THE EFFECT OF LOW LEVEL MERCURY EXPOSURE ON THE PSYCHOLOGICAL HEALTH OF DENTAL SURGEONS

and

RESEARCH PORTFOLIO

VOLUME ONE

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And Mercury conveyed them in a jar,
That friend of tricksters introduced by stealth
Disease for the apothecary's health,
Whose gratitude impelled him to proclaim:
"My deadliest drug shall bear my patron's name!" G.J.

Ambrose Bierce (1842-1914) *The Devil's Dictionary*

1. Major Research Project Literature Review

The effect of mercury exposure on psychological health:

A brief review

Prepared for submission to *Occupational and Environmental Medicine* (see Appendix A2)

ABSTRACT

Objectives: To summarise the biological effects of mercury (Hg), and to review the neuropsychological and emotional effects of mercury exposure in adult humans in 44 published group studies.

Method: Published articles were identified from indexed computer databases and other journal and textbook articles. Articles were inspected and data summarised in tables reproduced here.

Results: At urinary mercury levels (HgU) typical of mild occupational exposure (10-50 μg/l), below most recommended safety limits, about half of the studies examining memory found statistically significant deficits, with the same applying to attentional, motor and perceptual-motor tasks. At HgU above 50 μg/l, deficits also appear in about half the studies examining reasoning and perception. At HgU levels below 10 μg/l, some studies have found deficits, but overall results are inconclusive. Self-reports of emotional disturbance using well-standardised questionnaires show effects in about three-quarters of the studies where HgU is below 50 μg/l.

Conclusions: Recommended safety limits for mercury exposure may need to be re-examined, regular monitoring of mercury levels should be established for all mercury-exposed workers, and further studies of psychological effects are needed at mercury levels below 10-20 μg/l. There is also a need for longitudinal studies to assess recovery of function after exposure ceases.

KEY TERMS: mercury poisoning neurobehavioural mental health

Main Messages

- Mercury affects cognitive, motor and emotional function.
- Effects are often detectable within current recommended 'safe' levels of exposure.
- Standardised questionnaires of emotional disturbance may be more likely to detect effects at low mercury levels than formal performance tests.

Policy Implications

- Current recommended and legal limits for mercury exposure in the workplace may need to be re-examined, and perhaps lowered.
- Regular monitoring of workplace air and workers' body burden of mercury is highly desirable. This applies particularly to dental workers in Scotland, who currently have very infrequent monitoring on a volunteer basis.

Introduction

Mercury is one of the 'heavy metals', and is the only metallic element to be liquid at room temperature. It has many unusual physical and chemical properties which have lead to its extensive use in industry, science, medicine and agriculture. Mercury and its naturally occurring compounds have been known since ancient times, and were of particular interest in alchemy and early medicine. The properties of mercury which are most relevant to this review are its evaporation, its ability to form amalgams with other metals, and its toxic effects on biological systems. It evaporates slowly and the vapour is absorbed into the body by inhalation. It readily forms amalgams with other metals, and can used to extract them (e.g. in gold mining). Dental amalgam, the most familiar to us, is considered below, together with the biological effects of mercury.

Three Forms of Mercury

Mercury can be classified into three forms: -

(1) Elemental mercury, i.e. metallic mercury in liquid or vapour form or in amalgams. This is normally represented by the symbol Hg°.

(2) Ionic (inorganic) mercury: i.e. mercury salts, in which the mercury is present in the form of mercurous (Hg^{+}) or more usually mercuric (Hg^{++}) cations.[1]

(3) Organic mercury: where mercury is covalently bonded to a carbon atom. The most common examples of this are the alkyl compounds, notably methyl mercury (usually abbreviated MeHg, and usually referring to methyl mercury chloride).

[1] Some authors use the term 'inorganic' to include Hg^{0}

There is evidence that the three types differ in their ease of absorption into the body, and in their toxic effects [1,2].

Human Exposure

People exposed to mercury may include those involved in the industries listed in Table 1.1 (Appendix A1), and anyone directly using the mercury-containing products of these industries, or being exposed in the environment to the waste products of manufacture, usage, or disposal. People working in laboratories (including students and teachers) and hospitals may be exposed to mercury vapour from measuring instruments, including broken thermometers, and dental workers are exposed in dealing with amalgam. Dental amalgam is composed of silver, tin and other metals with 44-48% mercury [3] and provides the most common and continuous exposure to Hg° for most people, since mercury vapour is slowly released from dental fillings throughout their life, and rapidly during placement and removal. Mercury vapour is inhaled, and the rate of evaporation from fillings is increased markedly by chewing (e.g. [2] p.131). Hg° may be converted into MeHg by bacteria, both in the mouth (in small quantities) and in watercourses. The major source for ingestion of MeHg is fish, which absorb it through their gills from polluted water, or by eating smaller fish. Sources of air and water pollution include volcanic eruptions, effluent from industrial processes, the burning of coal, run-off from farming (pesticides and fungicides), inadequate disposal of batteries and light-fittings, and waste mercury from dental processes. The latter was a major contaminant of fresh water in Sweden, and has now been strictly controlled there and in Germany, although not in the U.K. The cremation of people with dental amalgam accounts for 1300 kg of mercury released into the atmosphere every year in Britain, some 11% of all mercury released by industry and power plants [4]. Mercury has

also been used in cosmetics (e.g. skin-lightening creams), contact lens solution, and some vaccines [5-7]. In Britain mercury compounds were widely used up to the 1950s in baby teething powders.

We are therefore all exposed to mercury in the environment. It has even been posited that there is a "mercury cycle", analogous to the nitrogen and carbon cycles. This background mercury level should be controlled for when assessing the level of mercury from occupational exposure. The estimated average daily retention of mercury from environment and food in the USA is 5.7 μg [8].

Toxicity and Recommended Maximum Exposure Limits

Maximum exposure limits change periodically, usually being revised downward, no doubt responding to decreasing public tolerance for industrial injury as well as to increase in knowledge of toxic effects. The effect on an individual will depend on the exposure level, the type of mercury (see above), the duration and pattern of exposure, and some properties of the individual (e.g. body weight, age, general health, and habits such as smoking). Recommended maximum exposure limits commonly refer to mercury in the air, since most industrial exposure is via inhalation. The UK Health and Safety Executive (HSE) limit for Hg^0 is currently 25 $\mu g/m^3$. Organic mercury compounds are regarded as more toxic than inorganic compounds or elemental mercury [2].

The level of mercury in the body is most conveniently measured by taking urine samples, and is usually reported in micrograms (μg) Hg per litre of urine. The W.H.O. proposed "threshold limit value" is 50 μg/l [9]. However, urine levels vary depending on how much

the urine is diluted. This can be controlled for by adjusting the specific gravity of the urine, or taking the ratio of mercury to another substance excreted, the usual one chosen being creatinine. The U.K. HSE "health guidance value" is 20 nmol/mmol creatinine, approximately equivalent to 44.5 μg/l urine in Ritchie et al.'s recent study [10]. (For equivalences of the various measures of Hg, see Table 1.2 in Appendix A1. For further discussion on toxicity see below).

Absorption of Mercury into the Body

Sources of mercury have been detailed above. The main route of absorption of elemental mercury (Hg°) into the body is by inhalation, the equilibrium between mercury in air and plasma being reached very quickly [1]. Hg° swallowed (e.g. during dental work) is not well absorbed and is mostly excreted, although of course this contributes to water pollution. Mercury salts and MeHg however are mainly absorbed via the digestive system, although in areas of high contamination they may be inhaled or possibly absorbed through the skin.

Distribution and Fate of Mercury in the Body

Once absorbed, mercury is distributed around the body by the blood stream. Hg° is transported mainly in the plasma [1,13] whereas 90% of organic mercury is transported inside red blood cells [1]. Hg° passes across the blood-brain barrier much more easily than ionic mercury [1], and cerebrospinal fluid concentrations are similar to plasma concentrations [13]. Once in the brain, Hg° is oxidised to Hg^{++} [1], as is MeHg [14] although more slowly. Higher concentrations of mercury are found in grey matter than white matter [1,15]. Mercury is found in all areas of the central nervous system, but

particularly in the cerebellum, spinal cord, and subcortical structures [1]. At a cellular level, MeHg concentrates particularly in glial cells and astrocytes [16]. Mercury also concentrates in other organs of the body, notably the kidneys and liver [1].

The half-life of mercury differs from organ to organ. For inorganic mercury, Foà ([1] p327) quotes 64 days for the kidney, and up to one year for the brain. It also varies for different forms of mercury, e.g. Charleston et al. [14] found half-lives of 38 days for MeHg and 200-500 days for inorganic mercury in monkeys. (This does not mean that MeHg is less dangerous, since it is more neurotoxic [2], and is also converted into inorganic mercury within the CNS, where it accumulates [14].) Anomalous results were found by Hursh et al. [17] who obtained a half-life of only 21 days for the human head, following radioactive Hg° inhalation.

Mercury is primarily eliminated from the body in urine, sweat and faeces, but can also be exhaled, and it is found in hair, nails and presumably also therefore in shed skin. (Since the average adult is said to shed 7 lbs. of skin per year, this may not be an insignificant method of excretion). Chelating agents such as DMPS (2,3-dimercaptopropane-1-sulphonic acid), which bind to mercury, can be used to assist elimination from the body [e.g. 18].

Biological Effects

Very small amounts of mercury damage the blood-brain barrier very quickly [1], allowing normally barred substances to cross. Mercury may also interfere with electrical properties of neurons, which may produce cognitive and motor effects [19]. These have been found in some workers exposed to mercury, and motor symptoms such as tremor are well-documented [1]. Mercury has a number of direct and indirect effects on the CNS at the cellular level, a few of which will be mentioned briefly here. MeHg severely inhibits oxygen uptake in neurons and increases production of oxidative free-radicals [20], probably by impairing enzyme function in mitochondria. Antioxidants can reduce the effects of MeHg in vitro [21]. MeHg and Hg^{++} also interfere with neurotransmitter release by affecting calcium channels [22]. Much research has focused on astrocytes which are ten times as susceptible to Hg^{++} as to MeHg [23]. [2]

Neuronal degeneration may continue long after initial exposure to MeHg. In Minamata Bay (Japan) in the 1950s over 2000 people were affected by eating seafood containing MeHg, many dying or suffering CNS damage [24]. Takeuchi et al. [25] found that after death the victims' brains weighed between 80 to 200 grams less than those of a control group, presumably resulting from cell death. At a neuroanatomical level, Hartman [2] reports on studies of MeHg, finding lesions in basal ganglia and cerebellum; and in cerebral cortex, including calcarine, pre- and post-central gyrii, and superior temporal gyrus (which are the primary projection areas for vision, movement, touch and hearing respectively). He contrasts this with lesions induced by inorganic mercury, which have been reported variously as uniformly distributed or as concentrated in occipital cortex and substantia nigra.

[2] For further information on neurotoxicology, see *Neurotoxicology* **17,** special issue on low levels of Hg.

Clinical Effects

Acute very high doses of Hg° cause lung and kidney damage and may cause death. Apparently small quantities in a confined area can be highly dangerous, e.g. Hartman [2] quotes Windebank et al. [26] where "3 members of a family suffered ataxia, anorexia and lethargy after their 9 year old some {sic} attempted to make "silver bullets", by heating lead shot and thermometer mercury in a frying pan". Poisoning by eating fungicide-treated grain killed over 5000 people in Iraq in 1971-2 and may have affected 50,000 ([2] p.130).

Chronic exposure of moderate to high levels of mercury causes erethism, a syndrome described variously as "irritability, anxiety, insomnia, hyper-reactivity, shyness and emotional instability" [1], or "mood swings, fatigue, loss of interest, withdrawal, sweating and blushing" [27]. Echeverria also mentions salivation, anorexia, motor symptoms (typically tremor, ataxia, and dysarthria), and "loss of mental capacity" [27]. Also common are poor memory, restriction of visual fields, partial deafness, and parasthaesias [1,2]. Non-neurological symptoms include kidney damage, skin disorders, bleeding gums and loosened teeth.

The psychological effects of mercury exposure are discussed in the following section.

Neuropsychological and Emotional Effects of Mercury

Introduction

There is a substantial literature on the effects of mercury, particularly MeHg, on children and the developing foetus, but that is outwith the scope of this review, which will confine itself mainly to neuropsychological studies on groups of people exposed to mercury as adults (Appendix A1, Table 1.3). Studies available mainly relate to occupational exposure, and most of these to Hg^0 (particularly chloralkali and dental workers), although a very few relate to industrial exposure to Hg^0 combined with other forms of mercury [29,31,44,47,62], and to organic mercury absorbed from food and the environment [61,67]. Five studies are also included on people with dental amalgams [36,38-41].

Table 1.3 should be referred to throughout the review. It summarises the studies by test and by urinary mercury concentration (HgU) of the target group. [3]

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[3] Where mercury values other than HgU were quoted in the original paper, this author has converted them using approximate equivalents found in other studies (Table 1.2); and where no mercury body measures were taken, or where there is no apparent HgU equivalent (as in x-ray studies of mercury in the head [37,45]) the study is classified according to typical mercury values for the occupational group being studied. The terms 'very low', 'low', 'moderate' and 'high' mercury, as used here, refer respectively to HgUs of <10, 10-50, 50-200, and >200 μg/l.

Some cautions are necessary in interpreting Table 1.3:

(a) Studies which looked at >1 group with elevated Hg levels, or used >1 test of a function, may have >1 entry on the same line.

(b) Where studies report both group differences and correlations, an impairment is recorded if either is significant with respect to mercury. Thus 'impairment' does not necessarily imply clinical impairment.

(c) The mercury level recorded is generally the mean for the group under study; it is theoretically possible that apparent impairment of the group as a whole is due to the effect of individuals within the group with much higher mercury levels.

(d) The level of significance of the deficits is reported, but this is of course a measure of reliability of the findings, and should not be confused with the size of the effect.

