# IMPROVEMENT IN PERCEPTION OF TRANSCUTANEOUS NERVE STIMULATION FOLLOWING DETOXIFICATION IN FIREFIGHTERS EXPOSED TO PCBS, PCDDS AND PCDFS

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## ABSTRACT

Seventeen symptomatic firefighters with a history of polychlorinated biphenyls, acute exposure to dibenzofurans, and dibenzodioxins were evaluated for peripheral neuropathy with the Neurometer<sup>R</sup>, a transcutaneous nerve stimulation device utilizing a constant current sine wave at fixed amperage for the evaluation of peripheral neuropathy. Prior to treatment with the Hubbard protocol (a method of detoxification aerobic utilizing niacin. exercise. sauna. and polyunsaturated oils for mobilization and excretion of fatstored xenobiotics), five of the 17 had abnormal current perception threshold measurements. Following treatment, all showed improvement, with two studies returning to normal range. This data should further stimulate review of the neurotoxic effects of toxic chemicals which have, heretofore, been thought to be irreversible.

current perception threshold, detoxification, firefighters, Hubbard method, Neurometer<sup>R</sup>, PCBs, PCDDs, PCDFs, peripheral neuropathy.

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# INTRODUCTION

A wide variety of toxic chemicals are known to induce neuropathy. Solvents, organohalide pesticides, polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-p-dioxins (PCDDs), to name a few, have been shown to cause neurological damage even at low levels of exposure (1,2,3). The neurological damage caused by these chemicals has often been regarded as irreversible. Many patients do not note improvement even though the source of exposure has been removed.

This study details the progress of five individuals who had abnormal current perception threshold (CPT) measurements following toxic exposure to PCBs, PCDDs and polychlorinated dibenzofurans (PCDFs), who underwent detoxification treatment by the Hubbard method (4), and who subsequently demonstrated improvement in their CPT levels to various degrees.

## MATERIALS AND METHODS

#### Patients:

Seventeen firefighters with a history of acute exposure to PCBs, PCDDs and PCDFs were chosen for study. These men were part of a group of approximately 100 firefighters and police officers who responded to a fire involving a transformer explosion at the Louisiana State University on April 3, 1987. They were exposed to PCBs and their by-products both at the scene and throughout cleanup operations, during which time protective measures were inconsistently utilized or inadequate to prevent exposure to the above chemicals. Following the fire, several of the firefighters became ill. Twenty-one of the firefighters exhibited the effects of toxic exposure and were referred for evaluation approximately four to five months after the incident. Their symptomatology, physical findings, and test results were consistent with a diagnosis of acute toxic exposure. A thorough description of medical observations is the subject of a separate publication (Curtis et al., in preparation).

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Seventeen of the twenty-one firefighters were evaluated for sensory loss; ten of these had complained of symptoms of neuropathy such as numbness in the extremities, burning sensation, or tingling. One of these, Patient A, had sustained a whiplash injury several years prior to the exposure and noted the onset of paresthesia in the right arm and hand at that time. However, he reported that his symptoms had become worse following the 1987 fire. No objective findings consistent with neuropathy were documented on physical examination in any of these patients.

#### Neuropathy Evaluation:

Neuropathic evaluation was done using the Neurometer<sup>R</sup>, a constant current transcutaneous nerve stimulator. This device utilizes a constant current electrical stimulus in a sinusoidal wave form to stimulate the most distal regions of the nerves being tested. It is therefore able to detect peripheral neuropathy in its early stages. The test results are quantitative, the test itself non-adversive, and the device is portable and easy to use (5,6).

Neurometer tests produce quantitative assessments of the current perception thresholds (CPTs) of the subject. In general, CPT measurements are obtained at three sites: the trigeminal, median, and peroneal nerves. At each site, the CPT value is determined for each of three frequencies -- 5 Hz, 250 Hz, and 2,500 Hz. These data are then analyzed by two methods. First, the CPT range analysis compares the CPT measurement of the patient to the CPT values obtained from a control population of 60 healthy individuals. Range analysis ratings are determined as described in Table 1. Secondly, the CPT ratio analysis compares the ratios of readings from various sites to these same ratios obtained from the control population. Ratio analysis ratings are determined as described in Table 2.

