

SURVEILLANCE AND PREVENTION OF WORK-RELATED CARPAL TUNNEL SYNDROME IN CALIFORNIA

Robert Harrison, MD, MPH, Principal Investigator
California Department of Public Health
Occupational Health Branch
850 Marina Bay Pkwy, Bldg P, 3rd Floor
Richmond, CA 94804
510.620.5769
Robert.Harrison@ucsf.edu

COOPERATIVE AGREEMENT #5 U01 OH07297-03
PUBLIC HEALTH INSTITUTE
555 - 12th Street, 10th Floor
Oakland, CA 94607
510.285.5500
communications@phi.org

TABLE OF CONTENTS

List of Terms and Abbreviations	3
Abstract	4
Highlights/Significant Findings	5
Translation of Findings	8
Outcomes/Relevance/Impact	8
Scientific Report	9
Publications	19

LIST OF TERMS AND ABBREVIATIONS

Cal/OSHA – California Occupational Safety and Health Administration

CDPH – California Department of Public Health

CTS - Carpal Tunnel Syndrome

DFR – Doctor's First Report of Occupational Injury or Illness

UCSF – University of California at San Francisco

UEWRMSD – Work-Related Upper Extremity Musculoskeletal Disorder

ABSTRACT

The Occupational Health Branch (OHB) of the California Department of Public Health aimed to characterize and prevent work-related carpal tunnel syndrome (CTS) in California by developing a program of CTS surveillance and intervention over a 7 year period. This was accomplished through a comprehensive program funded by a cooperative agreement from the National Institute for Occupational Safety and Health (NIOSH). The CTS program sought to describe and monitor CTS trends using surveillance, to conduct both case-based and targeted worksite investigations in high risk occupations, to develop and provide prevention recommendations, to further develop collaborations that enhanced program impact, and to evaluate the program to ensure effectiveness. Key findings and accomplishments include:

- A comprehensive surveillance system was implemented, which identified over 25,000 cases statewide in 5 years.
- An evaluation of reporting sources determined that multiple data sources are valuable and lead to improved surveillance.
- Surveillance and follow-up data collection efforts generated important findings for prevention, including identifying high risk occupations, industries, tasks and tools. They also documented important information on disability and the impact of CTS on workers.
- Evaluation of garment workers in a specialized clinic demonstrated that nearly all had musculoskeletal disorders, including carpal tunnel syndrome. But almost none of the workers were willing to report their injury. For this high-risk population, the project focused on low-cost prevention measures, rather than surveillance.
- Over the duration of the project, CTS staff conducted a total of 44 work site investigations. Common risk factors identified in a variety of workplaces included repetitive work, inadequate ergonomic programs, poor work organization, poorly designed workstations and equipment, non-neutral hand and wrist postures with mouse use, static or awkward postures of the neck, back and upper extremities, and high psychosocial stress.
- Many interventions were accomplished, including policy recommendations; the development of educational materials with a wide distribution among employers and workers; the addition of ergonomics training to the curriculum of courses for graphic artists and website designers; development of low cost improvements to work stations for garment workers, leading to a chair-lending program for garment factories in the Bay Area; and ergonomics training for workers in multiple job settings and industries.

HIGHLIGHTS/SIGNIFICANT FINDINGS

The highlights of the project are organized by the specific aims of the original project proposal:

AIM 1: Continue existing surveillance methods and expand case ascertainment to include electronically reported workers' compensation data, thereby updating the system to be consistent with national trends in information transfer.

Surveillance efforts identified 25,263 reports of work-related CTS between 1998 and 2002, indicating that the condition poses a major public health problem for the working population of California.

The overall rate of CTS for all industries over the five year period is 34 per 100,000 employed in California, with particularly high rates seen among the electric, gas and sanitary services, communications, local transit, lumber and wood product manufacturing, and transportation equipment manufacturing industries. Occupations with particularly high rates include order and billing clerks, cake decorators, social welfare eligibility clerks, and police and detective supervisors. Applying findings from other data sources used to evaluate DFR case capture suggests that the overall rate of CTS in California is actually much greater (94/100,000 employed).

Doctor's First Reports (DFRs) of Occupational Injury or Illness are a critical tool for identifying cases, but an evaluation using other data sources demonstrated that DFRs provide a significant undercount, only identifying about 1/3 of the cases reported through a comparison data source.

The Workers' Compensation Information System was pilot tested as a data source and was shown to be an effective tool for identifying many cases of CTS that were not identified through existing data sources.

In refining the case definition, cases with a diagnosis of "rule out CTS" were evaluated and determined to be worthwhile, as nearly 30% were classified as "definite" after additional follow-up information was collected. Similarly, DFR cases initially classified as "uncertain" were evaluated and determined to be valuable, as 87% increased in classification to "possible", "probable" or "definite" after follow-up.

AIM 2: Conduct telephone interviews and other follow-up of workers in industries and occupations identified as high risk through surveillance data, thereby identifying risk factors and developing approaches to prevention.

Follow-up data gathered through telephone interviews and medical record retrieval generated important information on treatment and disability, demonstrating that CTS is a cause of significant disability and cost among California workers. Follow-up information also illustrated that intervention and prevention measures in workplaces are often inadequate to address or prevent CTS in workers.

Over half (53%) of the cases reported that their CTS was associated with computer tasks. Similarly, over half the cases (58%) reported keyboard and/or mouse use as the primary tool associated with their injury. Data from follow-up telephone interviews and medical record retrieval indicate that CTS has a significant impact on workers and employers: 62% of cases had bilateral CTS, half had surgery, 68% of cases had to take a median of 3 months off work, and 55% of cases left their jobs due to their CTS.