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Perception

As mentioned above, some neuropathological studies have identified mercury-related lesions in the sensory primary projection areas of the cortex, so one might expect mercury to cause problems in perceptual function. In single clinical cases of mercury poisoning, this is indeed true. Hua et al. [68] found mild constriction of visual fields and poor visual judgement of angles and directions after chronic Hg^0 poisoning (610 μg/l urine). However, the group studies which have examined perception in chronic industrial exposure have generally not found deficits, with the exception of three studies which looked at pattern matching [52], visual evoked potentials [63] and visual form discrimination [61].

Attention/Information Processing

At very low mercury levels (below 10 μg/l urine) reaction time appears unimpaired, or perhaps even enhanced [10,35] but at high mercury levels it may be impaired [29,31].

The Trail Making Test (testing executive function) and attentional-switching are impaired at low or very low mercury levels [18,27,32,33], suggesting that the frontal lobes may be affected. In industrial workers with high mercury levels, Powell [62] found deficits using two subtests of the Test of Everyday Attention, although deficits on Trail Making were not significant.

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(e) The Table is somewhat simplified, e.g. some studies looked at Hg levels at several time periods, although they usually fell into the same broad HgU classification.

(f) Those studies at high Hg levels sometimes used controls who also had (lower) elevated Hg levels, thus reducing the chance of detecting an effect.

Motor Function

Tremor and poor motor co-ordination (including ataxia and dysarthria) are recognised symptoms of mercury poisoning. Echeverria and colleagues [27,28] have found impaired hand-steadiness in dentists at low or very low mercury levels. Finger, hand or foot tapping rates are reduced, sometimes even at low mercury levels [11,27,32,33]. Motor nerve conduction rates are reduced in some individuals [37,63].

Siblerud [39] has cited epidemiological studies showing an association between multiple sclerosis (MS) and poor dental health, and suggested that MS may be caused by an allergic reaction to mercury fillings. (His own study maintained that removal of amalgam improved the mental health of MS patients, but is very poorly controlled.) Others have suggested that Parkinsonism may result from mercury exposure, e.g. in dentists [69]. This may relate to the accumulation of mercury in the basal ganglia or substantia nigra (see above), where much dopamine is produced.

Perceptual-Motor Function

Eye-hand co-ordination and dexterity are impaired at high mercury levels, with some studies finding impairment even at low levels [e.g. 11,18,45]. Two studies found impaired drawing ability (both at low mercury levels) [33,37] and five did not [36,45,46,61,62]. Block design appears impaired only at moderate to high mercury levels [29,31], and Digit Symbol is impaired in two of ten studies at low mercury levels [18,33], but several at higher levels.

Memory/Learning

Verbal memory has often been found to be impaired when mercury is above recommended safety levels, but several studies have also shown impairment at low or very low levels, particularly on Digit Span [30,33,43]. The few studies of verbal learning however suggest impairment only at moderate to high levels [e.g. 47,62]. Various measures of visual memory have also shown impairment at low or very low mercury [27,33,45], although not consistently.

Intelligence

WAIS VIQ has not been shown to be impaired, although Similarities and Comprehension subtests have been [33,34]. Similarly, WAIS PIQ has not been shown to be impaired, but Digit Symbol and Block Design sometimes are (see above). Ravens Progressive Matrices was impaired in two studies at moderate mercury levels [29] but an abbreviated form was not impaired at high mercury levels [62].

Language

Few tests of language ability have been performed. Vocabulary shows no impairment, except for one study using synonyms [30]. There is some suggestion of impairment of word fluency and reading speed at moderate to high mercury levels [31,61]. In a single case study, Musiek and Hanlon [70] demonstrated impairment of speech comprehension after acute dimethyl mercury poisoning.

Emotion/Mental Health

Questionnaire measures of mental health have been consistent in showing effects at low or very low mercury levels, with exception of the GHQ-12 [10]. However, some results need to be interpreted with caution. For instance, Siblerud [40] found increased scores on the Beck Depression Inventory, but on inspection these are not due to mood as such, but to questions on fatigue, insomnia and somatic preoccupation. However, depression was found to be raised on the Profile of Mood States (POMS) [e.g. 27,30] and the Symptom Checklist (SCL 90-R) [37,39,45]. Fatigue is a common symptom of mercury poisoning, and has been found in four studies using the POMS [11,27,30,32] at low mercury levels.

Other symptoms/sub-scales found to be affected include anxiety/tension [18,27,39,45], confusion [11,18,27,30,32], aggression/hostility [18,27,33,39], psychoticism [39,45], and obsessional/compulsive symptoms [39,45]. Personality questionnaires have also found some effects [11,29,49,61,71].

Overview of Neuropsychological and Emotional Effects

At the equivalent of urinary mercury levels of <5 μg/l (typical of people with dental amalgam tooth restorations and moderate fish consumption, and most UK and US dentists) only Echeverria et al. [27] have found detrimental effects on cognitive and motor tests (Trail Making, attentional switching, visual memory, hand steadiness, and finger tapping showed significant slopes in a multiple regression). Some studies have found increased emotional and physical symptoms on questionnaire measures [27,40].

At 5-10 μg/l some verbal memory and vigilance differences have been found between dentists and controls [10,35], but in the latter study these did not correlate with mercury levels.

At 10-50 μg/l, below some recommended safety levels, deficits are beginning to be shown on attention/information processing (excluding reaction time), memory, motor and perceptual-motor tasks. Emotional problems are commonly reported.

At 50-200 μg/l problems are often demonstrated in all the above areas, and changes in perception, language, reasoning and personality are sometimes apparent. Above 200 μg/l every study reports deficits in at least one cognitive or emotional area.

Few studies have tried to link the effects of mercury with specific brain pathology, and brain imaging has rarely been used. Neuropathological findings have not been entirely consistent, and have not generally been matched up with clinical findings. However, one is struck by the similarity of the neuropsychological findings above to those found with diffuse brain injury, such as closed head injury, with the addition of motor problems which may relate to specific damage to cerebellum or subcortical areas such as basal ganglia.

Fatigue is commonly reported, which is also a prominent feature of Post-Concussion Syndrome (PCS), another example of diffuse brain damage. Headache is another feature of PCS, but this has not usually been reported with mercury unless in acute poisoning, except by Echeverria in dentists [27].

Impairments in attentional-switching and Trail Making suggest frontal lobe involvement, but attentional deficits or fatigue could be responsible for deficits in other functions such as memory, and this possibility should be examined more carefully.

With severe toxic doses of mercury, excessive sweating, shyness, blushing, social withdrawal and anxiety are common, suggesting possible damage to the autonomic nervous system, although social withdrawal is also seen with frontal lobe damage. However, anxiety could also be secondary to worries (e.g. about other symptoms, future health problems, employment prospects).

Methodological Issues

Results have been reported here according to urinary mercury levels (HgU, μg/l), or converted approximately to these from other measures. However, what is the index of mercury exposure most relevant to CNS damage? Direct measures of mercury levels in the head by X-ray fluorescence [37,45,72] in the 1980s appear not to have continued, and the authors did not report other mercury indices for comparison. Foà [1] has stated that HgU is "not a reliable indicator of internal dose" (p334), but it is the most commonly reported measure, and Ritchie et al. [10] found that it correlated well with atmospheric measures of Hg^0 in the workplace; hair and nail mercury correlated more closely with fish consumption, presumably due to MeHg. HgU correlates well with HgB (blood) [e.g. 44], and plasma mercury levels are similar to CSF mercury [13]. However, HgU is a measure of turnover of mercury rather than tissue level, and probably reflects mercury intake over the previous month [10]. Therefore HgU is probably best used when exposure is constant, and when Hg^0 is of main interest. Hair and nail samples may be better for MeHg detection.

The effect of any toxin is clearly a function of exposure duration as well as exposure level. Although important, durations have not been included in this review because many studies do not report them, and those that do report them in many different ways, so that it is difficult to make comparisons between the studies. For instance, some report number of years of exposure [e.g. 29, 53], some minimum length of exposure [e.g. 32], some number of peaks of HgU over time [e.g. 29], some actual levels at different time periods [e.g. 42,43]. Attempts to combine duration with level exist [e.g. 44,47] but are rare and involve assumptions about consistency of past exposure over time (unless repeated monitoring has taken place), whether long-duration+low-exposure and short-duration+high-exposure are equivalent, etc. A consistently reported measure of duration-by-dose level is highly desirable but is unlikely to be achieved.

The problem of psychological test selection is perennial. Tests need to be reliable, valid, sensitive to the effects of mercury, and appropriate for the purpose in hand (e.g. elucidating underlying causes of mercury deficits may require different tests from deciding whether an individual is clinically impaired and merits compensation). Clinical psychologists have used tests from their tradition which are commonly used for individual diagnostic purposes, and may not be appropriate for mass screenings. A few tests have been introduced from the experimental cognitive psychology tradition (e.g. iconic memory, Sternberg memory scanning); these techniques deserve further attention, since they are capable of separating the effects of different cognitive processes, whereas clinical tests usually involve combinations of functions. Traditional occupational-health screenings have mainly used psychomotor tests, which, while valuable, do not sample the full range of abilities. This has been recognised, and recently a number of wide-ranging computerised cognitive test

batteries have been used (e.g. NES (Neurobehavioural Evaluation System) [32]; CDR (Cognitive Drug Research) [10]).

It is a common experience in neuropsychological practice that patients sometimes complain of difficulties which are not detected on laboratory tests, and that tests sometimes reveal deficits which patients are unaware of. The former problem may be addressed by the use of self-report questionnaires and rating scales (if suitably reliable and valid) at least until further tests are developed. The latter problem means that we should not restrict investigations to the symptoms of which people complain.

Exposure to low levels of mercury over time might lead to cumulative brain-cell damage, and such damage may continue to increase after exposure ceases. Brain-cells are lost with normal ageing, but Weiss [24] calculates that an additional cell loss of only 0.1% per year from age 25 will at age 53 produce a brain equivalent to that of a normal 65 year-old. Deficits may therefore be more easily detected in older populations.

Suggestions for Future Neuropsychological and Mental Health Research

We know that mercury is toxic in high doses, and further research on people with high levels of mercury might best focus on the gaps in our knowledge such as the effect on perception, and the way in which neuropathology links with deficits. At low mercury levels, there is a need to establish reliably the dose-limits for neuropsychological and emotional dysfunction, which would appear to be much lower than current official "safe" limits; and to examine older people, in whom deficits from brain cell loss should be more apparent. At all mercury levels, it would be desirable to have clearer indicators of dose-by-duration, and to

identify whether attentional dysfunction or fatigue may be partly responsible for poorer performance on neuropsychological tasks, or whether they stand alone.

Behavioural and emotional problems need to be further elucidated, while attempting to control for other sources of psychological stress (such as life-events, work stress, and worries about mercury status), as well as exposure to other toxic substances, including alcohol. Ideally both participants and researchers would be blind to participants' mercury status during testing. If control groups cannot be matched for work stress etc., multivariate designs within mercury-exposed groups should be considered and extraneous variables controlled for statistically [e.g. 27].

Finally, can anything be done to reverse neurotoxicity? Most of the group studies reviewed here have been cross-sectional and therefore do not address this issue, except Langolf et al. [58] which does identify some recovery in forearm tremor following removal from the mercury source. Some single case studies also suggest that improvement in neuropsychological function [68] or movement disorder [69,73] is possible after mercury exposure ceases or with the administration of chelating agents. There is a need for much further work in this area.

Implications for Occupational Health and Safety

From the above review it can be seen that regular monitoring of and reduction of mercury levels is very important, and that current health guidance limits for HgU are almost certainly set too high.

Most of the studies reviewed here were conducted on chloralkali workers or dental workers. The chloralkali industry appears to be taking mercury exposure seriously, monitoring both air and body burden on a fairly regular basis. Moreover, chloralkali production using mercury is declining as other processes take over.

In contrast, in the UK at least, the use of mercury in dentistry continues unabated (apart from decisions by individual dentists or patients against its use). The use of dental amalgam is unlikely to decline in the foreseeable future, since currently available alternative tooth-restoration materials are either technically inferior, more expensive, or have their own health risks [74], and the UK government will not fund the placement of non-amalgam restorations in permanent posterior teeth under the National Health Service. Nor are dental workers being monitored in any systematic way. In Scotland, the only monitoring of body burden for dentists is a voluntary scheme of hair analysis, sampling individuals about once every five years [D. Halls, personal communication], but, as mentioned above, hair may not be an adequate measure of occupational exposure. Moreover, two-thirds of dental surgeries in a recent study had air mercury levels above the HSE Occupational Exposure Standard in one or more locations [10]. In these circumstances it is vital to institute routine mercury monitoring, and to carry out more research to determine whether dental and other workers are safe, or whether even at very low mercury levels their mental or physical health is at risk.

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2. Major Research Project Proposal

Effect of low level mercury exposure on psychological health of dental surgeons.

February 2000

PROPOSED RESEARCH STUDY – D. MARTINAGE – FEBRUARY 2000 [1]

(1) Title of Study

Effect of low level mercury exposure on psychological health of dental surgeons.

(2) Principal Investigator

Mr. David P. Martinage, doctoral student, Department of Psychological Medicine, University of Glasgow, and Consultant Clinical Psychologist, Ravenscraig Hospital, Greenock. TEL. 01475-633777 Ext.5113.

(3) Associate Investigator

Professor Tom McMillan, Professor of Clinical Neuropsychology, Department of Psychological Medicine, University of Glasgow. (supervisor)

(4) Advisor

Dr. Karen A. Ritchie, Department of Public Health, University of Glasgow.

(5) Location

Department of Psychological Medicine, University of Glasgow.

(6) Signature of Investigators

Date:

[1] Application was made to Glasgow Dental Hospital, Area Dental Ethics Committee. Approval for the study was granted at a Committee meeting on 27 March 2000, and by letter on 17 April 2000 (see Appendix B).