#### Detoxification Treatment:

Patients were treated using the Hubbard method of detoxification, a natural method of treatment designed to enhance mobilization of fat-stored xenobiotics, to efficiently distribute these released toxicants to channels of excretion, and to enhance excretion through any of This is accomplished using several natural routes. precisely controlled niacin dosages to enhance lipid mobilization, exercise to increase blood flow to all areas of the body, extensive low temperature sauna to induce sweating (2.5 to 5 hours per day at 140 to 180° F.), cold-pressed polyunsaturated oils to reduce enterohepatic recirculation and to increase lipid turnover, adequate water, potassium, and salts to replace those lost through profuse sweating, and vitamin and mineral supplements to protect the body and maintain a balanced dosage of nutrients (4). Measurements of the levels of PCBs, PCBDs, and PCDFs in the blood will form the basis of a further paper.

## RESULTS

The seventeen firefighters participating in this study were evaluated at the trigeminal, median and peroneal nerves using the Neurometer. Five of the men tested demonstrated abnormal results consistent with moderate to severe neuropathy (Tables 1 and 2). This level of aberration represents a statistically-significant deviation (p < 0.005) from a healthy population.

Of the five patients exhibiting abnormal CPT results, one (Patient A) had a history of a cervical injury several years prior to exposure. Symptomatology of these patients was consistent with the CPT findings. Headaches, decreased attention span, fatigue and decreased mental acuity were noted by all five patients with positive CPT findings, while numbness in extremities, muscle weakness and dizziness were noted by four of the five.

Subsequent to neuropathic evaluation, all of the men underwent detoxification treatment utilizing the Hubbard regimen (see Materials and Methods). Following treatment, all five patients with abnormal initial Neurometer results were retested. All five experienced subjective improvement and all showed improvement in their CPTs following detoxification.

Two of the patients showed marginal improvement (Patients A and B; Tables I and II); one of whom (Patient A) had incurred spinal trauma predating his toxic exposure. This individual's symptoms of neuropathy also predated the exposure. One patient (Patient C) showed moderate improvement. The most striking result is that two of the patients (D and E) returned to the normal range.

#### DISCUSSION

In this paper, we present data supporting the concept that exposure to pyrolytic products had produced a significant decrease in the neurological health of this group of firefighters. This data is gleaned from measurements using the Neurometer, a relatively new device which is garnering a good reputation due to its ability to quantify the level of peripheral neuropathy.

The Neurometer has proven reliable in the diagnosis of both diabetic and alcohol-induced peripheral neuropathy (6). In addition, it has been demonstrated to be the superior analytical tool for the assessment of peripheral nerve integrity when monitoring the efficacy of dialysis in diabetic patients (7). These studies showed that the Neurometer is as accurate as the nerve conduction test and stimulates a much higher compliance rate due to its non-invasive nature. This is important with this patient population as the assessment of peripheral neuropathy is one of the key elements in diagnosing inadequate hemodialysis (7).

Measurements of the CPT levels of the seventeen firefighters participating in this study show a statisticallysignificant deviation (p < 0.005) from a healthy

# Table 1 CPT Range Analysis Ratings \* Before and After Detoxification

Trigeminal					Median				Peroneal			
Patient		** h	m	1	h	m	1		h	m	1	
a	pre	0	+1	+3	0	0	+3		0	0	0	
	post	0	0	+3	0	+1	+2		0	0	0	
b	pre	0	0	0	0	0	+3		0	0	0	
	post	0	0	0	0	0	+2		0	0	0	
c	pre	0	0	0	+1	+1	+2		0	0	0	
	post	0	0	0	0	0	+1		0	0	0	
d	pre	+3	0	0	0	0	0		0	+1	0	
	post	+1	0	0	0	0	0		0	0	0	
e	pre	0	0	0	0	0	+2		0	0	0	
	post	0	0	0	0	0	0		0	0	0	

CPT Range analysis ratings are determined as: 0 = within healthy range +1 = CPT measure 2-3 Standard Deviations (S.D.) above the mean +2 = CPT measure 3-4 S.D. above the mean +2 = CPT measure 4-5 D above the mean

