Concurrent Medical Disease in Work-Related Carpal Tunnel Syndrome

Steven G. Atcheson, MD; John R. Ward, MD; Wing Lowe, PhD

Background: Work-related carpal tunnel syndrome (CTS) now accounts for more than 41% of all repetitive motion disorders in the United States. Carpal tunnel syndrome is also associated with obesity and many different medical diseases.

Patients and Methods: Two hundred ninety-seven patients medically certified with a work-related upper extremity industrial illness underwent a systematic search for concurrent medical diseases. Diagnoses of CTS were made using 4 separate case definitions.

Results: One hundred nine separate atraumatic illnesses (mainly hypothyroidism, diabetes mellitus, and various arthropathies) capable of causing arm pain or CTS were diagnosed in a third of all patients. Using record reviews and patient histories alone, 68% of these conditions would have been missed. One hundred ninety-eight patients had been diagnosed as having CTS 420 times in more than 1000 office visits, but diagnostic laboratory studies were ordered only 25 times. Every case definition of CTS was significantly associated with a related medical condition. Two definitions yielded more than 41% prevalence of concurrent disease (odds ratio, ≥2.36; P≤.004), and up to two thirds of these patients had either a medical disease or were obese (odds ratio, ≥3.15; P≤.001). Two cohorts totaling 114 patients (38%) working for companies employing nearly 19 000 people included all CTS claims filed during 2 evaluation periods. They did not differ from the other patients with CTS with respect to age, concurrent disease, or obesity.

Conclusions: Routine patient histories and record reviews are inadequate for proper evaluation of work-related CTS. Unrecognized medical diseases capable of causing CTS are common. Studies asserting an association between occupational hand usage and CTS are of questionable validity unless they prospectively account for confounding disease and obesity.

Arch Intern Med. 1998;158:1506-1512

Influential studies1-3 published in the last 2 decades concluded that repetitive or forceful hand use causes a variety of upper extremity workplace ailments, including tendinitis, tenosynovitis, and carpal tunnel syndrome (CTS). By 1985, the National Institute of Occupational Safety and Health had declared that there were “traumato-gens” in the workplace capable of causing these afflictions, and mandated their reporting.4,5 Repetitive motion disorders (stresses and strains resulting from free bodily motion with no impact involved)6 were surveyed by the Bureau of Labor Statistics in 1992. Nearly 90 000 cases resulting in lost work time were found. Carpal tunnel syndrome was the most common disabling condition at 36% of the total, and resulted in more lost work (median, 32 days per case) than any other illness or injury reported in 2.3 million cases.6 The 1994 Bureau of Labor Statistics survey of injuries and illnesses7 showed that repetitive motion disorders had increased by just 3% over the 1992 figures, but cases of CTS resulting in lost work time had increased by 16%, and by then represented more than 41% of all repetitive motion disorders.

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In 1996 the American Public Health Association sent a letter to members of the US Senate stating that work requiring repetitive motion, heavy lifting, or awkward postures was the primary cause of cumulative trauma disorders such as CTS.8,9 The letter, signed by 160 occupational health professionals, further stated that there was a strong consensus in the scientific community based on an
extensive body of solid scientific evidence that ergonomic factors were mainly responsible for these injuries and illnesses.

The view that repetitive use is a major cause of CTS has been challenged for several years. His enormous experience with CTS spanning 3 decades persuaded Phalen\textsuperscript{10,11} that occupation was seldom more than an aggravating factor. Nonetheless, a 1989 survey reported that up to 47\% of all cases of CTS were believed to be caused by workplace factors.\textsuperscript{12}

Nathan and Keniston\textsuperscript{13} summarized several years of their research on CTS in workers’ compensation patients, industrial workers, and control populations in both the United States and Japan. Symptoms were correlated with the prevalence of slowing of median nerve conduction. They concluded that nonworkplace variables such as age, obesity, wrist dimensions, and physical inactivity were greater risk factors for developing median nerve slowing and clinical CTS than workplace factors such as repetitive or forceful hand use or duration of employment. Schottland and colleagues\textsuperscript{14} found that median nerve conduction latencies were no different in a group of poultry processing workers when compared with those merely applying for that work. Hadler\textsuperscript{15} summarized the world’s medical writings concerning occupational CTS, whereby he determined that all major studies invoking a cause-and-effect relationship between work and CTS were seriously flawed.

