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The neuropsychological diagnosis of chronic solvent induced encephalopathy (CSE)—A reanalysis of neuropsychological test results in a group of CSE patients diagnosed 20 years ago, based on comparisons with matched controls

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ABSTRACT

Aims: The aims of the study were to analyze the type and size of deficit scores and the weight attached to symptoms in the diagnostic process for a group of patients diagnosed as having chronic solvent encephalopathy (CSE) at a time when exposure levels were high and financial incentives for CSE-sufferers were almost non-existent.

Methods: Forty-eight patients referred for possible CSE and 144 age-matched referents were tested with neuropsychological tests. Symptoms were recorded using the Q16. The WHO 1985 recommendations were used when assessing the outcome of the test results. All the subjects were men in manual occupations.

Results: Thirty-five patients were diagnosed as having CSE; the remaining 13 not so. The tests for cognitive speed and attention were the ones that discriminated best between the patients with CSE and their referents. The effect sizes of the neuropsychological tests were small to moderate, and the largest effect size ($d = 0.81$) was found for the WAIS Digit Symbol. The effect size of the difference between the CSE-group and their referents in terms of self-reported symptoms was large ($d = 3.35$). For the non-CSE-group the differences between patients and referents were smaller and non-significant. However, the effect size in terms of symptoms was almost as large among the non-CSE-group as among the patients diagnosed as having CSE.

Conclusions: The patients reported many symptoms but the neuropsychological tests showed only slight to moderate impairment of function. The similarity of the large effect size for symptoms, but different effect sizes for neuropsychological tests results between the CSE-group and non-CSE-group suggest symptoms were (and still are) not very useful in the diagnostic process of CSE. Objective testing with neuropsychological tests is necessary for diagnosis of CSE.

1. Introduction

Long-term exposure to organic solvents can lead to chronic solvent encephalopathy (CSE). The term is often used synonymously with chronic toxic encephalopathy (CTE). Toxic encephalopathy can be caused by exposure to various substances, but exposure to organic solvents is the most common cause of this condition. Terms like organic solvent syndrome or chronic painter's syndrome have also often been used for the condition referred to in this paper as CSE. Clinically, CSE is characterized by symptoms such as irritability, fatigue, headache, sleep disturbances, lability of affect, lack of initiative, concentration problems and memory complaints (van der Hoek et al., 2000). The term "organic solvents" is used to classify chemical compounds or mixtures used to "extract, dissolve or suspend" non-water soluble materials such as fats, oils, lipids, cellulose derivatives, waxes, plastics and polymers. Most of these solvents are liquids, and many of them pass easily through intact skin. They are lipophilic with affinity for nerve tissue, are soluble in blood and pass rapidly through the membranes of the lung.

1.1. The diagnosis of chronic solvent induced encephalopathy

Neurobehavioral testing has played a central role in studying the adverse effects in humans exposed to neurotoxic substances at work (Anger, 1990). The Nordic countries were among the first to study the effects of solvents on aspects of intellectual functioning such as memory and concentration (Spurgeon, 2006). In 1976, Denmark became the first country officially to recognize the disease and began providing compensation for affected workers (Spurgeon, 2006).

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The "gold standard" for the diagnosis of CSE was set in the 1980s at two consensus meetings on criteria for the diagnosis of CSE. The "Copenhagen meeting" (WHO, 1985) came to terms with the following classification:

Type I: Organic affective syndrome;
Type II: Mild chronic toxic encephalopathy;
Type III: Severe chronic toxic encephalopathy.

The "Raleigh (North Carolina) consensus meeting" (Cranmer and Golberg, 1986) agreed on the following classification:

Type 1: Symptoms only;
Type 2A: Sustained personality or mood change;
Type 2B: Impairment in intellectual function;
Type 3: Dementia.

The WHO 1985 criteria have been applied in Norway for more than 20 years and during the 1980s the process of diagnosing CSE came close to the "WHO-gold standard". In 1994, the occurrence of the diagnosis in the Scandinavian countries was the highest in Europe, seen in relation to number of inhabitants (Triebig and Hallermann, 2001). In 1998, Sweden reported 48 cases and Denmark 50 cases (Triebig and Hallermann, 2001), while Norway reported about 100 cases (Leira et al., 2006), making Norway the country with the highest occurrence of the CSE diagnosis in Europe. In 2006 the number of reported cases was about 40 (Leira et al., 2006). Occupational exposure to organic solvents has decreased considerably in recent years, at any rate in Europe. In Norway, it is estimated that the exposure levels were roughly about 10 times higher in 1986 than in 2007 (Woldbæk, 2008, personal communication). These estimates are based on analyses of more than 11,000 samples of combined solvents with a sampling time exceeding 60 min, taken from the Norwegian Exposure Database (Rajan et al., 1997).

