Hand and Wrist Disorders Among U.S. Poultry Processing Workers

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Abstract
It is not uncommon for food processing workers to have complaints of musculoskeletal disorders such as carpal tunnel syndrome (CTS) within a short period of being hired. It is often difficult to determine if such conditions are caused by the new work or are pre-existing conditions. The purpose of this study was to determine the prevalence of abnormal median nerve conduction and CTS among newly hired poultry processing workers. Hand symptom surveys assessing numbness, tingling, pain, and burning were administered. Nerve conduction studies of the median and ulnar nerves across the wrist were performed bilaterally on all new employees. Median mononeuropathy was defined as a peak median-ulnar latency difference of 0.6 ms or greater. The surveillance case definition for CTS included symptoms and nerve conduction studies indicating a median mononeuropathy across the carpal canal. Over a three-year period 2,387 newly hired poultry processing workers were evaluated. The prevalence of median mononeuropathy among men was and 12% and 9% in the right and left hands, respectively. And among women the prevalence of median mononeuropathy was and 20% and 17% in the right and left hands, respectively. Among the job applicants, 6 women and 9 men that had a median mononeuropathy indicated that they had symptoms consistent with CTS. Many workers at the time of hire appear to have objective evidence of abnormal median nerve conduction within the carpal canal. Few newly hired workers report characteristic CTS symptoms, including those with median mononeuropathy. Workers at the time of hire may not be forthcoming with regard to symptoms that indicate existing pathology.

Keywords: carpal tunnel syndrome, median mononeuropathy, food processing

Introduction
In terms of lost and restricted work days, surgery, rehabilitation, and retraining, one of the most costly disorders proposed to be associated with repeated trauma in the upper extremity is carpal tunnel syndrome (NCCI, 1991). If CTS is related to an employee's job, the employer in the United States often bares the burden of the costs through worker's compensation. These costs are in addition to the pain and suffering associated with the employees disability if the syndrome progresses to an advanced stage.

Nathan and Keniston (1993) suggested that in some industrial settings the duration of time between employment and the onset of CTS was too short to develop CTS as a result of occupational factors. Thus, pre-existing occupational or current non-occupational factors may have been causally associated with the development of CTS. Investigators have also reported major discrepancies between subjective CTS symptoms and the results of nerve conduction studies (Nathan and Keniston, 1993, Werner et al., 2001).

Because the diagnosis of CTS is based primarily on subjective reports of symptoms and subjective responses to clinical tests (provocative tests, vibration perception, current perception) sincere responses are required for an accurate diagnosis. Fearing employer reprisals, there is the potential for applicants with symptomology to deny or not be forthcoming with symptoms of pre-existing conditions like CTS or low back disorders. Employers may therefore be hiring workers with pre-existing medical conditions such as CTS and in some instances placing them in jobs that exacerbate their condition. Additionally, the employer is required to provide compensation to the employee if the condition is considered to be work-related.
The most widely accepted objective tests supporting or assessing the median neuropathy associated with CTS are electrophysiologic studies (Jablecki, 2002; Kimura, 1989; Remple et al, 1992; Stevens, 1987). Thus, at the time of employment, it may be beneficial to conduct CTS evaluations with nerve conduction studies to assess the integrity of the median nerve segment within the carpal tunnel. Nerve conduction tests at the time of hire may provide a baseline to assess dose-response relationships in longitudinal studies of risk factors for CTS. The purpose of this clinical investigation was to determine the prevalence of median nerve slowing across the carpal tunnel in applicants for industrial jobs.

Methods
Nerve conduction studies (NCS) were performed on both hands as part of a health assessment to applicants for jobs involved with poultry processing operations. Testing was performed following a conditional offer of employment but prior to the applicants job assignment at one of several processing areas in facility. All new applicants during a 3-year period were tested.
Each applicant completed a self-administered questionnaire (Rosecrance et al., 2002a) at the time of the health assessment. The questionnaire focused on hand symptoms that are commonly associated with CTS. Hand symptoms were coded as present if they were not caused by acute injury and had been present within the last two weeks. For surveillance purposes, an employee had symptoms consistent with CTS if they included numbness, tingling, pain/burning, or brachaligia paraesthesia nocturna localized to an anatomical area which included the median nerve distribution of the hand.
Nerve conduction studies were performed on both hands of each employee. Nerve conduction measurements were recorded with a Cadwell Sierra Wedge nerve conduction machine (Cadwell Labs, Kennewick, Washington). Mixed nerve latencies were determined over an 8 cm palmar segment for the median and ulnar nerves. Supramaximal stimulation was performed in the palm with a hand held bipolar stimulator. For sensory latencies, the recording electrode was eight centimeters proximal to the cathode of the bipolar stimulator. Median nerve latencies were measured with the active recording electrode placed over the median nerve two centimeters proximal to the distal wrist crease. The ulnar latency was measured with the active recording electrode placed two centimeters proximal to the distal wrist crease over the ulnar nerve. Sensory latency (peak latency) was determined as the time interval between onset of the stimulation artifact and the peak of the negative response. When median sensory responses were not obtained because of conduction blocks, median motor latencies were recorded. Median motor latencies were obtained by supramaximal stimulation of the median nerve 8 cm proximal to the abductor pollicis brevis. Motor latency was determined as the time between stimulation artifact and onset of the motor response. The choice of electrophysiologic NCS performed in this study was based on the practice parameters set forth by the American Association of Electrodiagnostic Medicine (Jablecki et al., 2002) and methods outlined by Anton and associates, (2002) and Roecrance and associates, (2002b).