Many medical conditions, including diabetes mellitus, thyroid disease, wrist osteoarthritis, and any form of inflammation affecting the wrist joints or tendon sheaths, are said to be associated with CTS.\textsuperscript{10,11,16-22} Prior studies\textsuperscript{1,3,21,23-25} that asserted a cause-and-effect relationship between occupation and CTS excluded patients with confounding medical diseases principally by retrospective case reviews and patient histories. We hypothesized that many patients already medically certified with a diagnosis of work-related CTS in fact have an underlying medical condition that could cause these symptoms without respect to occupation. Therefore, we evaluated 297 consecutive patients referred with a diagnosis of work-related CTS or arm pain, and systematically searched the prevalence of slowing of median nerve conduction. They also evaluated the presence of these medical diseases.

PRIOR MEDICAL ENCOUNTERS

Overall, these 297 patients made more than 1425 physician visits (4.8 per patient) for the industrial injuries,
and saw 695 different physicians (2.3 per patient) before their comprehensive evaluation. One hundred twenty-five patients underwent at least 1 nerve conduction velocity study, but only 37 of 297 had any blood testing performed. One hundred ninety-eight patients had been diagnosed as having CTS 420 times the better-defined connective tissue disorders, rheumatoid arthritis, systemic lupus erythematosus, and spondyloarthropathy occurred in 4.4% of all 297 patients. Twelve patients met our criteria for an unclassified inflammatory disease. Seven additional patients had arm pain or CTS-like symptoms and 2 of 4 showed abnormal results of the “arthritis” blood tests (ie, antinuclear antibody, rheumatoid factor, erythrocyte sedimentation rate, C-reactive protein, anemia of chronic disease, leukopenia, abnormal platelet count, or abnormal serum complement (4 points maximum)).

One new diagnosis of diabetes mellitus was made. The 17 patients with diabetes had a mean age of 49 years, and had been diabetic an average of 7.4 years (the incidence of CTS and other hand problems increases with the duration of diabetes).

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ASSOCIATED MEDICAL DISEASES AND CONDITIONS

Concurrent medical conditions were common among all 297 patients, not just those with CTS. One hundred nine separate diseases or illnesses capable of causing arm pain, CTS, or median neuropathy were identified in 98 patients (33%). Only 35 patients (11.8%) knew that they had any of these conditions. Table 2 segregates these conditions into 4 broad categories. Two metabolic diseases—hypothyroidism and diabetes mellitus—were the most prevalent, with either or both present in 33 patients.

Of 7 patients receiving chronic thyroid replacement therapy for hypothyroidism, 5 still had elevated thyrotropin levels. Thirteen new diagnoses of hypothyroidism were made after the claim was filed. The mean age of these 18 patients was 41 years. The mean thyrotropin value was 39.4 mU/L and the mean thyroid level was 58 nmol/L (reference range, 59-148 nmol/L), with a good matched thyrotropin correlation ($r = -0.603; P = .04$).

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ASSOCIATIONS OF DISEASE AND OCCUPATION WITH CTS

We tested each CTS case definition for associations with medical disease, obesity, age, sex, and each of the 9 job categories, using those not diagnosed as having CTS as internal controls.