(7) Introduction

Mercury is toxic to the nervous system. Mercury amalgams are used extensively for dental restoration, and dental workers may therefore be subject to occupational exposure, mainly by inhalation of inorganic mercury vapour. The Health and Safety Executive[2] have set exposure limits of mercury in air of 50 micrograms per cubic metre, and the World Health Organisation (1980) have set safety limits for the concentration of mercury in urine at 50 micrograms per litre. Dental workers are usually well within these limits. However, recent studies of dental workers in North America and Asia have suggested that there may be detrimental effects of mercury on psychological function even when urinary mercury levels are below the safety limits. (Gonzalez-Ramirez et.al. 1995, Bittner et.al. 1998, Ngim et.al. 1992, Echeverria et.al. 1995, 1998). These studies have found deficits in a number of cognitive and motor functions, including attention, visual memory, verbal memory, auditory span, hand steadiness, and digit-symbol substitution. Questionnaire measures have revealed higher levels of anger, fatigue, confusion, tension, and depression.

Dental procedures and practices in the U.K. may differ from those in North America and Asia. The only study of cognitive function in U.K. dentists published to date is Ritchie et.al. (1995), which was a pilot study for a larger project currently under way (Ritchie et.al., in progress). The 1995 study found deficits in verbal recall in older dentists compared with older G.P.'s, which appeared to be related to mercury

[2] HSE, EH40. This has since been revised to 25 $\mu g/m^3$ air, and HSE have issued a health guidance value for urine of 20nmol/mmol creatinine.

levels in urine. Younger participants did not show any significant effects. There were no significant deficits noted on the other cognitive tasks used, or on the General Health Questionnaire – 12 (a brief screening questionnaire for psychological morbidity).

The Ritchie et.al. studies used a series of very brief tests which are part of a computer battery, and it may well be that their second study with a much larger sample will show significant differences in cognitive function other than that already shown for verbal memory. The proposal for the present study is to extend and complement the work of Ritchie et.al. by using a longer battery comprising more traditional neuropsychological tests, which have been shown in other studies to be sensitive to the presence of mercury or other neurotoxins in the body. It is also proposed to look in much more detail at psychological health using a 90-item standardised questionnaire, the SCL-90-R (Symptom Checklist, Revised), and at memory and attention using the Cognitive Failures Questionnaire. Supplementary questionnaires will also be given to measure fatigue and biographical details and habits.

(8) Aims

To determine if Scottish dentists with levels of urinary mercury within safety limits have detectable psychological health problems, including neuropsychological deficits.

(9) Plan of investigation

Design

A group of 20 practising dentists with very low urinary mercury levels (as measured in 1999) will act as control group, and will be compared with a similar group of 20 dentists with mercury levels somewhat higher. The two groups should therefore be comparable for educational level, occupational stress, dexterity, and other factors which might influence psychological health and cognitive performance. If the two groups differ on other variables such as age, gender etc., these will be adjusted for statistically in the analysis.

The applicant will remain blind to the mercury status of the participants until the data have been collected.

Participants and Confidentiality

The participants will be selected from a sample of 180 who recently took part in another study conducted by Glasgow University Department of Public Health (Ritchie et.al., in progress). Various measures of mercury burden were taken in the study, including urinary mercury levels, which will be used to define the groups in the present study. (One of the researchers in the former study, Dr. Karen Ritchie, has kindly agreed to contact the participants on behalf of the applicant, in order that their names are not released without their consent; the participants will then contact the applicant directly themselves if they wish to take part).

Each participant will be assigned a code number, which will be used as an identifier on questionnaires etc. to ensure confidentiality. A written key relating participants' names to code numbers will be kept under secure conditions. Participants' names will not appear on any test forms, questionnaires, data sheets, computer files, or urine samples. All computers used will be registered under the Data Protection Act, and data management will comply with the Act.

Method

Participants will be given a 45-minute neuropsychological test battery (see below) and questionnaires to assess psychological health status, subjective memory/attention, fatigue, biographical details and personal habits. (Questionnaires are appended.)

The neuropsychology battery will be administered in a face-to-face setting; the questionnaires will be completed by the participants by themselves at a time convenient to them, but within one week of the neuropsychological testing, and returned to the applicant by post.

The test battery comprises the following tests, which have been selected for their known sensitivity to mercury exposure:

Digit Symbol (from the Wechsler Adult Intelligence Scale-Revised; symbols corresponding to digits are copied into boxes)

Digit Span (from the Wechsler Adult Intelligence Scale-Revised; participant hears digits and repeats them verbally, forwards or backwards)

Visual Reproduction (from the Wechsler Memory Scale, version III; line drawings are reproduced from memory)

Trail Making Test (numbers and letters arranged randomly on paper have to be joined in sequence with a pencil)

Intentional Hand Steadiness Test (a stylus has to be held inside a hole without touching the sides)

Grooved Pegboard (asymmetrical pegs are inserted into holes)

(it may only be possible to use one of the last two tests, depending on time and the availability of equipment.)

The following test which, although sensitivity to mercury is not proven, has been found to be sensitive to other neurotoxins, will broaden the scope of the test battery to sample another important area of function:

Auditory-Verbal Learning Test (list of words is presented verbally 5 times, and has to be recalled)

Further, it is desirable to have a measure related to premorbid IQ to ensure the comparability of groups. In general, tests of language tend to be unaffected by mercury exposure. After due consideration of alternatives, the

Spot-the-Word Test (real words and nonsense words have to be distinguished)

would appear to be suitable, in that it is easy and quick to administer, and gives standard scores. Although it may be subject to ceiling effects in the population under study, this is also true of the other measures available.

The main questionnaires are the

SCL-90-R (Symptom Checklist 90, Revised; a list of 90 psychological and/or physical symptoms)

Cognitive Failures Questionnaire (25 common errors in everyday life)

All the above tests are in routine use by psychologists.

In addition, questionnaires will be given on fatigue; and biographical details, habits, stressors etc. (modified from the one already approved by the Dental Hospital Ethics Committee for the Ritchie et.al. study).

(With the participants' permission, measures on a number of other tests may also be available, collected from an earlier study (Ritchie et.al., in progress):
simple reaction time, choice reaction time, Sternberg memory scanning, memory for word lists (immediate and delayed recall, recognition), number vigilance, spatial memory, General Health Questionnaire-12.)

It would be desirable to repeat the urinary mercury assays in order to verify that mercury levels have not changed substantially since the Ritchie et.al. study. (This will depend on cost and on obtaining a source of funding.) It may not be essential, however, since most authors report mercury persisting in the nervous system for

much longer than in the rest of the body (e.g. Foa (1985) quotes a half-life of up to 1 year.)

(10) Analysis

Data analysis will be conducted by the applicant using the computing facilities of Glasgow University, with statistical advice as necessary from University staff. If carried out, urine analyses will be conducted at Glasgow Royal Infirmary . Biochemistry Department.

(11) Timetable of work

March 2000	-finalisation of test battery, questionnaires and materials
	-application to Ethics Committee
	-order any remaining tests and equipment
	-get questionnaires printed and collated with test material
April 2000	-contact participants who have already
	-indicated interest in participating
	-contact remaining potential participants
	-begin data collection
January 2000	-complete data collection
February 2001	-begin data analysis
March 2001	-complete data analysis
April 2001	-begin write up
June 2001	-complete write up

(12) Equipment

- IHST Panel and Timer/Counter; and/or Grooved Pegboard
- Stimulus materials for Visual Reproduction test
- Printed questionnaires
- Test record forms
- Containers for urine samples

(13) Purpose/Implementation of Results

If participants with low mercury urine levels show deficits, Health and Safety procedures and safety levels may have to be revised. Dentists may need to consider whether to take chelating agents to remove accumulated mercury from the body, and have more frequent and more extensive health monitoring.

(14) Size of sample

The number of participants included in the study is constrained by the time taken to visit them and administer the neuropsychology battery; by the relatively small number of dentists with low (as opposed to very low) mercury levels in the Ritchie sample; and by the proportion of those who agree to take part (which will be lower than for Dr. Ritchie, who was able to pay for participation. In order to gauge interest, 20 dentists have already been contacted regarding the present study by Dr. Ritchie, of whom half have agreed in principle to take part).

(15) Supplementary Study

If it appears that the sample size is too small to yield useful results, it may be possible to conduct an additional study by post, using the questionnaires only (i.e. omitting the neuropsychological tests) on all the remaining dentists in the Ritchie study who are willing to co-operate. It is likely that this supplementary study would have higher compliance rates than the main study, since no time will be required to be taken from the participants' busy work schedule.

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3. Major Research Project Paper

The effect of low level mercury exposure on the psychological health of dental surgeons.

Prepared for submission to *Occupational and Environmental Medicine* (see Appendix A2)

ABSTRACT

Objectives: To investigate the neuropsychological and emotional effects of mercury exposure in dental surgeons in the West of Scotland.

Method: 40 dentists were given a battery of 8 neuropsychological and psychomotor tests; and completed questionnaires on emotional and behavioural symptoms (Symptom Checklist, SCL-90-R), everyday lapses of attention and memory (Cognitve Failures Questionnaire, CFQ), the effect of fatigue on daily functioning (Fatigue Impact Scale, FIS), and life-events. Urine samples were assayed for mercury (HgU), and the dentists divided in two groups according to HgU.

Results: Mean HgU for group 1 was 1.51 nmol/mmol creatinine, and for group 2 was 6.97. Group 2 did not show deficits compared to group 1 on any of the neuropsychological and psychomotor tests, but did initially have significantly higher scores on FIS, CFQ and SCL-90-R. However, when life-events were controlled for only FIS remained significant, but this may be due to a surprisingly high correlation between life-event score and HgU ($r = 0.42$, $p<0.01$) which is difficult to explain.

Conclusions: No evidence was found for an effect of low mercury levels on formal neuropsychological tests, but self-report questionnaires did reveal greater effects of fatigue, and suggest possible effects on memory and attention, and on emotional distress. These effects were obtained at urinary mercury levels well below the UK Health and Safety Executive HgU health guidance value of 20 nmol/mmol creatinine and the W.H.O. threshold limit value of 50 μg/l.

KEY TERMS: mercury poisoning neurobehavioural mental health

Main Messages

- Low body mercury levels in dentists show a relationship with fatigue, and suggest a relationship with emotional function and subjective memory and attentional problems.
- Some effects are detectable within current recommended 'safe' levels of exposure.
- Questionnaires measuring emotional disturbance, fatigue and cognition may be more likely to detect effects at low mercury levels than formal performance tests, although further research is needed to establish the precise relationship of these measures with mercury levels.

Policy Implications

- Regular monitoring of dental workers workplace air and body burden of mercury is highly desirable. This applies particularly to dental workers in Scotland, who currently have very infrequent monitoring on a volunteer basis.
- Standardised self-report questionnaires may provide a cost-effective way of monitoring subjective problems with cognition, emotion and fatigue.

INTRODUCTION

Mercury is well known as a neurotoxin, and many studies have demonstrated cognitive and emotional changes with occupational exposure [1]. The most studied group has been chloralkali workers, but dental workers have also been a focus for enquiry. Both these groups are exposed to elemental mercury vapour (Hg^0) which is predominantly absorbed via inhalation [2]. Deficits are typically found in memory, attention, motor and perceptual-motor function, and in self-reports of mental and physical symptoms. Six of the eight published studies on dental workers available to the author [3-8], and one unpublished [9], have shown mean urinary mercury (HgU) levels within W.H.O. recommended safety levels[1], yet deficits have still been found in one or more functions (Appendix A1, Table 1.3) in each study[2]. The remaining two studies also found deficits, but HgU levels are not quoted [11,12]. Some of the studies [5,8,9] involved mercury levels at or close to those expected of patients with amalgam tooth restorations (i.e. below about 5μg/l). There has been much controversy as to whether dental amalgam is safe for patients [13], with alternative-medicine practitioners [e.g. 14,15] and the media [e.g. 16] often claiming severe effects, and the dental profession usually maintaining there is no risk [e.g. 17,18]. Siblerud and colleagues have found small detrimental effects on mental health and personality questionnaires in people with amalgams [19-22], although two of the studies have major methodological flaws [19,22] and only one measured body burden of mercury [19].

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[1] The W.H.O. proposed "threshold limit value" of mercury in urine is 50 μg/l [10]. The UK Health and Safety Executive (HSE) "health guidance value" for urinary mercury is 20 nmol/mmol creatinine (approximately equivalent to 35-45 μg/l urine), and the HSE limit for Hg^0 in workplace air is currently 25 $\mu g/m^3$.

[2] References [3-9,11,12] here correspond to studies A,C,D,E,I,K,L,N,X in Table 1.3. It is not clear that all the studies applied corrrections for multiple comparisons.

The pattern of mercury exposure in dental workers may vary from country to country depending on working practices adopted. Only one published study of cognitive deficits has been carried out on U.K. dental workers. This used a computerised battery of very brief tests [8][3], which revealed deficits only in verbal memory, and this in the group of older dentists but not the younger (median ages 40 and 23 respectively). A much larger study has recently been completed in the West of Scotland [9] using the same battery on 180 dentists with a very low mean urine mercury level (5.6 μg/l). Number vigilance, memory scanning (Sternberg task) and self-report about memory were poorer in dentists than controls, but when scores were correlated with mercury levels (controlling for age and sex) the effect disappeared or was reversed. Surprisingly, correlations within the control group (180 university staff and postgraduates, mean HgU 1.5μg/l) on several measures suggested performance was better with higher HgU.

There is no systematic monitoring of body mercury levels in dentists in Scotland. There is a voluntary scheme, testing hair samples approximately every 5 years [David Halls 2001, personal communication], but Ritchie et al.[9] found that hair and nail mercury levels in dentists did not correlate with occupational exposure to Hg^0 (but did with fish consumption; fish is sometimes a source of methyl mercury). However, HgU showed good correlations with various measures of occupational exposure. Excessive levels (>25μg/m^3) of mercury vapour were found in at least one location within 68% of surgeries, most often around the dental chair base, skirting, amalgam mixing device, and in dentists' dosimeter readings.

[3] The Cognitive Drug Research battery takes about 20 minutes and comprises simple- and choice-reaction-times,word-list recall and recognition, spatial memory, Sternberg memory scanning, & number vigilance.

The present study seeks to determine whether there are neuropsychological, psychomotor or emotional effects of mercury exposure in dentists in the West of Scotland, using well-established and well-validated psychological tests and questionnaires. This compliments the Ritchie et al. study [9] which used a different range of tests.