This project demonstrated a successful integration of occupational health issues and data into mainstream public health at the county level by collaborating with local health departments and providing occupational CTS surveillance data for inclusion in local reports on the health status of local populations.

In collaboration with the University of California, San Francisco and the community-based organization Asian Immigrant Women Advocates, we provided ongoing assistance to the Asian Immigrant Women Workers Clinic. The primary objective of this clinic was to provide screening and treatment for work-related musculoskeletal health conditions among low-wage Asian immigrant garment workers. Of the first 100 workers examined in the clinic, all but one reported significant musculoskeletal problems at work, including CTS. In spite of a high prevalence of symptoms and diagnosed health conditions, only one garment worker with an WRMSD was willing to have her health care provider file a DFR. Fear of reprisal by the employer was most commonly cited by garment workers as a reason for not wanting to report their injury. Clearly, traditional methods of surveillance using DFRs are unlikely to identify the true incidence of CTS in this population, or other workers in low-wage immigrant populations. We concluded that it is probably not feasible to collect and analyze population-based data on WRMSDs in this population, but instead need to focus on partnerships with community-based organizations to identify practical ergonomic interventions for small employers.

AIM 3: Increase case-based field investigations and the subsequent development of targeted prevention and control strategies.

Over 7 years, CTS staff conducted a total of 44 work site investigations. Four of these were performed after identifying a large number of CTS cases from our surveillance data and forty were performed after determining that effective ergonomic interventions could reduce the risk to a large number of workers. The findings of selected investigations illustrate how our approach to work-site investigations ensured that the results of the surveillance system were linked to illness prevention.

Customer Service - The CTS surveillance data identified a cluster of 52 cases from the customer service department of a telephone company and a cluster of 10 customer service cases from an airline. Investigations of 3 work sites with reports of CTS in these 2 industries demonstrated that customer service computer work has many ergonomic risk factors, and that inadequate ergonomic programs and poor work organization and workstation designs may have led to these injuries.

Web Development - The CTS surveillance program sampled a total of 18 CTS cases from workers in web/software development companies, representing approximately 54 cases. Occupations included graphic artist, information developer, programmer, engineer, and tester. As a result of these cases, an investigation was conducted at a San Francisco website development company. A number of ergonomic risk factors were identified including non-neutral hand and wrist postures with mouse use, and static postures of the neck, back and upper extremities which may have led to the injuries.

Sewing Machine Operators - The CTS surveillance program sampled a total of 17 CTS cases among sewing machine operators, representing approximately 51 total cases over five years. California is the largest center of apparel manufacturing in the United States, employing approximately 144,000 workers. The CTS program performed ergonomic evaluations at 20 garment shops in the San Francisco and Los Angeles areas to assess the current health and safety conditions and collect data on ergonomic risk factors for sewing machine operators. Many risk factors for carpal tunnel syndrome were identified in these evaluations including poorly designed workstation equipment, lack of ergonomics training, highly repetitive work, and high psychosocial stress. This investigation spawned an intervention study in 3 shops in Oakland Chinatown, summarized below.

Janitors - The CTS surveillance program sampled a total of 109 CTS cases among janitorial workers, representing 327 total cases. A total of ten janitorial work sites were investigated to determine the extent of both ergonomic and chemical hazards. Numerous risk factors for musculoskeletal injuries were identified, including poorly designed cleaning equipment, awkward postures and highly repetitive work.

AIM 4: Emphasize dissemination of results generated by surveillance and field investigation activities, and use findings to increase industry-wide prevention efforts

At the time of the public hearings on the ergonomics standard, the CTS project provided surveillance data and technical consultation to Cal/OSHA to support passage of a comprehensive hazard-based ergonomic standard for California. Based on our CTS surveillance data and experience with case follow-up, we recommended the use of a "hazard trigger" rather than relying on physician recognition and diagnosis of WRMSDs.

Customer Service – Recommendations were made to the employer, including the use of an upper extremity support board and improved work organization. As a result of our investigations, the project ergonomist developed the booklet *Office Ergonomics Guidelines* which we routinely disseminated to CTS cases who incurred their injuries from computer usage.

Web Development - Several recommendations were made to the employer, including provision of good forearm support; use of a variety of pointing devices for each task; selection of pen-based pointing devices that are designed to reduce pinch grip force;

and training of workers to alternate hands for pointing device use. As a result of this work, the project ergonomist worked with San Francisco City College to develop a curriculum on ergonomics for graphics and website design courses.

Sewing Machine Operators - Through a worksite intervention project in garment shops in Oakland, we were able to demonstrate a significant reduction in musculoskeletal symptoms among 40 garment workers over a twelve-month period. As a result of these findings, the Oakland City Council has appropriated \$25,000 for a chair-lending program for garment factories in the Bay Area.

We also developed and conducted an ergonomics training program that included over 200 garment workers from over 20 factories in the Oakland Chinatown area. The community-based organization is now using this information as the basis for an ergonomics training video that is used in English as a Second Language classes.

Janitors – CTS staff presented their findings and recommendations to instructors at the San Francisco City College Custodial Training Program, and taught several health and safety classes to the students in this program. A report was prepared describing the characteristics of this industry, the health and safety conditions at the ten work sites, barriers that employers and workers face in understanding health and safety, and prevention strategies for reducing CTS and other musculoskeletal injuries. This report was presented to CCHSWC.