Medical diseases and obesity were significantly correlated with CTS diagnoses (Figure 1). Combining all medical diseases resulted in a powerful variable, such that any CTS diagnosis was strongly associated with any disease. Combining medical disease or obesity into 1 variable produced striking associations with all 4 ways of diagnosing CTS (Figure 2, top). Figure 2 also depicts the different proportions of disease and obesity in the 4 CTS categories. Medical diseases were 40% to 75% more common in those with CTS than in the control groups. In 2 categories, about two thirds of the patients with CTS had a concurrent medical disease or were obese (odds ratio,
We analyzed the association between work and CTS. Because we had no category of patients who were not working, we could measure only the correlations with a specific job category compared with any or all the others. The industrial category was used as the baseline job category. Figure 1 shows odds ratios for 5 occupations.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Diseases Known to All Patients (N = 297)</th>
<th>Diseases Finally Diagnosed in All Patients (N = 297)</th>
<th>Diseases in Those Meeting the NIOSH CTS Case Definition (n = 193)</th>
<th>Diseases in Those Meeting Paired Clinical CTS Definition† (n = 96)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic</td>
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<td>41 (13.8)</td>
<td>31 (16.1)</td>
<td>17 (17.7)</td>
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<tr>
<td>Hypothyroidism‡</td>
<td>5 (1.7)</td>
<td>18 (6.1)</td>
<td>12 (6.2)</td>
<td>7 (7.2)</td>
</tr>
<tr>
<td>Diabetes mellitus‡</td>
<td>16 (5.4)</td>
<td>17 (5.7)</td>
<td>14 (7.3)</td>
<td>9 (9.3)</td>
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<tr>
<td>Gout</td>
<td>3 (1.0)</td>
<td>3 (1.0)</td>
<td>2 (1.0)</td>
<td>...</td>
</tr>
<tr>
<td>Other§</td>
<td>1 (0.3)</td>
<td>3 (1.0)</td>
<td>3 (1.6)</td>
<td>1 (1.0)</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>8 (2.6)</td>
<td>33 (11.1)</td>
<td>24 (12.4)</td>
<td>15 (15.6)</td>
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<tr>
<td>Unclassified†</td>
<td>...</td>
<td>12 (4.0)</td>
<td>10 (5.1)</td>
<td>5 (5.2)</td>
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<td>Spondyloarthropathy¶</td>
<td>3 (1.0)</td>
<td>7 (2.4)</td>
<td>4 (2.1)</td>
<td>3 (3.1)</td>
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<td>Rheumatoid arthritis</td>
<td>...</td>
<td>5 (1.7)</td>
<td>3 (1.6)</td>
<td>2 (2.1)</td>
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<td>Seronegative arthritis</td>
<td>2 (0.6)</td>
<td>5 (1.7)</td>
<td>3 (1.6)</td>
<td>2 (2.1)</td>
</tr>
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<td>Raynaud phenomenon/SLE</td>
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<td>4 (1.3)</td>
<td>4 (2.1)</td>
<td>3 (3.1)</td>
</tr>
<tr>
<td>Osteoarthritis/degenerative</td>
<td>2 (0.6)</td>
<td>35 (11.7)</td>
<td>23 (11.9)</td>
<td>14 (14.5)</td>
</tr>
<tr>
<td>Wrist§</td>
<td>1 (0.3)</td>
<td>18 (6.1)</td>
<td>12 (6.2)</td>
<td>8 (8.3)</td>
</tr>
<tr>
<td>Finger**</td>
<td>1 (0.3)</td>
<td>7 (2.4)</td>
<td>4 (2.1)</td>
<td>3 (3.1)</td>
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<td>...</td>
<td>4 (1.3)</td>
<td>2 (1.0)</td>
<td>2 (2.1)</td>
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<tr>
<td>Elbow</td>
<td>...</td>
<td>3 (1.0)</td>
<td>2 (1.0)</td>
<td>...</td>
</tr>
<tr>
<td>Other‡‡</td>
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<td>3 (1.0)</td>
<td>3 (1.6)</td>
<td>1 (1.0)</td>
</tr>
<tr>
<td>Acute trauma/RSD</td>
<td>...</td>
<td>29 (9.8)</td>
<td>9 (4.6)</td>
<td>4 (4.2)</td>
</tr>
<tr>
<td>Wrist</td>
<td>...</td>
<td>15 (5.1)</td>
<td>7 (3.6)</td>
<td>3 (3.1)</td>
</tr>
<tr>
<td>Hand/forearm/elbow</td>
<td>...</td>
<td>8 (2.7)</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>RSD (5 with acute trauma)</td>
<td>...</td>
<td>6 (2.0)</td>
<td>2 (1.0)</td>
<td>1 (1.0)</td>
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<tr>
<td>Total Medical Diseases</td>
<td>35 (11.8)</td>
<td>109 (36.7)</td>
<td>78 (40.4)</td>
<td>46 (47.9)</td>
</tr>
</tbody>
</table>