METHOD

Participants

Participants were 40 dental surgeons practising in the West of Scotland[4], selected from 180 participants in a larger study [9][5] according to urinary mercury levels (HgU) mostly obtained in 1999. 105 dentists were contacted in batches[6], working from the highest and lowest HgUs towards the middle. 49 consented (7 on reminder), a response rate of 47%. The aim was to obtain 40 participants in 2 groups with the lowest and highest possible mercury levels. To help equate the groups for work-stress, participants were selected only if working at least 28 hours/week (not necessarily all clinical work). 42 were thus eligible, but 1 withdrew and 1 was held in reserve, leaving 18 in the lower HgU group, and 22 in the higher group. Unfortunately, when new HgU levels were obtained in the present study, the HgU distributions of these two groups overlapped. The total sample was therefore re-divided according to the new HgU into two groups of 28 and 10 (2 people with epilepsy being excluded). (For further details and descriptions of the participants see 'Results' and Table 3.1.)

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[4] The dentists were located in Glasgow, Ayrshire, Lanarkshire, Renfrewshire, Inverclyde and Dumbartonshire.

[5] The original 180 dentists in the Ritchie study were selected as follows: 129 randomly selected from employment registers in the West of Scotland, plus 51 volunteers. The dentists were paid for their participation, whereas in the present study they were not paid, which may account for the lower uptake in the present study.

[6] To maintain confidentiality, the names of the original participants had to remain unknown to this author until they had agreed to take part in the present study. Therefore, Dr. Ritchie distributed the consent forms and information sheet regarding this study, but replies were made to this author, who remained blind to the participants' mercury status until testing and scoring were completed.

Tests

Cognitive and motor tests were selected to reflect a range of abilities shown in previous studies to be vulnerable to the effects of heavy metals, particularly mercury. In contrast, Spot-the-Word was selected as unlikely to be effected by mercury, to provide an indicator of verbal IQ for matching the groups. The tests took about 45 minutes to administer, and were given in the following order (see Appendix C1 for more information):-

Rey Auditory-Verbal Learning Test [23]: list A, comprising 15 nouns, is presented aurally at the rate of 1 word per second for 5 trials, and has to be recalled after each trial (A1 to A5). A parallel list of 15 different words, B, is then presented once and recalled. This is followed by recall of list A immediately (A6, to test for interference) and after 30 minutes (A7, delayed recall) without further presentation.
(For this study, responses were tape recorded.)

Visual Reproduction: (from the Wechsler Memory Scale, version III [24]) 5 line-drawings are viewed in turn for 10 seconds each and reproduced from memory immediately and after 30 minutes.

Digit Symbol: (from the Wechsler Adult Intelligence Scale-Revised [25])
Symbols arbitrarily corresponding to digits are copied into digit-labelled boxes for 90 seconds.

Intentional Hand Steadiness [26]: A thin metal stylus has to be held inside a hole in a metal plate without touching the sides. 9 holes are provided (in this study the 6 smallest

were used, beginning with the largest and working down, of diameters 4.75, 4.0, 3.2, 2.8, 2.35, and 2mm, and the diameter of the stylus was 1.6mm). A buzzer sounds when the stylus contacts the plate, and the total time in contact during a 15 second period is recorded on an electronic timer. Each hand is tested, dominant first, and no support is allowed for hand or arm.

Digit Span:(from the Wechsler Adult Intelligence Scale-Revised [25])
Participant hears sequences of digits of increasing lengths and repeats them orally forwards, then further sequences are given and repeated backwards.

Trail Making Test [27]: **form A**: Numbers arranged pseudo-randomly on paper have to be joined in sequence with a pencil. **form B**: As A, but comprising both numbers and letters which have to be joined alternately. Dominant hand only. Time taken is measured, which includes time to correct mistakes.

Spot-the-Word Test (from SCOLP) [28]: pairs of real and nonsense words are presented in a list; participants have to mark the real word. Since some of the real words are uncommon, this has been interpreted as an index of premorbid verbal IQ.

Grooved Pegboard [29]: 25 asymmetrical pegs are inserted into holes with one hand, and time taken is recorded. Each hand is used in turn, dominant first.

Rey Auditory-Verbal Learning Test: delayed recall (trial A7).

Visual Reproduction: delayed recall.

Self-report Questionnaires (Appendix C2)

SCL-90-R (Symptom Checklist-90, Revised [30]): a list of 90 psychological and/or physical symptoms each rated 0 to 4 for level of distress, providing summary scores on 9 subscales.

The **Cognitive Failures Questionnaire** (Broadbent [31]): samples a range of deficits in memory and attention as commonly experienced by people in daily life. It comprises 25 problems, each rated 0 to 4 for frequency of occurrence.

The Fatigue Impact Scale [32]: comprises 40 questions, each rated 0 to 4 for the impact of fatigue in three domains: cognitive, physical, and social. (This is arguably more relevant to functioning than fatigue *per se*.)

Life-events have an effect on mental health, and should be controlled for since they may affect SCL-90R scores. Participants were asked which life-events had occurred in the previous 6 months, on a list of common events to which Holmes and Rahe [33] had assigned weights according to the impact on individuals. The weights were summed into a single score to be used as a covariate in subsequent analysis. [7]

A lifestyle questionnaire was modified from that used by Ritchie et al [9], examining biographical information, personal habits (especially those affecting exposure to mercury), and health.

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[7] It is recognised that this is a rather crude measure of life-events, which are normally established by lengthy interview, but such a procedure was precluded in the present study.

Procedure

The author contacted each dentist by telephone to arrange an appointment for cognitive testing at the dentist's own surgery.[8] The appointment was arranged such that the dentist was working normally for the most of the 4 weeks prior to testing (i.e. not on study leave or holiday, except for occasional days off). This was to ensure that mercury exposure and work-stress levels were controlled for. Most dentists chose to be tested at lunchtime, so that it was rarely possible to test more than one dentist on the same day. The data collection took place between June 2000 and February 2001.

The author personally administered all the cognitive tests. The dentists were handed the questionnaires at the test interview, and were asked to complete and return them by post within one week. The dentists were also asked to provide a urine sample for mercury testing, either immediately before or immediately after the cognitive tests. Two were unable to provide the sample, but did so the following day. The urine samples were kept cool and taken to Glasgow Royal Infirmary Biochemistry Department, where they were stabilised within 24 hours and analysed for mercury content using cold vapour atomic absorption spectrometry. The author was blind to the mercury status of the participants until after the test results and questionnaires had been scored.

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[8] Testing conditions in the surgeries were far from ideal. Dentists were asked to switch off telephones in the room and ask other staff not to enter, but occasionally such interruptions did occur. Many surgeries were subject to noise, e.g. from staff and patients in adjacent rooms, equipment, and road traffic outside. Most dentists were tested sitting in a high chair at a bench worktop, which often did not allow them space underneath for knees, so that they had to sit sideways. Instructions for motor tests normally requiring positioning of equipment to be square to the table edge were therefore adapted to the most comfortable and practical position for the dentist. When the dentist was required to draw or complete forms, a clipboard was used flat on the bench top or desk, to provide a uniform writing surface.

Most dentists enjoyed the tests, although a small number showed some test anxiety. Several stated how important they felt it was to take part in the study. Ten asked for feedback on their own specific HgU and test results (this was provided to them after the data analyses were completed; a general summary of the results was also provided to all the participants).

RESULTS

Mercury levels

There has been a non-significant reduction in HgU in these participants between the Ritchie et al. study [9] and the present study (from 3.2 to 2.9 nmol/mmol creatinine). Several dentists said that they had taken action to reduce air Hg^0 following feedback from the earlier study, which could account for this, although none of them had requested or received feedback on HgU [Ritchie, personal communication]. The correlation for HgU between the two studies is only 0.55, and the original separation of the groups no longer holds. The sample was therefore re-divided on the basis of current HgU before further analysis.

The maximum HgU for Ritchie et al.'s large control group (N=163 [9]) was 4.2 nmol/mmol creatinine. Inspection of the histogram of HgUs for dentists in the current study (Figure 3.1) shows a natural gap at about this point. No dentists' HgUs fell between 2.9 and 4.3 nmol/mmol creatinine. It therefore seemed appropriate to separate the dentists into two groups at 4.2, since values of 4.3 and above are outwith Ritchie et al.'s control group range. Hereafter the new groups are referred to as group 1, 'very low Hg', and group 2, 'low Hg'.

Preliminary screening

The lifestyle questionnaire asked if participants had any neurological or other problem which might affect test results. Two dentists reported having epilepsy and were excluded. Five other positive responders were included (2 pregnant, 3 with past actual or possible

CNS problems) since their scores on the main dependent variables fell within the range of the rest of their group, none of the point biserial correlations between these variables and presence/absence of a problem were significant, and the correlation of group membership with presence/absence of a problem was also n.s. (p=0.469).

Group characteristics

Groups were comparable for age, sex, caffeine consumption, years in practice, sickness record and total hours worked (Table 3.1). All dentists were Caucasian. Group 2 worked significantly longer hours in the surgery, and had almost twice the number of amalgam fillings in their own teeth as group 1, which may partly account for higher HgU levels. Group 2 also drank significantly less alcohol. Two participants smoked a little (2 cigarettes/day and 1 cigar/day), both in group1.

Control variables

If control variables significantly correlated with dependent variables they were used as covariates in all parametric analyses. Age, sex and alcohol consumption were covariates with cognitive tests, and age and life-events score were covariates for the questionnaire measures. Caffeine correlated significantly only with Digit Span, and was used as an additional covariate in that analysis.

The groups did not differ on the measure of general intellectual function, Spot-the Word.

Analyses

All analyses were performed using SPSS 9.0. Age-scaled scores were used when available. Continuous dependent variables were normalised by transformation where possible. Since it was predicted that mercury impairs cognitive and emotional function, most significance tests were 1-tailed planned comparisons.

Results for cognitive and psychomotor tests are summarised in Tables 3.2a, 3.2b and 3.3. All comparisons were non-significant, except for Grooved Pegboard, dominant hand, which showed against prediction that group 2 was faster than group 1. However, the partial correlation (controlling for age, sex and alcohol consumption) of HgU (urine/creatinine) with Grooved Pegboard, and indeed with all other cognitive and psychomotor tests, was not significant.

The analysis also shows that older dentists were significantly slower on Trail Making A, and higher alcohol consumption was associated with slower performance on Grooved Pegboard, dominant hand. Women were faster than men on Trail Making B, Grooved Pegboard for both hands, and Digit Symbol.

Results for the questionnaires are summarised in Tables 3.4a, 3.4b, 3.5 and 3.6. Controlling for age, group 2 reported significantly higher scores than group 1 on SCL-90-R, CFQ and FIS (Table 3.4a). When life-event score was also controlled for, only FIS was significant (Table 3.4b). The correlations between HgU and these variables are shown in Table 3.7. HgU is significantly correlated with life-event score, which is quite unexpected and may have influenced the analysis of covariance. Therefore SCL-90-R was examined further.

Non-parametric analysis of SCL-90-R subscales (1-tailed, Table 3.5, Figure 3.2), showed significant effects on Interpersonal Sensitivity, Anxiety, Hostility, and Paranoid Ideation, although none of these was significant after correction for multiple comparisons. This suggests that each of them contributes a small amount of the variance to the significance of the questionnaire as a whole.

However, since a relationship between the Paranoid Ideation subscale and mercury has not previously been reported (as far as this author is aware), the 6 individual items of the subscale were examined separately. Although group 2 scored higher than group 1 on all 6 items, the effect was only significant for items 68 and 76 ($p<0.001$ and $p<0.01$ respectively, 2-tailed; both remained significant when adjusted for the 6 comparisons, at $p<0.01$ and $p<0.05$). These two items were 'Having ideas or beliefs that others do not share' and 'Others not giving you proper credit for your achievements'.

With FIS, group 2 had significantly greater scores than group 1 on all three subscales (Table 3.6, Figure 3.3)[9], although the Cognitive subscale was no longer significant after correction for multiple comparisons.

[9] Analysis of subscales with covariates is not possible parametrically, because large numbers of zero values render the distributions non-transformable.

DISCUSSION

No dentist in this study had an HgU above the HSE recommended limits. However, 25% of the sample had HgUs above the 100th percentile of Ritchie et al.'s [9] large control group of non-dentists. Several of the dentists said they had taken measures to reduce Hg^0 vapour in the surgery since feedback from Ritchie et al., and some dentists' HgUs had indeed reduced over that period, but for some others HgU had increased, and the mean change was not significant. Some dentists commented that they did not use available protective measures such as gloves and face-masks because they were not of practical design and impeded work. This design problem should not be insurmountable, but since other dentists manage well with this equipment, may even be solvable with additional training in their proper use. Improved Hg management in some surgeries is clearly still required, and would no doubt be assisted by routine and systematic monitoring of air and urine, which does not take place in Scotland at present.

Regarding the cognitive test results, it may be that at these low mercury levels there is no deleterious effect on cognitive function. Indeed Ritchie et al. [9] were unable to find any with a much larger sample of dentists, and even found some evidence for enhancement of function with higher HgU within the control group. The only significant indication of the latter effect here is the faster speed shown by group 2 on the Grooved Pegboard. Echeverria et al. [5] however did find detrimental effects of mercury in dental workers at even lower HgU levels than in this study (1 μg/l, equivalent to group 1 here and the Ritchie et al. control group) on Trail Making Test A and B, visual retention (NES), hand steadiness and finger tapping. There is a trend for dentists in group 2 here to <u>feel</u> they have more cognitive problems, as shown by the CFQ (still significant after controlling for age, but not after controlling for life-events), even though the cognitive and psychomotor tests do not

show any such effect. Discrepancies between formal cognitive test results and subjective report are common in neuropsychological practice and are well-documented [e.g. 34].

Fatigue is an often-reported symptom of mercury poisoning, although the effect of fatigue on daily functioning has not generally been examined. The significance of the FIS results appears to show that even low levels of mercury affect social and physical, and possibly cognitive, activities, although other interpretations are possible (e.g. tiredness might increase exposure to mercury).