+3 = CPT measure >4 S.D. above the mean

h = Stimulus at 2000 Hz m = Stimulus at 250 Hz

1 = Stimulus at 5 Hz

# Table 2 CPT Ratio Analysis Ratings \* Before and After Detoxification

Trigeminal			Median			Peroneal					
Patient		h:l	h:m	m:l	h:l	h:m	m:l	h:l	h:m	h:1 *	
a	pre	2	0	2	1	0	0	0	0	0	
	post	2	0	2	0	0	0	0	0	0	
b	pre	0	0	0	2	0	1	0	0	0	
	post	0	0	0	0	0	0	0	0	0	
с	pre	0	0	2	0	0	0	0	0	0	
	post	0	0	2	0	0	0	0	0	0	
d	Dre	0	0	0	0	0	0	0	0	0	
	post	0	0	0	0	0	0	0	0	0	
e	pre	0	0	0	2	0	0	0	0	0	
	post	0	0	0	0	0	0	0	0	0	
B. I	Between Sites Rat	tios									
Med/Trig				Per/Tri	g		Per/Me	Per/Med ***			
Patient		h:h	m:m	1:1	h:h	m:m	1:1	h:h	m:m	1:1	
a	pre	0	0	0	0	0	0	0	2	0	
	post	0	0	0	0	0	0	0	2	0	
ь	pre	0	0	0	0	0	0	2	0	0	
	post	0	0	0	0	0	0	0	0	0	
С	pre	0	0	0	0	0	0	0	2	0	
	post	0	0	0	0	0	0	0	0	0	
d	pre	1	1	0	0	0	0	0	0	0	
	post	0	0	0	0	0	0	0	0	0	
e	pre	0	1	0	0	0	0	0	0	0	
	post	0	1	0	0	0	0	0	0	0	
* CPT Ratio analysis ratings are determined as:				**			***				
0 = no detection of abnormality (range is >3.5 S.D.)				h = st	imulus at 2	000 Hz	Med = Median				
1 = ratio is within 10% above the healthy range					m = s	m = stimulus at 250 Hz			Tri = Trigeminal		
2 = Ratio is greater than 10% above the healthy range				1 = sti	mulus at 5	Hz	Per =	Per = Peroneal			
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population. This level of neuropathy is consistent with the known exposure of these men to the PCBs, PCDDs, and PCDFs present at the site of a transformer explosion. Nervous system effects in this population are supported by the work of Kilburn and Warshaw. Utilizing a battery of neurobehavioral tests (8), these researchers have shown that there is a statisticallysignificant decrease in neurobehavioral health among These authors concluded that firefighters in general. firefighters as a group are subject to neurological damage from the multiple chemical exposures inherent in their profession; furthermore, the twenty-one firefighters referred for evaluation following this transformer incident have a statistically-significant decrease in neurobehavioral scores relative to firefighters in their own department who were not involved in this fire (9).

It is notable that the symptomatic complaints of these individuals had worsened over the four to five months following exposure, despite their removal from active participation in the fire department and, therefore, the lack of opportunity for re-exposure. Physical findings, such as skin lesions, had also continued through this period (Curtis et al., in preparation).

The firefighters were treated with the detoxification method developed by Hubbard. Previous studies have demonstrated the effectiveness of this program in the removal of polybrominated biphenyls, PCBs, pesticides and other compounds (10,11,12) from exposed individuals. This was, therefore, the method of choice following this exposure to PCBs and their pyrolytic products.

Subsequent to treatment, all of the firefighters demonstrated improvement in their CPT examination. This is consistent with the significant improvement in symptomatology noted for these individuals. Two patients showed slight CPT improvement, one showed moderate CPT improvement with post-treatment scores close to the normal range. Two of the individuals demonstrated marked CPT improvement with posttreatment scores returning to the normal range (Tables 1 and 2).

The degree of improvement in the CPT levels may be related to the original degree of injury. It should be noted that the two individuals returning to normal range had less severe initial findings. We would not, however, like to imply that the level of improvement possible in toxic exposure cases is limited. It is also important to note that one of the two cases demonstrating only slight improvement on detoxification had incurred prior traumatic nerve damage and demonstrated neuropathy prior to this toxic exposure incident.

## SUMMARY

A detoxification regimen that has been shown to remove or reduce the body burden of xenobiotics was shown to be efficacious in the remission of neuropathy. It is interesting to speculate that the continuing neuropathy observed following toxic exposure may, in some cases, be due to the persistence of these chemicals in the adipose tissue. Damage heretofore thought to be permanent may in many instances by partially reversible. Further study is merited to elucidate the degree of improvement possible for different pathologies through the simple expedient of removing persistent xenobiotics from the body.

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