*CTS indicates carpal tunnel syndrome; NIOSH, National Institute of Occupational Safety and Health; ellipses, not applicable; RSD, reflex sympathetic dystrophy; and SLE, systemic lupus erythematosus. Values are numbers (percentages) of each column total.

‡‡One patient each with large wrist cysts, lymphedema following mastectomy, and congenital wrist atrophy.

¶One patient with known psoriasis, 2 with known inflammatory bowel disease; none had been diagnosed previously as having spondyloarthropathy, psoriatic arthritis, or enteritis-associated arthritis.

#Includes pantrapezial joints. Six patients had associated arthritis of the fingers, 1 had elbow disease, and 1 had a cervical spondylitis.

‡Includes wrist disease; 1 patient had elbow osteoarthritis.

††One patient with wrist and elbow osteoarthritis.

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ARCH INTERN MED/VOL 158, JULY 27, 1998

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Table 2. Associated Disease in 297 Patients Diagnosed as Having Work-Related Arm Pain or CTS*

We identified 2 cohorts of claimants that included all CTS claims filed during 2 evaluation periods. There were 114 patients (38.4% of the total) of a pool of 18975 employees working for 19 different companies. The annual incidence of CTS claims was 1.23 and 1.49 per 1000 employees, respectively, compared with 1.74 paid CTS claims per 1000 full-time employees reported in Washington State in the middle of the 1980s. A community incidence of 0.99 cases of CTS per 1000 residents was calculated for Rochester, Minn. We compared the patients in our complete CTS cohorts with the remaining patients and found no significant differences among the groups with respect to CTS diagnoses, disease, obesity, or age.

**REFERRAL BIASES**
Two hundred eighty-four (96%) of 297 patients were referred by 5 separate companies. There was no correlation between referral source and presence of concurrent disease ($P = .86, \chi^2$ test). The prevalence of diseases ultimately diagnosed was not dependent on the number of physicians previously seen, the total number of physician visits, or the date the patient was evaluated. A patient with 1 prior CTS diagnosis was as likely to have a concurrent disease as another patient with more than 1 previous diagnosis.

Our mean patient age was 40 years, 83% aged 25 to 54 years compared with 80% aged 25 to 54 years in the 1992 Bureau of Labor Statistics survey of repetitive motion injuries.6 Seventy-seven percent of our patients were female compared with 65% in the 1992 study. Phalen10,11 found that 26% of his 823 patients had a specific systemic inflammatory or metabolic disease (eg, diabetes mellitus, myxedema, gout, inflammatory arthritis, or connective tissue disease). Of our patients (depending on the CTS definition), 28% to 31% had these same conditions. In a 1976 study of 1201 patients with CTS not selected for occupation, Posch and Marcotte17 found that 8% had diabetes or hypothyroidism, as did 12% of Phalen's patients. Of our patients with CTS, 12.4% to 14.6% had these 2 diseases. The Mayo Clinic reported on all 1016 residents of Rochester, with CTS diagnosed from 1961-1980.22,42 Of these patients, 6.1% had diabetes mellitus, 5.3% degenerative arthritis of the wrists, and 6.5% collagen vascular disease— all findings similar to ours. A recent study43 of patients surgically treated for CTS, which included workers' compensation patients, reported that 32 (36.4%) of 88 subjects had 1 of the medical diseases that we found.

Our study population was selected exclusively for work-related arm pain, yet had a prevalence of nontraumatic medical conditions similar to that in the general community. If occupational hand usage was a significant independent predictor of CTS, we should have found less medical disease in our patients.

