Hand wrist	From questionnaire: Nocturnal hand pain
A	67	2.4	1.5	13.4	31%	31%	32%
B–J	388	0.2	0.1	0.9	22%	17%	6%
Office	156	0	0	0	10%	3%	2%
Total	611	0.4	0.2	2.0	20%	15%	8%

[a]Rates are per 100 employees per year or percent as indicated.
Source: Condensed from tables in Ref. 25.)

tacts with seven of these companies all confirmed the existence of, and the management's concern with, work-related CTS among their employees. One company, a manufacturer of garden, automotive, and industrial hoses, cooperated with NIOSH in an ergonomic and epidemiological investigation of their CTD problem [25].

The investigation consisted of the review of WC claims and OSHA 200 logs, administration of a questionnaire, and an ergonomic walk-through assessment and analysis of videotapes. Table 4 shows a summary of crude incidence rate of CTS (and related disorders) by department.

It can be noted in Table 4 that positive responses by questionnaire (data-generating surveillance) were far more frequent than those detected by WC claims or OSHA 200 logs (record-based surveillance). This is consistent with the previous discussion on the varying degree of detection by different surveillance methods. However, regardless of surveillance methodology, the interdepartmental comparisons showed a consistently higher rate for a specific department (Department A). A later ergonomic survey revealed that the CTDs in this department were indeed caused by very forceful and repetitive manual work, which required frequent bending and twisting of the wrist, elbow, and shoulder.

It is interesting to note that this company was initially selected because of a very high overall incidence rate of WC claims for CTDs. However, it was later found that the high rate was spurious and was due to the erroneously small number of employees (denominator) listed in an industrial directory for the state. The company would not have been selected if the number of employees had been listed correctly. Nevertheless, upon further inquiry and site visit, it was revealed that Department A had a very high incidence rate of CTDs compared to other departments.

This case illustrates that for the purpose of in-plant surveillance for CTDs, WC claims and OSHA 200 logs can be used effectively to detect high-risk departments or jobs. At the same time, however, it was learned that for the purpose of public health surveillance, an overall low or moderate rate of CTDs determined by a simple calculation may be misleading, because the problem areas may be identified only after a detailed in-plant investigation.

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