The SCL-90-R results must be interpreted with caution. The effects found became non-significant after controlling for life-events, but it could be argued that this was because of the, as yet unexplained, high correlation of life-events with HgU. However, the trends noted are consistent with some often reported symptoms of mercury poisoning ([1] p137-40; [2] p329; [5] p972), for instance shyness and social withdrawal, which are included within the Interpersonal Sensitivity subscale; irritability and anger, within the Hostility subscale; and of course anxiety. The finding on Paranoid Ideation does not appear to fit with most previous reports, although Foà [2] does mention 'intolerance toward any criticism', and although interesting may be a random result.

An alternative explanation for the trend towards higher anxiety scores in group 2 might be the longer hours worked in the surgery, if this work is stressful, although total work hours did not differ between groups. Another possibility is self-selection of participants, those having previously been informed of high Hg air levels at work perhaps being worried about the effects and more likely to take part in the study (although they had not requested feedback on previous HgU [Ritchie, personal communication], and were not informed of

which group they were assigned to). Against this, the volunteer rate did not differ significantly between those with higher and lower prior HgU levels.

If knowledge or suspicion of high body Hg levels does increase anxiety, this in turn could increase fatigue (e.g. via increased muscle tension) and cognitive failures (such as inattention). It is perhaps less likely, but not impossible, that anxiety could mediate increases in Hostility and Interpersonal Sensitivity. In future research in these areas it is therefore important to control for participants' perceptions of their Hg status.

The relationship of life-events score with SCL-90-R is not surprising, and was the reason for its inclusion in the study as a control variable, and the relationship of life-events with fatigue and Cognitive Failures could perhaps be understood in terms of 'stress' as a mediator. However, the correlation of life-events score with HgU is difficult to explain. One of several possibilities is that life stresses affect how careful dentists are in allowing themselves to be exposed to mercury, perhaps via the mediator of fatigue. Many of the items on the Holmes-Rahe scale are ill-defined and subject to multiple interpretation, which makes it difficult to hypothesise possible direction of causation.. It would be desirable in future research to have a more detailed measure of life-events, and to separate those over which the participants might have some influence (intentionally or not) from those which are 'acts of God'.

In conclusion, this study has not found any evidence that performance on the particular cognitive and motor tests used here is impaired by low levels of mercury. However, there is a trend suggesting that dentists' own perceptions of cognitive errors may be related to mercury levels, although the relationship may be an indirect one. The SCL-90-R, a global

measure of emotional problems, has shown deficits in other studies, but effects shown here became non-significant after controlling for life-events. The only clearly significant variables related to body mercury levels in this study were the effects of fatigue, and (surprisingly) life-events.

This appears to be the first study to examine detailed self-report of cognitive failures, impact of fatigue, and life-events in relation to mercury levels, and the relationship between these variables needs further study and its nature elucidated. Participants' perceptions of their mercury status should be controlled, preferably with a double-blind design, and possible causal relationships between mercury levels and life-events explored. Research on self-report questionnaires could be particularly valuable because, if it can be shown that they measure genuine (non-artifactual) effects of mercury, they may be potentially more sensitive than formal cognitive tests, are certainly much cheaper to administer, and could be used in mass screening programmes.

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TABLES and FIGURES

Table 3.1: Description of groups

	group 1 very low HgU	group 2 low HgU	group 1 very low HgU	group 2 low HgU	significance	
N =	28	10				
female =	15	3			ns	
male =	13	7				
variable	**mean**		**standard deviation**			
age	39.8	39.9	8.3	8.6	ns	
HgU nmol/mmol creatinine	1.51	6.97	0.68	2.70	***	
HgU µg/l	2.79	14.12	1.91	9.72	***	
years in practice	15.6	16.8	7.6	8.2	ns	
total hours work/week	36.6	39.9	5.2	5.4	ns	
hours in surgery/week	32.4	36.4	4.7	3.5	*	
number of days holiday leave from work in previous 4 weeks	0.93	2.10	1.88	2.08	ns	
number of days absent from work due to illness in previous year	2.04	0.40	3.90	0.52	ns	
centigrams alcohol/week	12.54	6.20	8.92	7.11	*	(1)
mg caffeine/day	315	324	253	231	ns	(2)
number of meals containing fish/week	2.36	1.40	1.19	0.97	ns	
life-event score	58.6	119.8	48.5	112.8	ns	(1)
number of amalgam surfaces in own teeth	10.3	19.3	8.5	12.6	*	

(1) log transform (2) square-root transform ANOVA * $p<0.05$ ** $p<0.01$ *** $p<0.001$ (2-tailed)

Table 3.2a: Analysis of Covariance for parametric cognitive and psychomotor tests

variable	AGE		SEX		ALCOHOL		MERCURY GROUPS	
	F	Sig.	F	Sig.	F	Sig.	F	Sig.
Digit Symbol, age-scaled	1.247	0.272	6.309	*0.017	0.162	0.690	1.969	0.170
Spot-the-Word, age-scaled	3.548	0.068	3.018	0.092	0.460	0.502	0.760	0.390
Visual Reproduction Immediate Recall, age-scaled (1)	0.689	0.412	0.011	0.919	0.078	0.781	0.169	0.684
Visual Reproduction Delayed Recall, age-scaled (1)	1.482	0.232	0.036	0.850	0.369	0.548	2.794	0.104
Trail Making Test A, time (2)	5.848	*0.021	0.032	0.859	1.528	0.225	0.685	0.414
Trail Making Test B, time (2)	2.099	0.157	4.435	*0.043	0.035	0.853	0.959	0.335
Grooved Pegboard, dominant hand, time (3)	0.055	0.816	9.904	**0.003	4.340	*0.045	9.419	**0.004
Grooved Pegboard, non-dominant hand, time (3)	3.987	0.054	13.667	**0.001	1.426	0.241	0.471	0.497
Rey Auditory-Verbal Learning Test, no. correct,sum of trials 1-5	2.539	0.121	1.824	0.186	0.475	0.496	0.242	0.626

* $p<0.05$ ** $p<0.01$ corrected for multiple comparisons; df = 1,33 for all tests

(1) square transform (2) log transform (3) reciprocal transform

Table 3.2b: Analysis of Covariance for parametric cognitive and psychomotor tests(continued)

variable	AGE		SEX		ALCOHOL		CAFFEINE		MERCURY GROUPS	
	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.
Digit Span total score	2.779	0.106	0.495	0.487	0.036	0.851	6.051	0.020	0.350	0.558
Hand Steadiness, dominant hand seconds touching plate, sum of all holes	1.020	0.320	1.036	0.317	0.368	0.549	0.934	0.341	0.010	0.920
Hand Steadiness, non-dominant hand seconds touching plate, sum of all holes	0.326	0.572	0.325	0.573	3.209	0.083	2.886	0.099	0.535	0.470

all n.s. ; df = 1,32 for all tests

(this analysis was run separately from that in Table 3.2a, because inclusion of Hand Steadiness with the rest prevented calculation of Box's test for equality of covariance matrices. Digit Span total scores were used because age-scaled scores were non-normal and not transformable. Caffeine was included as a covariate because of significant correlations with Digit Span.)

Table 3.3: Group means for cognitive and psychomotor tests

variable	mean		standard deviation	
	group 1 very low HgU	group 2 low HgU	group 1 very low HgU	group 2 low HgU
N =	28	10	28	10
Digit Symbol, age-scaled	12.18	12.80	1.91	2.39
Spot-the-Word, age-scaled	12.68	12.50	1.68	2.17
Visual Reproduction Immediate Recall, age-scaled	11.29	12.00	2.69	1.41
Visual Reproduction Delayed Recall, age-scaled	12.93	14.40	2.55	1.90
Trail Making Test A, time	27.28	28.04	8.88	6.87
Trail Making Test B, time	54.50	64.36	13.83	22.18
Grooved Pegboard, dominant hand, time	63.16	*59.12	7.13	10.12
Grooved Pegboard, non-dominant hand, time	70.40	68.62	10.78	8.96
Rey Auditory-Verbal Learning Test, no. correct,sum of trials 1-5	55.46	57.30	9.18	5.68
Hand Steadiness, dominant hand seconds touching plate, sum all holes	9.45	9.35 a	5.54	4.47
Hand Steadiness, non-dominant hand seconds touching plate, sum all holes	9.55	10.09 a	5.34	4.89
Digit Span, age-scaled	12.00	12.20	1.94	3.12

* $p<0.05$ ** $p<0.01$ corrected for multiple comparisons

a: N=9

Table 3.4a: Analysis of Covariance for self-report symptom questionnaires with age controlled

variable	AGE		MERCURY GROUPS	
	F	Sig.	F	Sig.
SCL-90-R, GSI (1)	1.799	0.188	4.953	*0.033
Fatigue Impact Scale (1)	5.351	*0.027	6.865	*0.013
Cognitive Failures Questionnaire (1)	7.972	**0.008	5.013	*0.032

* p<0.05 ** p<0.01 corrected for multiple comparisons; df = 1,35 for all tests

(1) log transform

Table 3.4b: Analysis of Covariance for self-report symptom questionnaires with age and life-event score controlled

variable	AGE		LIFE-EVENTS		MERCURY GROUPS	
	F	Sig.	F	Sig.	F	Sig.
SCL-90-R, GSI (1)	1.025	0.318	7.616	**0.009	2.026	0.164
Fatigue Impact Scale (1)	4.386	*0.044	2.056	0.161	4.266	*0.047
Cognitive Failures Questionnaire (1)	6.721	*0.014	4.045	0.052	2.477	0.125

* p<0.05 ** p<0.01 corrected for multiple comparisons; df = 1,34 for all tests

(1) log transform

Table 3.5: Group means for SCL-90-R scales

variable	mean		standard deviation	
	group 1 very low HgU	group 2 low HgU	group 1 very low HgU	group 2 low HgU
N =	28	10		
SCL-90-R, Global Severity Index	0.339	*0.610	0.302	0.449
SCL-90-R, Positive Symptom Total	21.25	*32.40	12.65	16.13
SCL-90-R, Positive Symptom Distress Index	1.30	1.45	0.34	0.69
SUBSCALES raw scores				
Somatisation	0.324	0.333	0.396	0.307
Obsessive-Compulsive	0.625	0.900	0.462	0.548
Interpersonal Sensitivity	0.298	*0.722	0.271	0.677
Depression	0.522	0.939	0.602	0.933
Anxiety	0.296	*0.530	0.346	0.374
Hostility	0.351	**0.800	0.539	0.543
Phobic Anxiety	0.026	0.143	0.068	0.316
Paranoid Ideation	0.185	*0.717	0.254	0.857
Psychoticism	0.104	0.290	0.177	0.390
Additional Items	0.505	0.700	0.486	0.701

significant difference between groups * $p<0.05$ ** $p<0.01$ (Mann-Whitney 1-tailed)

(not corrected for multiple comparisons; when corrections are made for subtests, group differences are no longer sig.)

Table 3.6: Group means for CFQ and FIS

variable	mean		standard deviation	
	group 1 very low HgU	group 2 low HgU	group 1 very low HgU	group 2 low HgU
N =	28	10		
Cognitive Failures Questionnaire	32.04	41.00	11.86	14.50
Fatigue Impact Scale-Total	15.04	**37.6	21.41	36.12
Fatigue Impact Scale-Cognitive	5.14	*9.6	6.71	8.07
Fatigue Impact Scale-Physical	3.11	**9.1	5.45	9.92
Fatigue Impact Scale-Social	6.79	**18.9	10.76	18.90

significant difference between groups * p<0.05 ** p<0.01 (1-tailed Mann-Whitney)

(not corrected for multiple comparisons; when corrections are made for subtests, group differences are still sig. for Social* and Physical**)

Table 3.7 Questionnaires, HgU and life-event score

Correlations

		1	2	3	4	5
1) logn HgU	Pearson Correlation	1.0	.418**	.324*	.235	.376*
	Sig. (2-tailed)	.	.009	.047	.156	.020
	N	38	38	38	38	38
2) logn LIFE-EVENTS	Pearson Correlation	.418**	1.0	.424**	.363*	.507**
	Sig. (2-tailed)	.009	.	.008	.025	.001
	N	38	38	38	38	38
3) logn CFQ	Pearson Correlation	.324*	.424**	1.0	.555**	.636**
	Sig. (2-tailed)	.047	.008	.	.000	.000
	N	38	38	38	38	38
4) logn FIS total score	Pearson Correlation	.235	.363*	.555**	1.0	.656**
	Sig. (2-tailed)	.156	.025	.000	.	.000
	N	38	38	38	38	38
5) logn SCL-90-R GSI	Pearson Correlation	.376*	.507**	.636**	.656**	1.0
	Sig. (2-tailed)	.020	.001	.000	.000	.
	N	38	38	38	38	38