Concurrent medical disease is given only brief mention in writings on work-related CTS.1,2,21,23 A study of CTS in supermarket workers25 found several subjects with preexisting medical conditions such as diabetes mellitus or hypothyroidism, but those authors thought that the physical demands of the job were more important in causing CTS.

Chart reviews and routine questionnaires are inadequate. Using historical information alone, we would have missed 74 (68%) of 109 diseases eventually diagnosed. Future studies of work-related CTS should account for confounding diseases in a prospective manner, using specific diagnostic criteria.

Many of our patients' jobs reportedly increase the risk for developing CTS.123,44,46 We lacked a control group

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**Figure 1. Odds ratio of separate disease and occupation categories in patients with carpal tunnel syndrome (CTS) defined 4 ways. All odds derived from multivariate logistic regression model. Industrial vs all nonindustrial. All other occupations are vs industrial. Each horizontal bar shows the exact odds with the 95% confidence interval. NIOSH indicates National Institute of Occupational Safety and Health.**

**Figure 2. Disease or obesity in work-related carpal tunnel syndrome (CTS). Odds ratios and $P$ values are calculated using multivariate logistic regression analysis. Age, sex, and each separate job category (vs industrial) included as variables. NIOSH indicates National Institute of Occupational Safety and Health; CI, confidence interval.**

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**Table 1. Odds Ratios of Disease or Obesity in CTS (Exact Odds With 95% CI)**

<table>
<thead>
<tr>
<th>Case Definition</th>
<th>No. of Prior Diagnoses</th>
<th>CTS CTS CTS CTS</th>
<th>NIOSH Criteria</th>
<th>Posch and Marcotte17</th>
<th>Paired Clinical Criteria</th>
<th>Examiner's Assessment</th>
<th>P&lt;.001</th>
<th>P&lt;.006</th>
<th>P=.00</th>
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<tr>
<td>0</td>
<td>199</td>
<td>No Yes No Yes No</td>
<td>3</td>
<td>104</td>
<td>170</td>
<td>127</td>
<td>201</td>
<td>96</td>
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<tr>
<td>1</td>
<td>198</td>
<td>No Yes No Yes No</td>
<td>2</td>
<td>101</td>
<td>170</td>
<td>127</td>
<td>198</td>
<td>96</td>
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<td>193</td>
<td>No Yes No Yes No</td>
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<td>3</td>
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<td>193</td>
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<td>170</td>
<td>127</td>
<td>201</td>
<td>96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
of patients who were not working, so we could not test the total effect of work as an independent variable. We also did not perform any job-site task analyses. This was not a study of hand usage and CTS. We simply grouped the various jobs into certain categories because of previous assertions and widely held beliefs that certain occupations increase the risk of developing CTS. Data entry work is assumed to be highly repetitive, a type of hand usage said to be a risk factor for CTS. In Nevada, the judiciary decided that CTS is an occupational disease in professional “21” dealers. Workers in supermarkets, regardless of specific tasks, are reportedly at high risk for CTS. We expected to find some interaction between occupation and disease that would strengthen the associations with CTS. None was found in any of the 4 CTS diagnostic groups, suggesting that disease and occupation are independently associated with CTS.

We doubt that referral bias is an important confounder of our data. Nearly 40% of our patients included all CTS claimants working for 19 companies. The patients with CTS in these 2 comprehensive cohorts were little different with respect to nonoccupational risk factors from the remainder.

Previous studies diagnosed work-related CTS using a variety of clinical and electrodiagnostic criteria. Two of our CTS case definitions used available electrodiagnostic data and a third used clinical findings only. The fourth definition (National Institute of Occupational Safety and Health) can be fulfilled with or without electrodiagnostic tests. Electrodiagnostic validation of the National Institute of Occupational Safety and Health criteria and paired clinical criteria similar to ours have been published and found to be unsuitable for use in screening most populations at risk for CTS.

Despite using these disparate definitions of CTS, with a resultant wide prevalence spread (from 32%-67% of the patients), we still found uniformly strong associations with medical disease and uniformly weak ones with occupation.