TRANSLATION OF FINDINGS

This project documented that CTS among workers in California remains an important public health problem, with many workers affected and substantial impacts in terms of disability and cost. Our data illustrate that many workplaces lack any kind of ergonomic policy or training, and suffer from poor work organization, as well as poor workstation or equipment design. Some key findings that can be applied to many workplaces include:

- Repetitive work can lead to injury—job rotation can help prevent a single worker from performing the same task for an extended period
- Poorly designed workstation/equipment—the high-risk jobs studied here (customer service representative, web designer, garment worker, janitor) all benefited from interventions improving workstations and equipment. Many of these interventions were low cost, such as purchasing adjustable chairs that fit workers, adjusting workstations to provide support for intermittent keyboarding, or substituting ergonomically preferable computer pointing devices.

OUTCOMES/RELEVANCE/IMPACT

The California Carpal Tunnel Syndrome (CTS) surveillance program demonstrated that a significant burden of this important work-related musculoskeletal problem exists in California, and that particular high-risk occupations and industries can be targeted for investigation and prevention recommendations. A multi-source surveillance system was successfully utilized to capture physician reports of CTS, and demonstrated that successful public health surveillance can be utilized as an adjunct to OSHA logs and BLS

data systems. Case-based and outbreak investigations were conducted that led to several recommendations for feasible, low cost interventions that can prevent work-related CTS.

SCIENTIFIC REPORT

SURVEILLANCE

1 CASE ASCERTAINMENT

Over 7 years, the California Carpal Tunnel Syndrome (CTS) surveillance program developed a multi-source surveillance system for efficient and timely case reporting. Our primary source of data was the Doctors First Report of Occupational Injury or Illness (DFR), as well as other reporting sources described below.

a. Doctors First Reports of Occupational Injury or Illness (DFR)

For over six decades, all physicians in California have been required to complete a written report for suspected work injury or illness. The DFR is sent by the physician to the workers' compensation insurance carrier within five days after treating a suspected work-related injury or illness. The DFR includes demographic and occupational information, narrative about the injury-causing event, examination findings, diagnosis, and the treatment plan. The workers' compensation insurance carrier forwards the DFR to the California Department of Industrial Relations (DIR), Division of Labor Statistics and Research. A Memorandum of Understanding has been established between CDHS and DIR that allows the CTS program access to these reports. As of March 1, 2002, all DFRs have been forwarded directly by DIR to the CTS program offices. Beginning January 1, 1998, CTS project staff reviewed approximately 600,000 DFRs annually in order to retrieve those meeting specific case ascertainment criteria.

In the CTS surveillance system, an extensive amount of information was coded and abstracted from each report, including industry, occupation, specificity of symptoms, physical tests performed, test results, treatments provided, work process, and tool used. Since over 5,000 reports received annually with this extensive coding would have overwhelmed available staff and resources, a representative sample of the reports were selected for data entry and processing. A simple, systematic sampling plan was implemented involving the inclusion of every third DFR for data processing and follow-up as appropriate. This design resulted in approximately 1,700 reports for processing annually, and allowed for any population characteristic with an expected prevalence of 50% to be detected, with a precision of $\pm 2\%$ at a confidence level of 95%. This design was chosen because it allowed for a representative sample, as no known periodicity exists in DFR data that would affect a sample of every third report. Also, this method avoided any possible temporal variation that could introduce bias if selected days, weeks or months were chosen to reduce the sample size. Each DFR included in the sample was assigned a unique identification number. All DFRs not included in the sample were archived for future access as necessary, and only name, social security number, date of birth, and date of diagnosis were entered into an archive database.

b. Direct reporting by an HMO

In addition to utilizing DFR reports sent by all insurance carriers to DIR, the largest health maintenance organization in Northern California (Kaiser Permanente) functioned as a reporter for CTS surveillance and sent copies of DFRs directly to the

CTS program on a quarterly basis. DFRs included all work-related visits with an ICD-9 code of 354.00 or the term carpal tunnel syndrome in the report. Direct reporting by Kaiser not only identified additional cases, but also provided a unique opportunity to evaluate the completeness of case identification through the existing DFR reporting system (**see III.E.2 below**). The cases received directly from Kaiser were compared to the existing DFR and archive datasets to determine how much overlap there was between data sources. This direct Kaiser reporting documented that up to 63% of DFRs were not submitted by insurance carriers to DIR as required by law. Over the period 1998 to 2002, we identified 857 cases of CTS through this data source that would have been missed through the existing DFR data system.

c. Workers' Compensation Information System (WCIS)

In 2000, California began switching from a paper-based system for workers' compensation information, to an electronic system that is consistent with national data standards. This system collects Employers' First Reports for all workers who have filed a workers' compensation claim. The CTS program has established an MOU with the Department of Industrial Relations to access WCIS data on a quarterly basis. A limited preliminary assessment suggested that the addition of WCIS data will nearly double the current level of CTS case ascertainment. A pilot ascertainment of cases using a 2000-2001 data file from WCIS identified 3,885 cases of CTS. While it is unknown how many of these cases have already been identified through the DFR system, pilot matching between DFRs and WCIS for other health endpoints have shown only a 10-20% overlap between the two data sources. This suggests that the addition of WCIS for regular case ascertainment for CTS would provide an important additional source for case ascertainment.

2 CASE DEFINITIONS AND CASE CLASSIFICATION

All DFR reports that included a health care provider diagnosis of CTS or suspected CTS were designated a potential case of CTS. The CTS surveillance program adopted the NIOSH SENSOR surveillance case definition for carpal tunnel syndrome (Matte 1989).

A pilot project was conducted in 1998 to examine the utility of including DFRs of other UEWRMSDs in the case ascertainment criteria. A total of 560 cases were analyzed, including 270 CTS (48%) cases and 290 (52%) cases of other UEWRMSDs. Comparisons between the CTS and UEWRMSD cases showed no statistically significant difference by sex, age, industry, or occupation. However, CTS cases did differ significantly from UEWRMSD cases in terms of whether the DFR was able to provide documentation of symptoms and objective evidence as required by the SENSOR case definition (chi square=158, $p<.01$). Therefore, we chose to include only CTS cases in our DFR surveillance system.