Nerve conduction studies were performed by occupational health nurses trained and experienced in conducting the studies. Skin temperature was measured using a surface thermistor probe. Temperature was measured in the mid-palm and recorded prior to testing. Nerve conduction testing was performed in a warm room with the ambient temperature maintained between 21 and 23 degrees Celsius.
The primary electrophysiological measurement used to determine the prevalence of median nerve slowing was a comparison of the median nerve sensory latency to the ipsilateral ulnar nerve sensory latency. Thus, the median-ulnar latency difference in the right and left hands was used to determine the prevalence of median nerve slowing. The median ulnar latency difference was calculated by subtracting the ulnar sensory latency from the median sensory latency. Median nerve slowing was defined as a median ulnar latency difference of 0.5 ms or greater. This was chosen as a surveillance, rather than a diagnostic definition of median nerve slowing. A 0.6 ms difference was established because it represents a very conservative criterion for determining median nerve slowing within the carpal tunnel (Redmond and Rivner, 1988; Rosecrance et al., 2002). If a median sensory latency was not obtained because of a sensory conduction block, a median motor latency greater than 4.4 ms was used as the criteria for median nerve slowing.
Because the primary criteria for median nerve slowing was a comparison of the median and ulnar nerves, temperature correction was not performed on the latency values. The ulnar nerve served as an internal control for the median response. The median ulnar latency difference values were tested against a normal distribution with a mean and variance equal to the sample mean and variance.

Results
Over a three-year period 2,387 newly hired poultry processing workers (1695 men, 692 women) were evaluated. The average age was 32.0 years (SD, 11.3) and 33.1years SD, 9.9) for the men and women workers, respectively. Participation rate was 100% since the nerve conduction screening was part of the new hire process. Some applicants were excluded from the participating due to positive results to drug testing. Mean body mass index was 28 for men and 31 for women. The prevalence of median mononeuropathy among men was and 12% and 9% in the right and left hands, respectively. And among women the prevalence of median mononeuropathy was 20% and 17% in the right and left hands, respectively. Among the job applicants, only 6 (4.8%) women and 9 (4.8%) men that had a median mononeuropathy in either hand indicated that they had symptoms consistent with CTS in that hand.

Conclusions
Slowed median nerve conduction across the carpal tunnel in incumbent workers is reported to range between 3 and 49 percent (Bingham et al., 1996; Chaing et al., 1990; Franzblau et al., 1993; Nathan and Keniston, 1993; Nathan et al., 1988; Schottland et al., 1991; Werner et al., 2001). By definition, carpal tunnel syndrome is a condition primarily based upon neurological signs and symptoms and confirmed with nerve conduction studies. Median nerve conduction abnormalities within the carpal tunnel without symptoms do not necessarily constitute carpal tunnel syndrome. However, carpal tunnel syndrome in the face of normal electrodiagnostic findings has been reported and treated surgically (Grundberg, 1983).
While abnormal nerve conduction findings in the absence of symptoms do not represent clinical disease, prolonged latencies are objective evidence of segmental demyelination, axonal stenosis, or conduction block of large diameter axons (Kimura, 1989). Many of the

asymptomatic workers with abnormal nerve conduction tests in the present study may represent pre-symptomatic or asymptomatic neuropathy similar to the type of sub-clinical entrapment neuropathy described by Neary et al., (1975). Based upon our experience, asymptomatic workers with the most severe median nerve slowing are more likely to develop CTS with continued exposure to CTS risk factors (whether personal characteristics, occupational factors, or a combination).
Performing nerve conduction studies on applicants after a conditional offer of employment raises some important occupational issues. If the applicant with a positive NCS is eventually hired, will evidence of median neuropathy during application for employment be used by an employer to contest future CTS compensation claims? Additionally, if the applicant with a positive test is hired, placed in a job requiring repetitive hand intensive tasks, and develops CTS, can the employer be held liable for exposing an employee with significant median neuropathy to workplace hazards associated with CTS?
We conclude that a large percentage of applicants for food processing jobs have pre-existing median neuropathy within the carpal tunnel. It is quite likely that many employees diagnosed with carpal tunnel syndrome had the condition or its silent sub-clinical neuropathy before they began their employment. It is not known, however, whether their previous job tasks, recreational activities, personal characteristics, or a combination of these factors led to their condition. It is likely that CTS is a disease with multiple causality and that determining a single causative agent may be futile.

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