Obesity, female sex, and increasing age are associated with CTS, as we also found (Figure 1). We used a body mass index (a measure of weight in kilograms divided by the square of the height in meters) of 30 kg/m² or more to define obesity. Other studies found significant correlations with CTS at lesser body mass index levels. Most studies of occupation and CTS did not account for obesity. More recent studies looked at this association and found significant correlations.

Articles on CTS often list many associated medical conditions, but a cause-and-effect relationship for all these diseases and CTS has not been proved. Diabetes mellitus is listed as a cause of CTS by some, but only as a predisposing condition by others. We addressed this issue by deciding in advance that those medical conditions reported associated with CTS or median neurophy, or known to involve the wrist joints or tendons, would qualify for inclusion as a concurrent disease in this study.

We did not evaluate several variables reported in other studies to be associated with CTS, including size of wrist, physical activity, cigarette smoking, use of oral contraceptives, and menstrual disorders. There are no studies evaluating associations among all reported nonoccupational factors and work-related CTS, as recently emphasized by Armstrong and Martin.37 This was an observational study, and our methods of analysis limited the scope of our conclusions. We could only report the relative strength of the associations between disease, obesity, or occupation and CTS. We could not measure absolute risk and we cannot assert a true cause-and-effect relationship. Overdiagnosis of concurrent disease in patients with CTS would overstate our conclusions. Diagnosis of connective tissue diseases such as rheumatoid arthritis and the spondyloarthropathies is often uncertain, as reflected in our 12 patients with unclassified inflammatory disease.

There seemed to be an assumption by most practitioners that their patients had work-related carpal tunnel disease, rather than a syndrome. The treating or consulting physicians seldom sought nonoccupational explanations for suspected CTS. Writings on CTS discourage attempts to diagnose concurrent medical disease. An essay on CTS states that “the vast majority of sufferers will not have any relevant associated disease.” A text on occupational injuries admonishes the reader that “hematologic tests are often ordered, but they are not warranted except in specific cases.”

The nature of the workers’ compensation system itself reinforces this incomplete approach to the diagnosis of arm pain. A physician who orders laboratory tests to determine whether a worker has CTS is likely to not get paid by the compensation carrier, who will argue that the visit was not related to the occupational illness. If an underlying medical disease is diagnosed, the patient’s compensation claim might well be rejected.

The debate concerning whether certain occupations actually cause repetitive motion disorders is now well over a century old and far from settled, as so thoroughly documented by Dembe. In the dual care system available to employees in the United States, a physician treating a patient for a presumed occupational illness may be contractually unable to provide any care for nonoccupational conditions. Workers’ compensation policies provide first-dollar coverage with no out-of-pocket expense to the patient. Physician and patient alike are induced to assert that the job is the dominant cause of the symptoms so the patient can continue treatment sponsored by an insurance system especially unsuitable for the care of chronic medical illnesses.

This study reported data on 297 people concerned with their arm pain to see a physician. Each had a unique story, but many were worried about their futures. Consider this 59-year-old woman: at the same job for 38 years, she was told by her workers’ compensation physician that she was permanently disabled from her work because of her industrial CTS. She desperately wanted to continue working. Her serum thyrotropin level was later found to be 24 mU/L. Should her physician have treated both the hypothyroidism and the CTS symptoms, and then help her decide about future work? There is no evidence that successful treatment of CTS precludes such a patient from returning to her previous job.

The physician who fails to determine if a claimant’s wrist pain or hand numbness could result from a
treatable medical condition may ultimately cause physical or economic damage. Carpal tunnel syndrome occasionally causes permanent harm, so research into workplace factors that might induce or aggravate this condition is important. We believe that the physician should first consider known n workplace factors before electrodiagnostic studies are ordered. Those with work-related arm pain would be better served if their physicians used a traditional approach to the differential diagnosis of CTS.

Accepted for publication October 9, 1997.

Philippe Gaillard performed the initial statistical analyses. Stanley J. Bigos, MD, suggested a number of improvements to the manuscript. We owe special thanks to Norrin M. Hadler, MD, whose critical review allowed us to do better justice to both the intents and the results of this study.

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REFERENCES