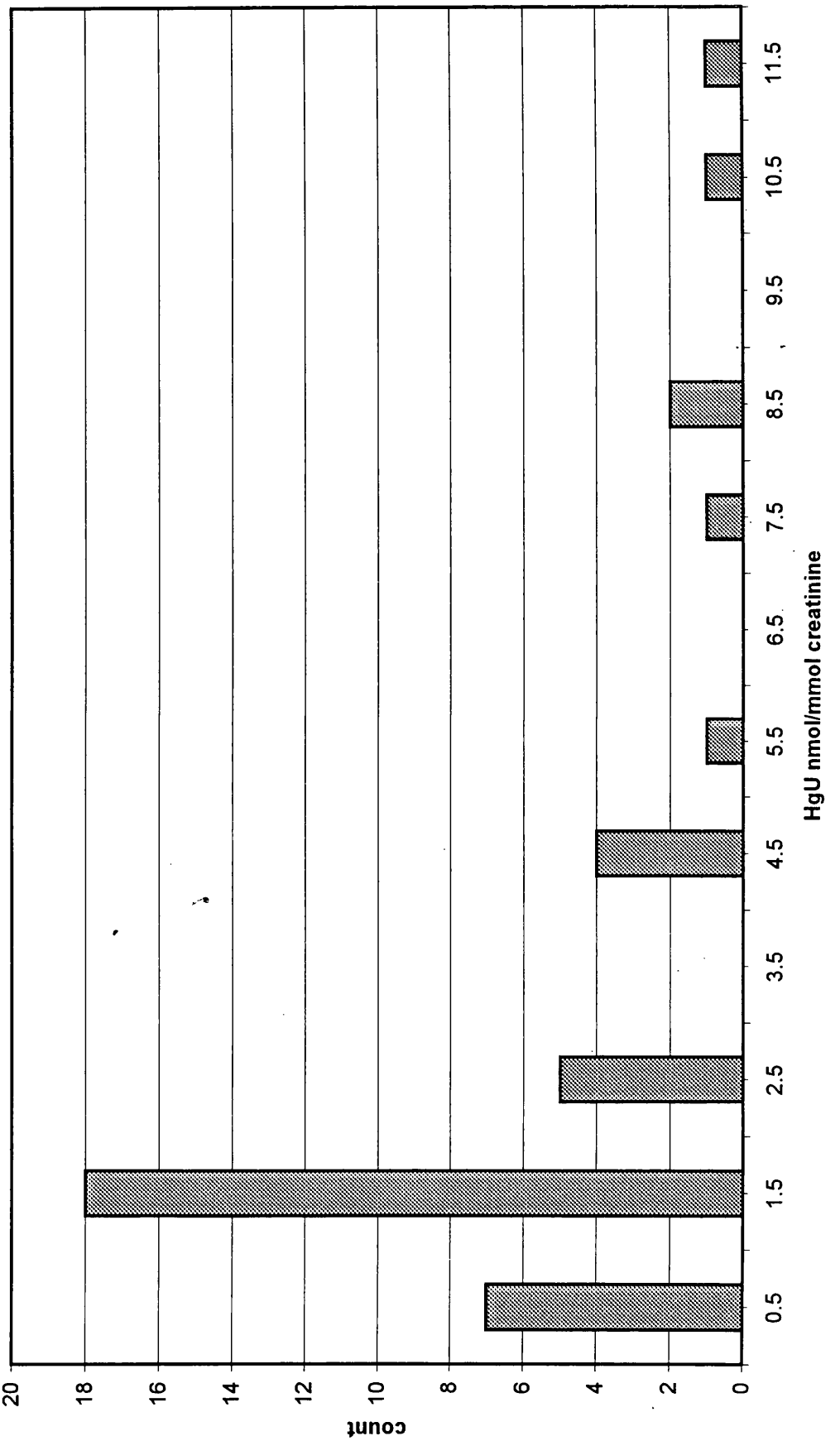


Figure 3.1 HgU distribution, data from present study

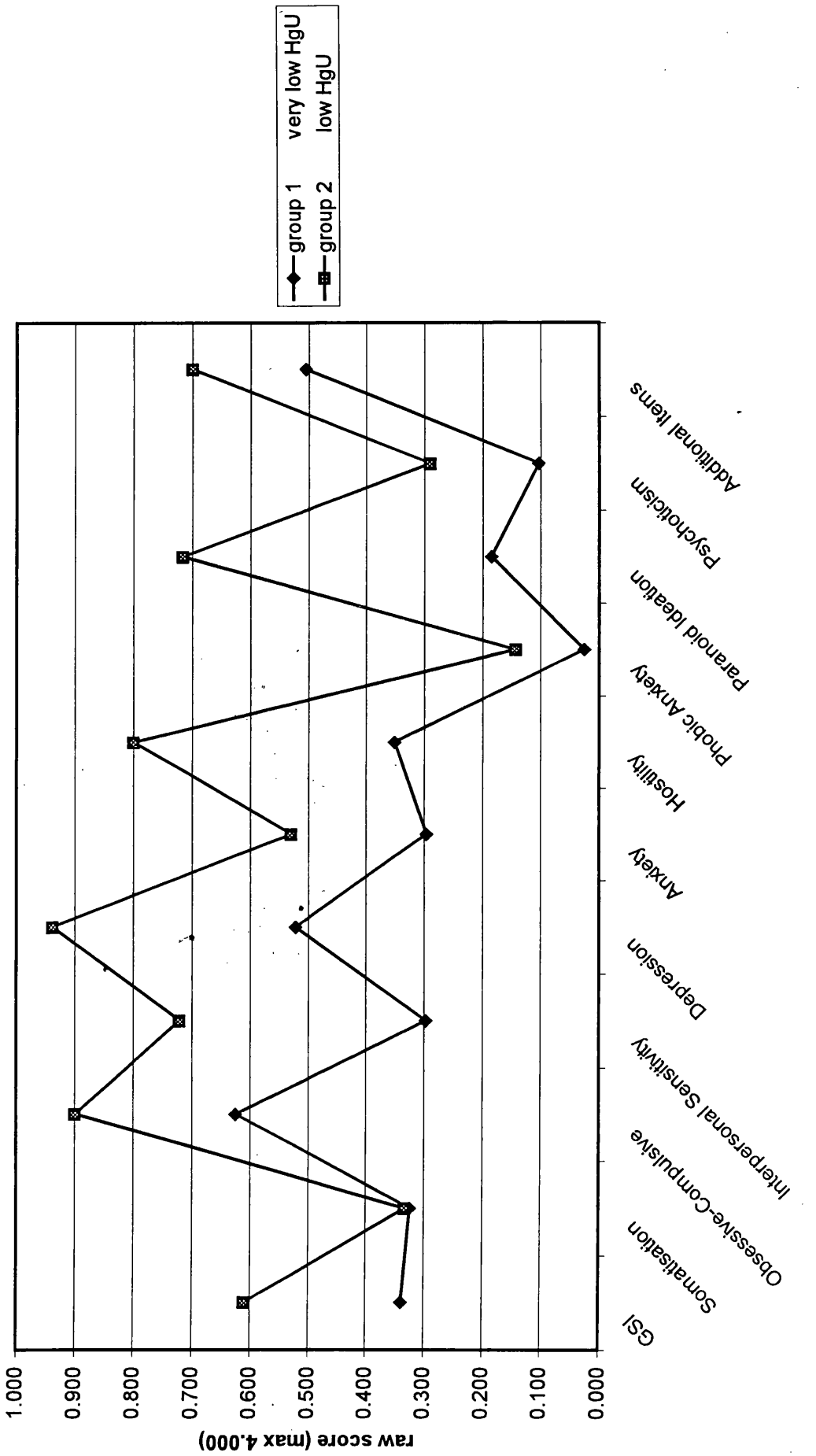
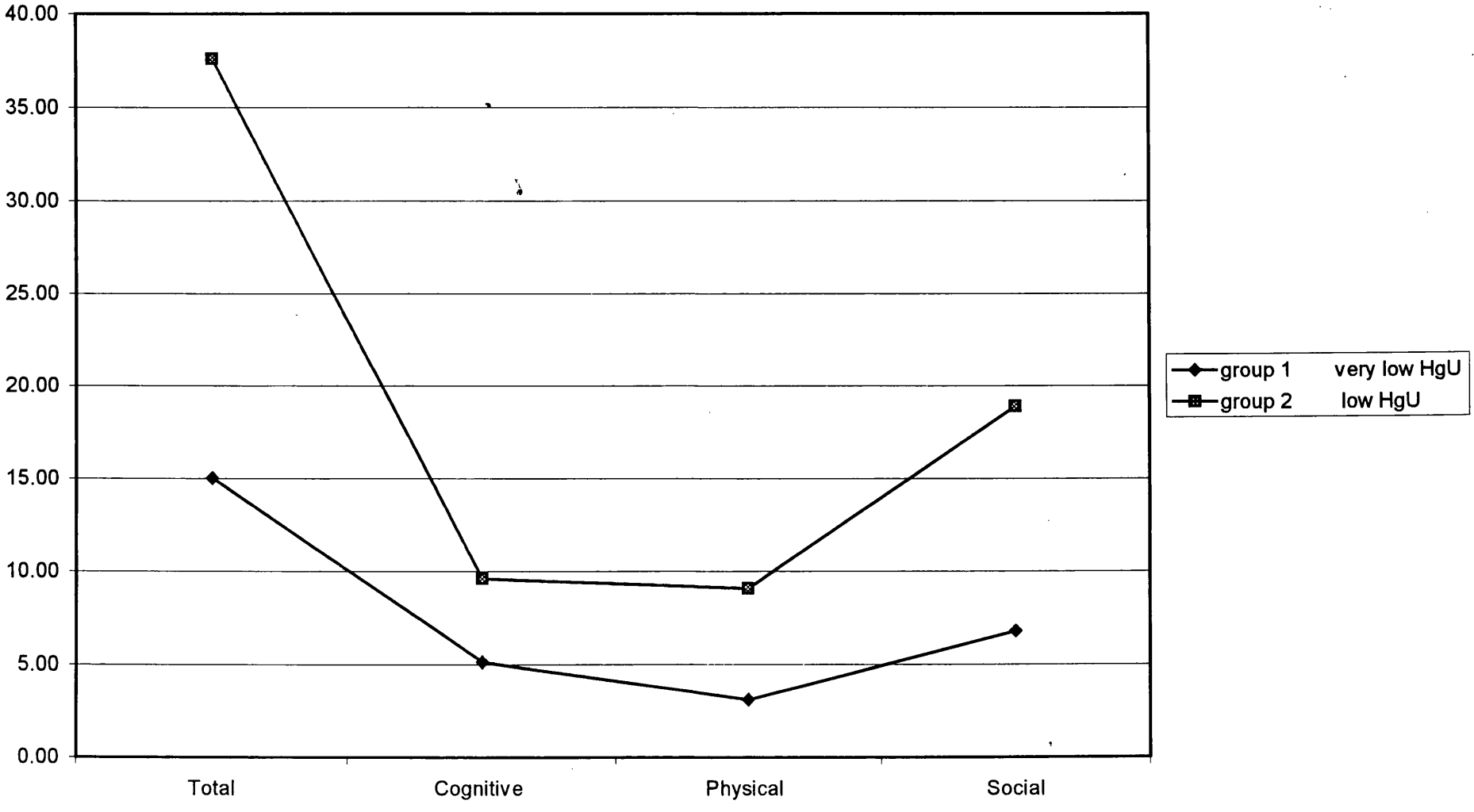


Figure 3.2: SCL-90-R GSI and subscale means

Figure 3.3: Fatigue Impact Scale means



4. Small Scale Service-Related Project

Have referrals to a Clinical Psychology Service increased in complexity?

Prepared for submission to *Clinical Psychology* (see Appendix D3)

Have referrals to an Adult Clinical Psychology Service increased in complexity?

In recent years my colleagues and I have had the distinct impression that outpatient referrals to our adult clinical psychology service have increased in complexity. If true, this might have service implications, for instance in terms of the number of appointments necessary for treatment, and hence the number of patients we are able to see and the length of the waiting list. However, we recently discovered that attempting to define what we meant by 'complexity' and what our perception was based on was somewhat problematic. The type of problem referred was certainly one element, for instance, simple phobias appear to be referred rarely these days, and cases of multiple trauma, such as survivors of child sexual abuse, more frequently. We also felt that anxiety cases now more often require cognitive intervention as well as simpler stress-management techniques, but in general it was clear that 'complexity' required more operational definition.

There appear to be few studies that have addressed the issue of complexity of referrals, although many have looked at co-morbidity of specific diagnoses. Upson & Wright (1999) compared self-referrals with professional referrals on psychologists' ratings of complexity, severity and chronicity, defining complexity in terms of number of presenting problems, previous history of psychological treatment, and involvement with other agencies. They found that referral source did not relate significantly to complexity or to the other measures.

This study aims to look for evidence relevant to our perception of increased complexity within an existing patient-contact database, beginning with type of problem referred and

those parameters used by Upson & Wright, and going on to look for other possible indirect indicators of complexity.

METHOD

The database has been kept since November 1992. The data recording form used was adapted from one produced by the National Psychology Advisory Committee (NPAC) for Scotland. A copy of the form is included in Appendix D2. Data on each patient is recorded at referral (Sheet A), at first contact (Sheet B) and at discharge (Sheet C).

Limitations of the data and exclusion criteria

(a) The database is incomplete, as there is a backlog of data collation and coding. This means that there are fewer cases coded for more recent years. To control for this the different years were compared using percentages within each year.

(b) The turnover in staff makes it difficult to ensure consistency in coding of data over time. It was therefore decided to use data only from those psychologists working in the department throughout the period in question (N=2), which should reduce variability. It is still possible that the data coding practices of these psychologists may have changed over time, but this is likely to have been minimised by detailed coding instructions.

It was also decided to restrict the data analysed to the types of work responsibility for the two psychologists which have been fairly consistent over the time period. In effect this meant including only outpatients, and excluding group-work and pain-management clinics.

(c) In the case of referrals made in the most recent years, some patients may still be in therapy, and among those where therapy has been completed there may be a higher proportion of the simpler cases. Therefore, in order not to bias the data, a cut-off was imposed on referral date at 31.12.99.

(d) Patients who were referred but never seen were excluded from all analyses, and patients who failed to complete treatment were excluded as necessary.

RESULTS

(1) Type of main problem identified at initial assessment

This department uses a list of problems which can be grouped into the broad categories shown in Figure 4.1. (Source data for all the figures can be found in the tables in Appendix D1.) The problem list is individual to this department, and problems are not defined by standard criteria. However, it may be reasonable to assume a degree of consistency of categorisation over time, since the two psychologists involved were very experienced even at the beginning of the data collection (being qualified 10 and 16 years), and any changes over time therefore are probably likely to reflect a genuine change in type of problem referred. Percentages

are reported in order to correct for variations in the number of cases on the database for different years.

It can be seen from Figure 4.1 that, as we suspected, the proportion of referrals of phobias has declined with time (Spearman's rho = -0.85, $p<0.05$, 2-tailed). It also appears that the proportion of affective disorders (mostly depression) and traumas (post-traumatic stress, including adult survivors of childhood sexual abuse) has increased, and the proportion of referrals for relationship problems has declined (perhaps because more use has been made of Relate). The relevant correlations are consistent with this but unfortunately not significant.

Whilst it could be argued that, on average, phobias are less complex than affective disorders and trauma, it is difficult to say the same for relationship problems. However, there is some very limited support here for the suggestion that change in the type of problem referred over time may contribute to the perception of increasing complexity of cases referred.