A comprehensive occupational CTS telephone questionnaire was developed based on literature review, input from NIOSH and other SENSOR states, and comments from project consultants. The CTS questionnaire incorporates questions from established instruments that have been previously validated where possible to allow comparison with established large-scale data sources. The study protocol was approved by the California Health and Human Services Agency Committee for the Protection of Human Subjects, with verbal consent obtained from all subjects. The questionnaire includes

information on medical history, employment history, job tasks and exposures, non-occupational risks and exposures, disability, workers' compensation, other employees at risk, psycho-social factors, and workplace ergonomics programs. When cases were unreachable for telephone interview, we requested medical records to assist with case confirmation and classification.

Because DFRs vary substantially in the degree of detailed medical information they provide, many CTS cases lacked documentation of objective evidence such as electrodiagnostic findings or signs as included in the case definition. Because of these discrepancies, for the first three years of data collection, each case was preliminarily classified as "definite", "probable", "possible", and "uncertain" based on DFR information. Interview data and medical record retrieval were then used for a sample of cases to evaluate the accuracy, utility, and consistency of these categories. Results show that DFRs have good positive predictive value and are useful for identifying true cases of CTS. As a result, the four categories of case classification were determined to not be useful and were eliminated for subsequent years of data collection. The revised protocol included telephone interviews and medical record retrieval to collect additional data for cases from high risk industries, occupations or job tasks that were part of special project activities (such as customer service and web design). Follow-up information was collected on over 900 cases.

3 DATA MANAGEMENT AND ANALYSES

We developed a PC-based relational database system in MS Access to maintain data collected from reporting sources, follow-up interviews, and medical records review. Our system facilitated tracking of multi-source data collection, data entry, administrative tasks, and data quality control/validation. The database system had administrative features to assist with case management, including components to summarize case interview status, generate letters to send out with educational materials, and automate medical record requests. Standardized procedures for data input and quality control of the data were routinely performed, and included a comparison of all entered records with original reports for accuracy.

All cases were assigned a unique identification number and were coded for industry and occupation using North American Industry Classification System and Census Occupational Classification codes. As described above, additional coding of CTS data included symptoms, physical test results, process or exposure leading to injury, and treatment rendered. The work task and tool codes were adapted from the Bureau of Labor Statistics (BLS) Occupational Illness and Injury Classification System. Occupation and industry-specific rates were calculated using denominator data from the California Employment Development Department Labor Market Information. Prior to data analysis, data were thoroughly cleaned and edited, including removal of duplicates.

4 SURVEILLANCE FINDINGS

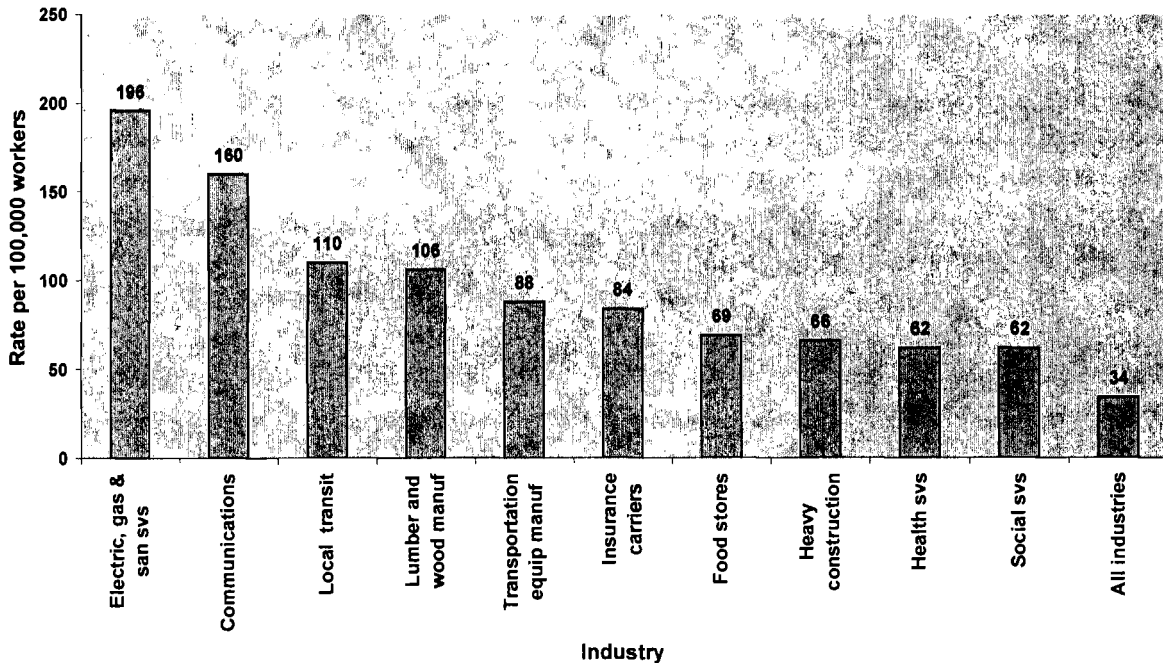
For the five year period 1998 to 2002, the California CTS surveillance system received an estimated 25,263 cases of CTS (average 5,053 cases annually). Of these cases, one-third or 8,421 cases were sampled for data entry and processing. CTS surveillance data include frequencies of CTS cases by month and year of receipt,