1.2. Suboptimal performance and motivational aspects of the neuropsychological examination

A neuropsychological examination is based on the assumption that the patient does his best. A patient who is tested to assess whether, for instance, he can keep his driver's licence will be highly motivated to perform at his best. However, when the neuropsychological examination is made in connection with a claim for financial compensation, the patient may fear that good test results might decrease the chance of being awarded payment.

In recent years attention has been drawn to the concept of cognitive malingering (Greve et al., 2006), or suboptimal performance (van Hout et al., 2003). Malingering can be defined as the intentional exaggeration or fabrication of illness or disability motivated by external incentive. Greve et al. (2006) estimated that indications of malingered cognitive dysfunction were found in from 30% to over 45% of subjects with an identifiable financial incentive. van Hout et al. (2003) reported that 46% of a group of solvent-exposed patients failed one of two tests for malingering, though only 18.6% failed both tests.

1.3. Financial compensation for occupational injury

During the last two decades many of the patients tested for possible CSE in Norway have had a financial incentive to be diagnosed as having the condition. Since 1990 there have been two systems of compensation for non-financial loss, for example reduced quality of life, caused by occupational injury/illness. In addition to the "old" system under the National Insurance Scheme, a new law ensures the worker much higher compensation (more than 10 times higher) in addition to that awarded from the National Insurance Scheme. Further more, the Occupational Injury Insurance Act ensures the patient compensation for the difference between presumed income and actual income as a result of occupational disease. Thus the economic benefits have become much more important in the diagnosis of CSE. The new system places greater focus on the role of the physicians and psychologists who are making the diagnosis, since this will have a marked influence not only on the treatment but also on the amount of money that the patients will receive, given that the patients are diagnosed as having an occupational injury or illness, and that the medical invalidity exceeds 15%.

1.4. The use of published norms versus control groups

Usually the clinician compares the test results with published norms. However, such norms can have weaknesses. Norms for neuropsychological tests are often based on small sample sizes and may include subjects of both genders and with different levels of education (Mitrushina et al., 1999). Heaton et al. (1991) reported that the diagnostic accuracy of neuropsychological tests is highly affected by the demographic variables age and education and, in the case of some tests, gender. Test norms that do not discriminate between different levels of age and education appear to be most appropriate for middle-aged individuals with an average level of education. Older subjects with a level of education lower than high school run a higher risk than younger patients do of being incorrectly classified as having cerebral impairment even though they are healthy. Younger subjects with higher education (at least a Bachelor's degree), more often will be classified as not having a cerebral impairment even when they have been diagnosed as brain-damaged (Heaton et al., 1991). Gade et al. (1988), illustrated this problem when they reanalyzed the test results for a group of CSE patients who had been given the diagnosis on the basis of a comparison with published norms. When the patients were compared with referents instead of with published norms, the evidence of impairment disappeared (Gade et al., 1988).

The aims of the study were to reanalyze the neuropsychological test results of a group of typical patients diagnosed as having CSE before the law ensuring workers with occupational diseases higher compensation became operative. Further, the aim was to compare the test results with those of a group of referents consisting of age-matched manual workers instead of with published norms. The test results were reanalyzed in terms of the type of and size of deficit scores. Further, the aim was to evaluate the weight attached to symptoms during the process of diagnosis.

2. Subjects and methods

During the years 1987–1989, 350 patients (317 men and 33 women) underwent a medical examination at the Department of Occupational Medicine at the National Institute of Occupational Health (NIOH), Oslo. (125 patients were examined in 1987; 111 in 1988; 114 in 1989.) Among these 350 patients, 188 (including 19 women) were examined with neuropsychological tests. Sixty patients who went through a neuropsychological examination had been exposed to other substances among which H_2S (16 patients) and formaldehyde (11 patients) represented the largest groups, and 19 solvent-exposed men had been diagnosed previously and went through a second examination. The remaining 109 patients (including 11 women) with possible CSE met to their first consultation at the outpatient clinic of the NIOH. Among the 98 male patients with possible CSE, every other male patient was randomly selected to be tested with the personality test Minnesota Multiphasic Personality Inventory (MMPI) (Dahlstrom et al., 1972;