(2) Number of problems identified at initial assessment

This data was extracted for the years 1993-1996, and is presented in Figure 4.2 (data for more than one problem were not available after 1996). It can be seen that there was little change over the 4 years in the number of problems identified; if there is any change at all, there may be a slight decrease in the number of problems with time. This data therefore does not appear to support the idea of increasing complexity of cases.

(3) Number of previous episodes of care with the psychology service

The percentages of cases per year that have 0, 1, or more than 1 previous episodes with our psychology service were examined (Figure 4.3, in Appendix D1). There appears to be very slight increase in the number of previous episodes, but this is not significant. There is no support here for increasing complexity.

(4) Involvement with other agencies

The data on this has not been reliably coded on our forms, and the closest approximation is to compare direct referrals from GPs with referrals from other professions, since the latter by definition has more agencies than the GP involved. There is a slight increase in the proportion of non-GP referrals and then a decrease, but the change is not significant (Figure 4.4, Appendix D1).

So far we have little evidence of an increase in complexity of referrals with time. Are there any other indirect indicators which might be associated with complexity?

(5) Duration of main presenting problem

It is possible that problems enduring for a longer period of time may be perceived as more complex. In our database, duration is recorded in 6 bands, which have been collapsed into 2 (more than 1 year, and 1 year or less) for Figure 4.5. ("Duration" here refers to the duration of the episode of a problem/illness, which is current at the

assessment, irrespective of how many previous episodes there have been. It is therefore an under-estimate of chronicity for those problems which recur in clearly defined periods, as opposed to those which are continuous).

Figure 4.5 shows that, whilst the longer problem duration is the more frequent, there has been no increase in problem duration over time. Therefore, the duration of the main presenting problem does not appear to relate to perceptions of increasing complexity of cases.

(6) Length of Treatment (number of appointments)

More complex cases are likely to need longer treatment. The number of appointments kept by the patient is probably the most relevant index of length of treatment. This data is presented in Figure 4.6, for cases where treatment was completed.

The mean number of appointments shows a decline with time, which is the opposite of what would be expected if complexity were increasing. However, data distributions are skewed and there are a number of outliers which distort the data. The outliers can be eliminated using a "5% Trim" (i.e. removing the top 5% and bottom 5% of data points, using the EXAMINE sub-program of SPSS 6 for Windows). The resulting means appear to show no change with time. However, SPSS also includes other measures of central tendency called "M-Estimators", or weighted means, which the SPSS glossary maintains are superior to mean or median when data distributions have extreme values. One of these (Tukey) is presented in

Figure 4.6. Regression analysis on these data shows a significant increase in the number of appointments with time ($F=15.27$, df 1, 5, $p=0.0113$). However, the increase is very small (0.17 appointments per patient per year) and unlikely to have been perceived by the psychologists. Hence it is unlikely to have influenced the perception of complexity.

(7) Proportion of appointments missed

It is possible that perception of case complexity may be influenced by the degree of chaos in patients' lives, which will impact upon attendance at appointments. Therefore the proportion of appointments missed was examined and is shown in Figure 4.7, for cases where treatment was completed.

There appears to be a slight decrease in missed appointments until 1996, and a sudden increase in 1997. However, overall there is no significant difference between the years 1993 to 1999.

(8) Number of psychological approaches used

It may be expected that more complex cases will, on average, need more than one type of psychological intervention. Our data form allows for coding of two intervention techniques/types from a list of very broad categories (e.g. behavioural, cognitive, psychodynamic etc.). Therefore, the number of cases where a second intervention was recorded was calculated as a proportion of the number where any

intervention was recorded. This data is presented in Figure 4.8. It can clearly be seen that the number of psychological approaches used does not increase with time, and therefore does not relate to the perception of increased complexity.

CONCLUSIONS

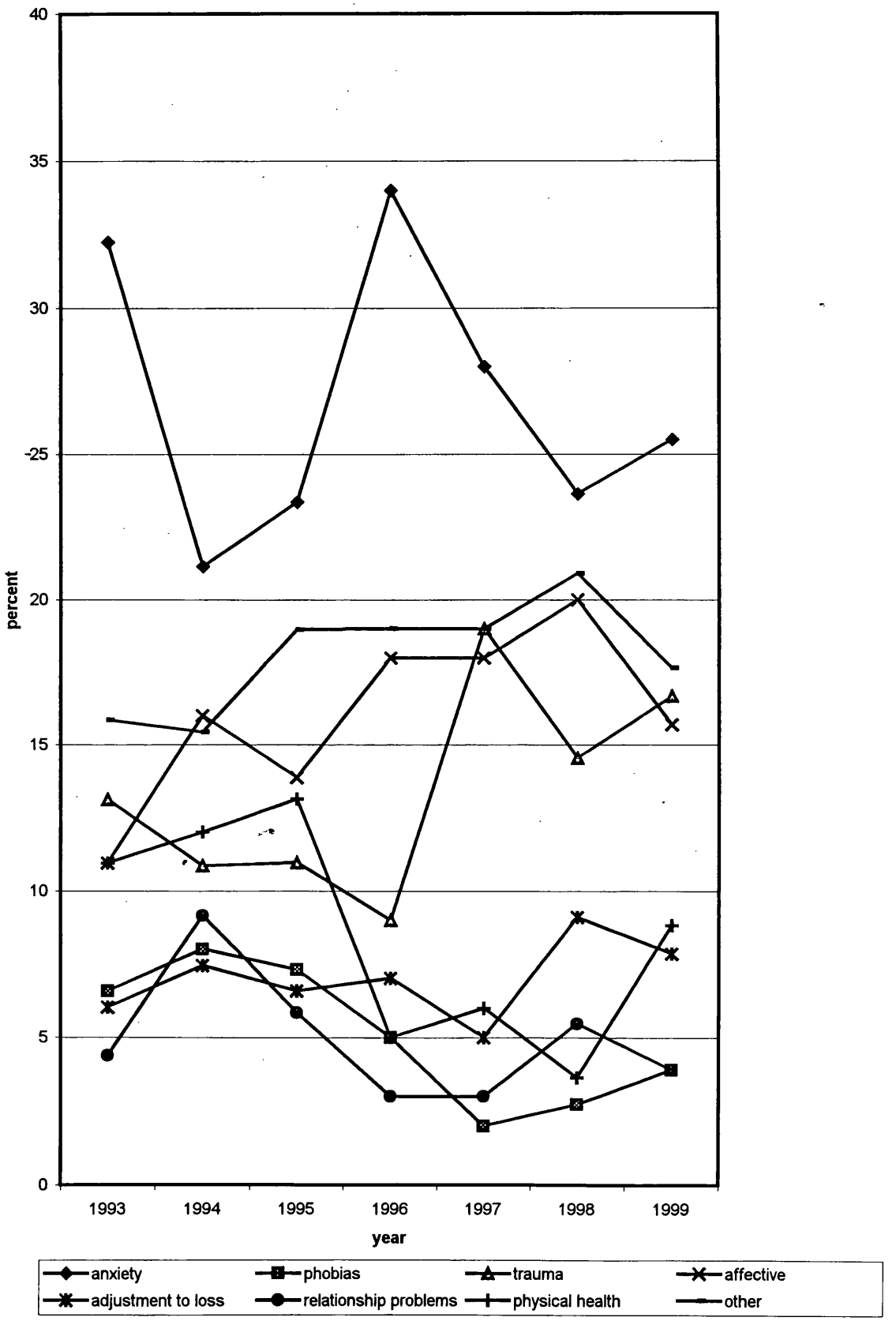
The perception that the complexity of cases referred to this department has increased with time may relate to the significant decrease in the proportion of phobias from 1993 to 1999, other changes in problem type being non-significant. However, this marginal change in problem type does not appear to be accompanied by an increase in the number of problems identified (although the data available here is restricted to 1993 to 1996). Nor does the perceived increase in complexity with time appear to relate to number of previous episodes of care with our service, whether referred by GP or other profession, increase in duration of main presenting problem, length of treatment, proportion of appointments missed, or to the number of different psychological approaches required.

In conclusion, there is little sound evidence from retrospective data analysis to suggest that the complexity of referrals to our service has changed over a 7-year period, although a prospective study with more precise definitions might produce different results.

REFERENCES

Upson, P., and Wright, J. (1999) Self-referrals: another outbreak of the "worried well"? **Clinical Psychology Forum, 134,** 18-21

Figure 4.1: PROBLEM TYPE BY YEAR OF REFERRAL
percent of cases coded for that year



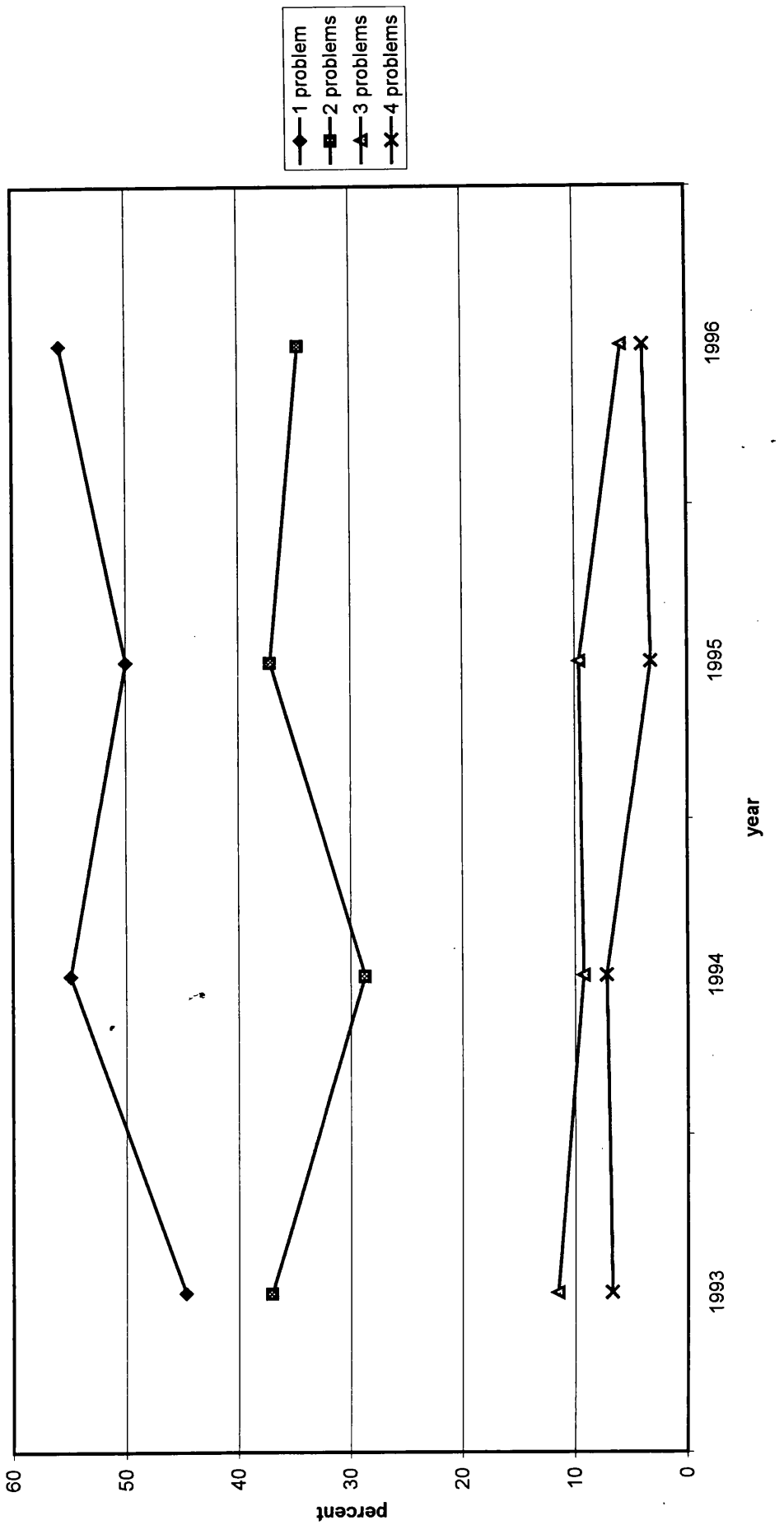


Figure 4.2: NUMBER OF PROBLEMS IDENTIFIED PER PATIENT, BY YEAR

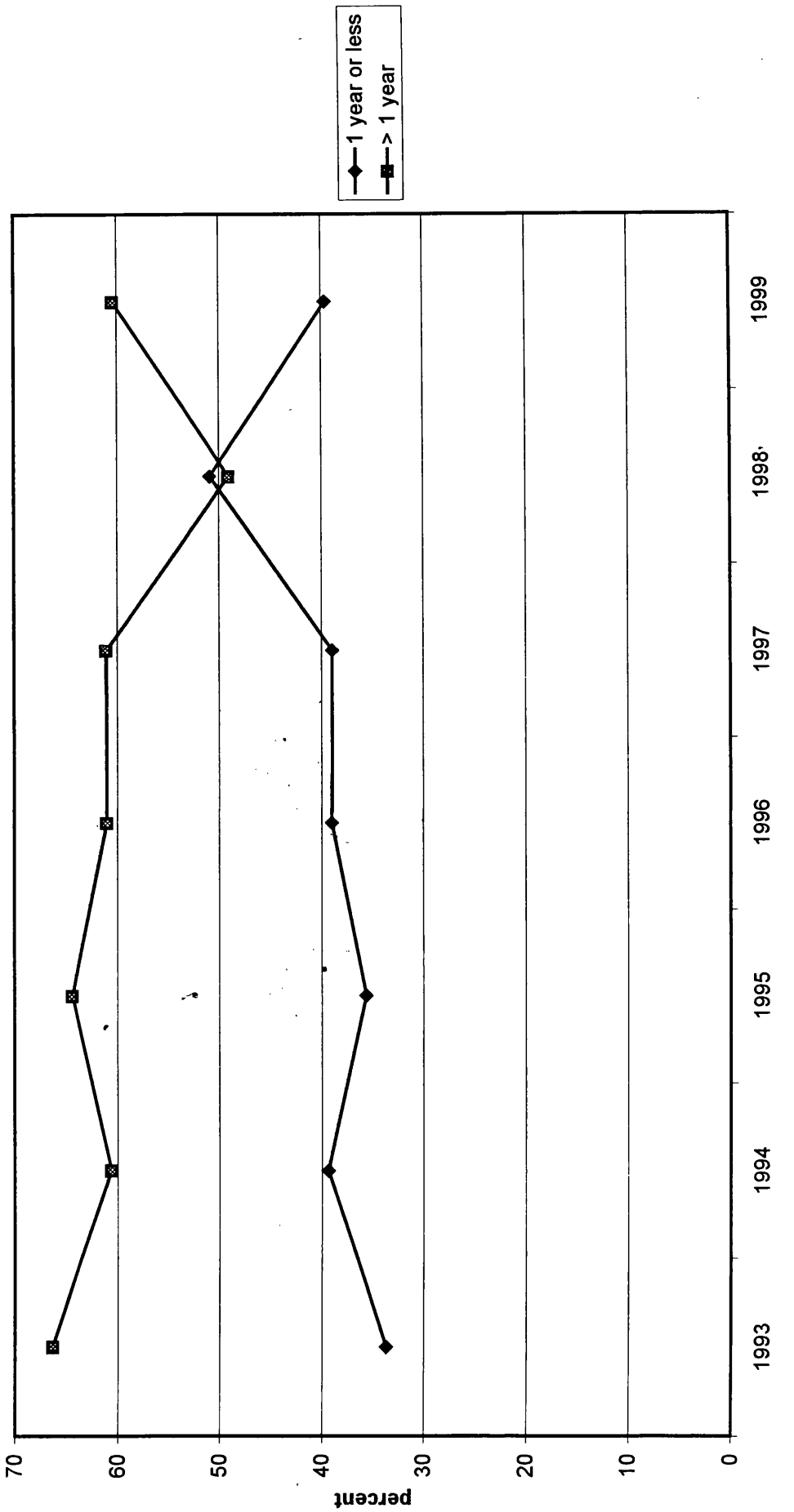


Figure 4.5: DURATION OF PROBLEM BY YEAR OF REFERRAL
(simplified)