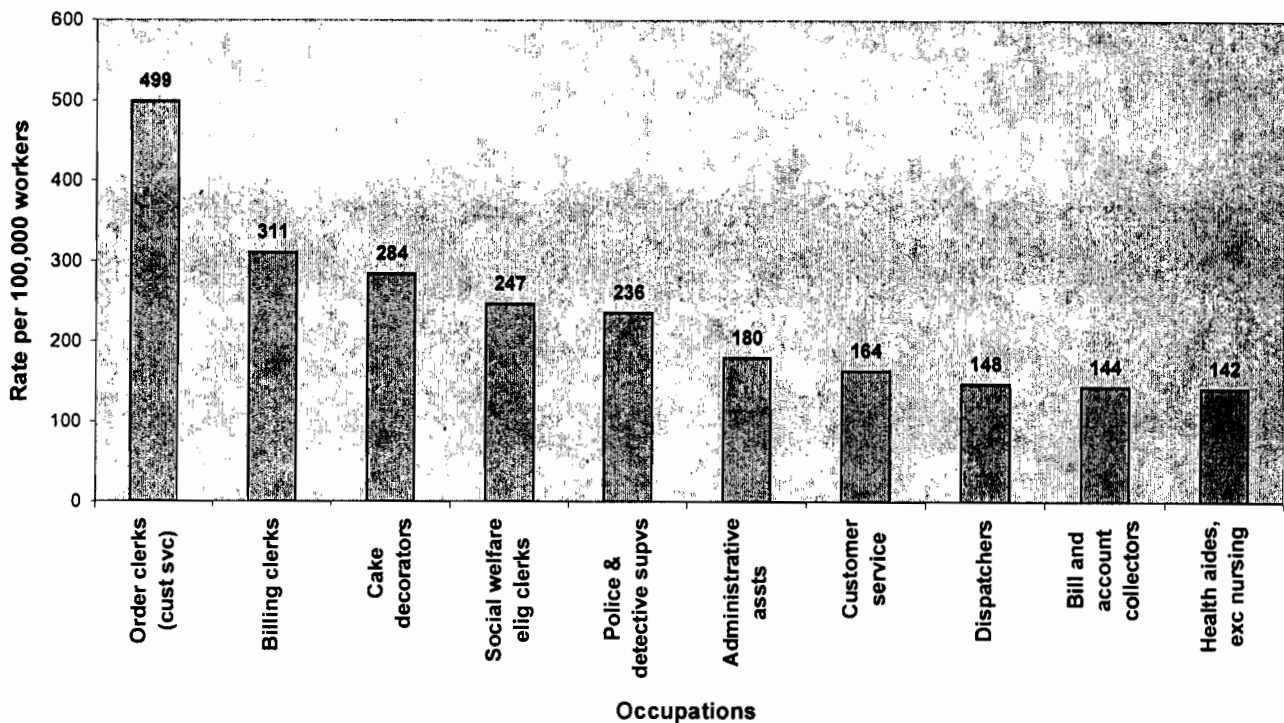
gender, age, SIC code, Census Occupational Code, symptoms, physical tests, treatment, work process, tool used and rates by industry and occupation. Data for cases that completed an interview are also included.

The overall rate of CTS for all industries over the five year period is 34 per 100,000 employed in California, with particularly high rates seen among the electric, gas and sanitary services, communications, local transit, lumber and wood product manufacturing, and transportation equipment manufacturing industries. Occupations with particularly high rates include order and billing clerks, cake decorators, social welfare eligibility clerks, and police and detective supervisors (**Figures 1 and 2**). Using DFR data reported directly to the CTS program from Kaiser to evaluate case capture through the standard DFR system, we determined that only about 36% of DFRs are captured through the standard system of physician reports to workers' compensation insurers. This finding suggests that the overall rate of CTS in California is actually much greater (94/100,000 employed).

Figure 1. Top Ten Industries by Rate

*Surveillance of Occupational CTS in California,
1998-2002 n=25,263*

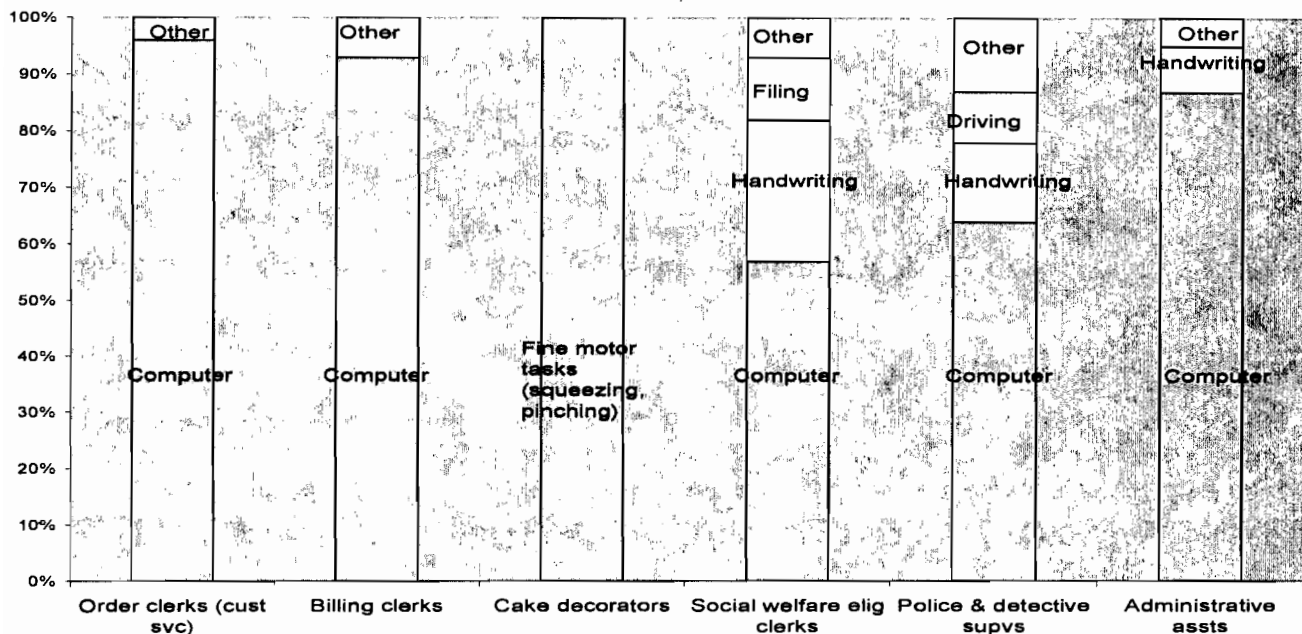




Over half (53%) of the cases reported that their CTS was associated with computer tasks. Other work tasks identified were reaching and twisting, for instance with a tool (11%); loading or lifting (9%); fine motor tasks, such as squeezing or pinching (5%); handwriting (4%); and sorting, packing or counting (4%). Similarly, over half the cases (58%) reported keyboard and/or mouse use as the primary tool associated with their injury. Other tools associated with CTS were hand tools (4%), scanners (3%), and power tools (3%). In **Figure 3**, the top six occupations with the highest rates of CTS are shown by the work tasks most commonly associated with each occupation.

Figure 3. Top 6 Occupations with the Highest Rates of CTS by Most Common Job Tasks Reported

Surveillance of Occupational CTS in California—1998-2002
N=25,263



The evidence for these cases being work-related is strong: 64% reported they had received no training on work practices to prevent repetitive stress injuries, and only about half of cases reported that their employer made changes to the workplace to prevent further injury. 88% of cases had no non-occupational risk factors, while 90% reported repetitive tasks in the workplace.

Data from follow-up telephone interviews and medical record retrieval indicate that work-related CTS has a significant impact on workers and employers: 62% of cases had bilateral CTS, half had surgery, 68% of cases had to take a median of 3 months off work, and 55% of cases left their jobs due to their CTS. 84% of cases interviewed had received electrodiagnostic testing, of which 86% showed positive results. Even more than 3.5 years after diagnosis, 2/3 of cases still reported experiencing symptoms in the prior 2 weeks.

5 RELATED STUDIES

As a result of the CTS program, we initiated several related projects and studies. The results of these efforts were used to improve our CTS program by enhancing our sources for data reporting, focusing our workplace intervention activities on high-risk occupations, and improving our methods for outreach and education.

a. Asian Immigrant Women Advocates Clinic

In collaboration with the University of California, San Francisco and the community-based organization Asian Immigrant Women Advocates (AIWA), we provided ongoing assistance to the Asian Immigrant Women Workers Clinic (AIWWC). The primary objective of this clinic was to provide screening and treatment for work-related musculoskeletal health conditions among low-wage Asian immigrant garment workers. The population served by this clinic was predominately Cantonese-speaking women that work as sewing machine operators in the Oakland Chinatown area. Of the first 100 workers examined in the clinic, all but one reported significant musculoskeletal problems at work. The primary disorders included low back strain, tenosynovitis, and CTS (7%). Over a two-year period, the CTS project industrial hygienist provided ergonomic consultation to the biweekly AIWWC, including design of data collection instruments to determine ergonomic hazards and reported symptoms. In spite of a high prevalence of symptoms and diagnosed health conditions, only one garment worker with an UEWRMSD was willing to have her health care provider file a DFR. Fear of reprisal by the employer was most commonly cited by garment workers as a reason for not wanting to report their injury. Clearly, our traditional methods of surveillance using DFRs are unlikely to identify the true incidence of CTS in this population, or other workers in low-wage immigrant populations. We have concluded that it is probably not feasible to collect and analyze population-based data on UEWRMSDs in this population, but instead need to focus on partnerships with community-based organizations to identify practical ergonomic interventions for small employers.

b. Santa Clara County

At the request of the County epidemiologist, CTS staff collaborated with Santa Clara County to include county-specific work-related CTS data in a report on injury prevalence and risk factors. Results showed that, while gender and age distributions were similar between the County and the State as a whole, there were differences in industry, occupation and work tasks. Workers with CTS in Santa Clara County were twice as likely to work in the manufacturing industry compared to workers with CTS in the state as a whole (34% vs 17%), and were much less likely to work in the transportation, communications and utility (8% vs 14%) or government industries (7% vs 13%). Santa Clara County cases were also more likely to be in managerial and professional specialty occupations, which include such jobs as computer programming and software development (31% vs 19%). Work task associated with CTS cases was more likely to involve computing in Santa Clara County compared with the state (63% vs 53%) and was less likely to involve reaching and twisting, as is often involved in tool use (8% vs 11%). This project demonstrated a successful integration of occupational health issues and data into mainstream public health at the county level.

c. California Ergonomic Standard

California is the only State with a specific standard to control ergonomic hazards. Approved by the California Occupational Safety and Health Standards Board in 1997, employers are required to implement an ergonomics program after the occurrence of at least two repetitive injuries among workers performing the same or similar tasks. At the time of the public hearings on the ergonomics standard, CTS project staff provided surveillance data and technical consultation to Cal/OSHA to support passage of a comprehensive hazard-based ergonomic standard. Based on our CTS surveillance data and experience with case follow-up, we recommended the use of a "hazard trigger" rather than relying on physician recognition and diagnosis of WRMSDs. In the early part of 2004, we again provided data and supporting technical documentation to Cal/OSHA and the California Occupational Safety and Health Standards Board in support of a revision to the current ergonomic standard. Disorders associated with repetitive motion continue to result in significant lost work time (median 30 days), suggesting that early identification of symptoms and prevention of disability have not been effectively implemented by employers.

CASE FOLLOWUP AND WORKPLACE INTERVENTION

1 CURRENT APPROACHES

We performed workplace field investigations for selected cases to gather in-depth data about the work process and biomechanical risk factors for CTS. The data provided by our investigations linked the CTS case identified in the surveillance system with the context in which the ergonomic hazards occurred. In this way, our field investigations enhanced our capacity to formulate, evaluate and disseminate effective prevention strategies. CTS reports were selected for follow-up based on the magnitude of the

public health impact represented by the incident report(s): (1) CTS cases involving a large number of workers, or involving an ergonomic exposure that was common to a large population of workers; (2) a large number or rate of CTS reports related to a single hazard, occupation, industry, or task; (3) an ability to reduce the physical risk factors for CTS or where we believed work site evaluation suggested that prevention recommendations were feasible (including possibly tool/equipment redesign) and/or there was an opportunity to distribute industry-wide prevention materials; and (4) "sentinel events," which are case reports that may represent a new or emerging hazard, or a failure of recognized control measures or regulations to effectively control exposures. All CTS reports were reviewed by the CTS industrial hygienist to determine if they met our criteria for follow-up.

The California Department of Health Services' Occupational Health Branch has the authority to gain access to the workplace for the purpose of conducting investigations of work-related morbidity and mortality (California Health and Safety Code Section 105175-105180). Investigations were initiated by contacting the incident case(s) at home, and workers were asked to participate in a voluntary interview describing the incident, their symptoms, medical treatment, workplace exposures, control measures, and other information. Subsequent to the worker interview, the employer was contacted to arrange the work site investigation. Site visits were conducted according to our written Field Investigations Policy and Procedures manual, and included employer and employee representatives (unions, other worker advocacy organizations, and/or individual workers). Worker interviews were conducted by multi-cultural and bilingual staff in a private location (private office at the workplace or in their homes). We utilized the services of a bilingual research assistant to assist with field investigations, conduct Spanish interviews as needed, and perform translation of written materials. Educational materials and a toll-free phone number were provided to workers to facilitate ready access to information about health, safety, and workers' rights, as well as to CTS staff.

Workplace investigations included the following methods: task analysis using checklists, videotaping, interviews with employers, employees and other individuals involved in the incident; worker focus groups; symptom surveys of a representative number of workers; review of written policy and procedures, medical records, and regulatory investigations; and analysis of the relevant scientific literature. For common computer-related tasks, we employed a checklist and guide book that was developed and validated by the University of California, San Francisco/Berkeley Ergonomics Program. Structured questionnaires were developed for CTS investigations to obtain occupational, demographic, and health data from employees in facilities where it was not feasible to interview every potentially exposed employee at length during field investigations. Following the conclusion of our investigation, preliminary recommendations were made in writing via a letter sent within one to three weeks to the employer, labor representatives, and/or monitored workers. The final report with detailed findings and recommendations was completed and distributed within 6 months after the investigation was completed.

2 FINDINGS AND ACCOMPLISHMENTS

Over 7 years, CTS staff conducted a total of 44 work site investigations (an average of 5 to 6 per year): four of these were performed after identifying a large number of CTS cases from our surveillance data (criteria #1 above), and forty were performed after determining that effective ergonomic interventions could reduce the risk to a large number of workers (criteria #3 above). The findings of selected investigations illustrate how our approach to work-site investigations ensured that the results of the surveillance system were linked to illness prevention.

a. Computer Technology: Customer Service and Reservation Agents

FINDINGS: Computer-based customer service work is one of the most rapidly expanding occupations in the service sector. The annual average rate of growth is between 15% and 25% (Call Center Magazine, March, 1999). There are approximately 60,000 call centers in the United States, employing about 3 million agents. The CTS surveillance data identified a cluster of 52 cases from a telephone company and a cluster of 10 cases from an airline. Investigations of 3 work sites with reports of CTS in these 2 industries demonstrated that customer service computer work has many ergonomic risk factors, and that inadequate ergonomic programs and poor work organization and workstation designs may have led to these injuries.

INTERVENTION: Recommendations were made to the employer, including the use of an upper extremity support board and improved work organization. As a result of our investigations, the project ergonomist developed the booklet *Office Ergonomics Guidelines* which we routinely disseminated to CTS cases who incurred their injuries from computer usage.

b. Computer Technology: Website Design

FINDINGS: The computer and electronics industry in California has been growing at a rapid rate since the 1970s and is home to nearly 25% of the nation's software and computer manufacturing industry. The computer industry employs more than 350,000 workers in California. The CTS surveillance program sampled a total of 18 CTS cases from workers in web/software development companies, representing approximately 54 cases. Occupations included graphic artist, information developer, programmer, engineer, and tester. As a result of these cases, an investigation was conducted at a San Francisco website development company. A number of ergonomic risk factors were identified including non-neutral hand and wrist postures with mouse use, and static postures of the neck, back and upper extremities which may have led to the injuries.

INTERVENTION: Several recommendations were made to the employer, including provision of good forearm support; use of a variety of pointing devices for each task; selection of pen-based pointing devices that are designed to reduce pinch grip force; and training of workers to alternate hands for pointing device use. As a result of this work, the project ergonomist worked with San Francisco City College to develop a curriculum on ergonomics for graphics and website design courses.

c. Sewing Machine Operators

FINDINGS: The CTS surveillance program sampled a total of 17 CTS cases among sewing machine operators, representing approximately 51 total cases over five years. California is the largest center of apparel manufacturing in the United States, employing approximately 144,000 workers. The industry is known for its low wages, lack of benefits, and poor working conditions. The majority of sewing machine operators are immigrants who do not report work-related injuries due to language/cultural barriers and the fear of retaliation and deportation. The CTS program performed ergonomic evaluations at 20 garment shops in the San Francisco and Los Angeles areas to assess the current health and safety conditions and collect data on ergonomic risk factors for sewing machine operators. Many risk factors for carpal tunnel syndrome were identified in these evaluations including poorly designed workstation equipment, lack of ergonomics training, highly repetitive work, and high psychosocial stress. An intervention study was then performed in 3 shops in Oakland Chinatown.

INTERVENTION: The CTS program staff worked collaboratively with the University of California Berkeley/San Francisco Ergonomics Program, the University of California, San Francisco Nursing Program, and a community-based organization (Asian Immigrant Women Advocates - AIWA) on two innovative activities. First, the CTS program worked collaboratively with our partners to develop and implement a set of low-cost, feasible interventions to reduce the biomechanical risk factors during sewing machine work. Using a collaborative research model, we worked with a team of garment workers to design an ergonomic sewing machine station that could be implemented for less than \$300 by the garment shop owners. With funding from the Wellness Foundation and California Endowment, we recruited three small garment shop owners that agreed to install our modifications (at no cost to them). Over a twelve-month period, we were able to demonstrate a significant reduction in musculoskeletal symptoms among 40 garment workers. As a result of these findings, the Oakland City Council has appropriated \$25,000 for a chair-lending program for garment factories in the Bay Area. This program has achieved broad recognition both locally and nationally (Appendix B17). Second, we quickly identified that garment workers lacked basic understanding of ergonomic principles and steps that they could take to improve their working conditions. As a result, we developed and conducted an ergonomics training program that included over 200 garment workers from over 20 factories in the Oakland Chinatown area. The community-based organization is now using this information as the basis for an ergonomics training video that is used in English as a Second Language classes (*"Mending the Pain"*).

Utilizing our data and experience from the Oakland Chinatown intervention activities, the CTS project staff initiated a large NIOSH-funded prospective intervention study in collaboration with the University of California, Los Angeles School of Public Health and the UC Berkeley/San Francisco Ergonomics Program. In this study, a formal evaluation was conducted of the effectiveness of ergonomic interventions among a total of 230 workers recruited from 9 garment shops in Los Angeles. This study was the largest to date of ergonomic interventions in the garment industry, and provided important

information about the use of simple, low-cost interventions to reduce the incidence of UEWRMSDs in this population.

d. Janitors

FINDINGS: The CTS surveillance program sampled a total of 109 CTS cases among janitorial workers, representing 327 total cases. There are approximately 266,000 janitorial workers in California, most non-English speaking immigrant workers with few benefits and poor working conditions. In collaboration with the UCSF Nursing Program, we received funding from the California Commission on Health and Safety and Workers Compensation (CCHSWC) for a three-year study to assess the extent of health and safety hazards in this industry. A total of ten janitorial work sites were investigated to determine the extent of both ergonomic and chemical hazards. Additional employers and key informants were interviewed, including industry organizations, government officials, and community organizations (such as the Maintenance Cooperation Trust Fund, a statewide watchdog organization in the janitorial industry concerned with the health and safety of custodians). Standardized questionnaires (Appendix B18) were developed and administered to employers, workers and industry organizations to collect additional information on the industry and barriers to health and safety programs. Numerous risk factors for musculoskeletal injuries have been identified in janitorial work, including poorly designed cleaning equipment, awkward postures and highly repetitive work.

INTERVENTION: CTS staff presented their findings and recommendations to instructors at the San Francisco City College Custodial Training Program, and taught several health and safety classes to the students in this program. A report was prepared describing the characteristics of this industry, the health and safety conditions at the ten work sites, barriers that employers and workers face in understanding health and safety, and prevention strategies for reducing CTS and other musculoskeletal injuries. This report was presented to CCHSWC.

PUBLICATIONS

- Chan, et al, Preventing Musculoskeletal Disorders in Garment Workers: Preliminary Results Regarding Ergonomics Risk Factors and Proposed Interventions Among Sewing Machine Operators in the San Francisco Bay Area. American Conference of Governmental Industrial Hygienists (ACGIH) Journal, August 2001.
- Meyers, et al, Predicting Adoption of Effective Safety Interventions, Paper T-5, Proceedings of the Summer Conference of the National Institute for Farm Safety, June, 2002

MATERIALS AVAILABLE FOR OTHER INVESTIGATIONS

Garment Worker Fact Sheet

The project published an ergonomics fact sheet for sewing machine operators. The fact sheet focuses on best practices for both employers and employees and has been translated into Spanish and Chinese. We also developed a 4-page pamphlet describing

the preliminary results of the project. In addition, we have produced a step-by-step instruction manual on how to make the interventions. Both have been translated into Chinese and were disseminated statewide.

Newsletter

OHB staff developed a newsletter for regular distribution to all clinicians who have reported cases to the CTS surveillance project, community groups, public health agencies, and the list of recipients described below.

Update of CTS booklet

Staff updated a 1990 general booklet on CTS in English. A Spanish version was also developed. This booklet was sent out to all cases that received follow-up.

Office Ergonomics Fact Sheet

Project staff and UCSF developed an office ergonomics fact sheet and disseminated it. The fact sheet provides recommendations which improve a worker's reach, vision, and support while using the computer. Poor reach, vision, and support often result in musculoskeletal disorders while performing computer work tasks. CTS cases received this fact sheet as part of their educational package.