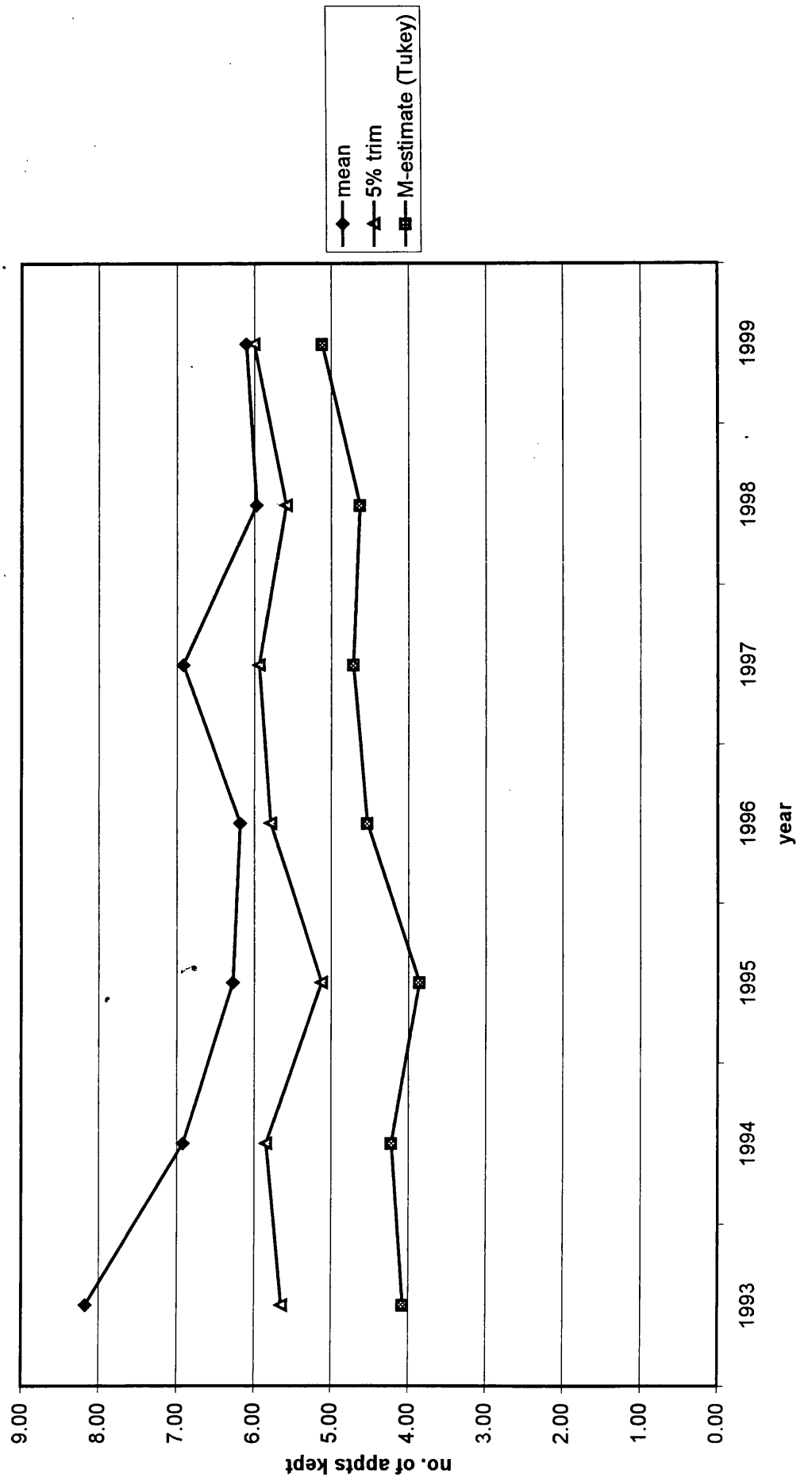


Figure 4.6: NUMBER OF APPOINTMENTS KEPT BY YEAR OF REFERRAL
(cases with treatment completed)

Figure 4.7: PERCENT OF APPOINTMENTS MISSED BY YEAR OF REFERRRAL
(cases with treatment completed)

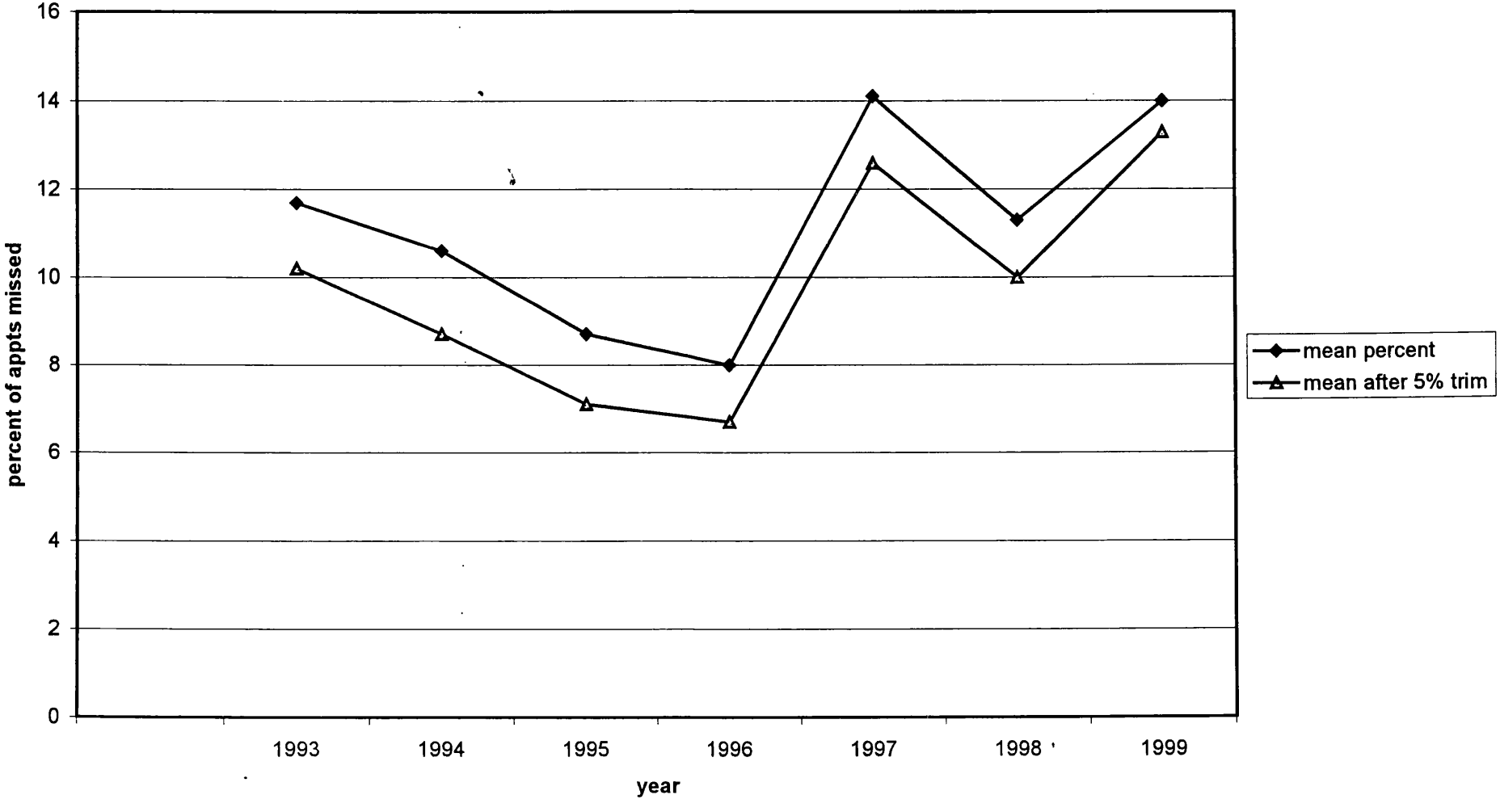
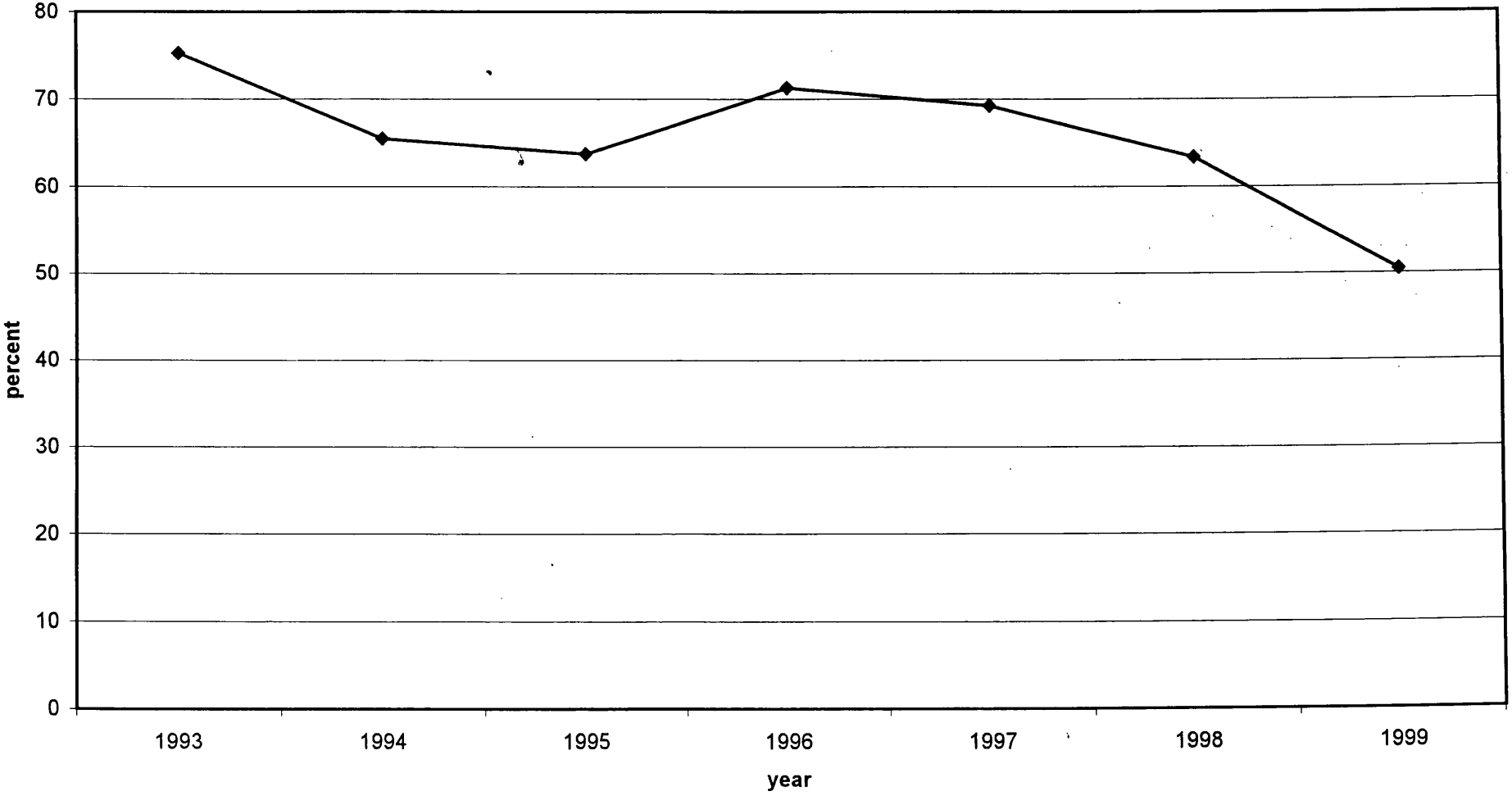


Figure 4.8: PERCENT OF CASES WITH MORE THAN ONE TYPE OF INTERVENTION BY YEAR OF REFERRAL (excludes cases where groupwork is main intervention)



5. Single Clinical Case Research Study

Can sustained and spatial attention be improved after chronic brain damage? A single case study

Prepared for submission to *Brain Injury* (see Appendix 4)

ABSTRACT

primary objective: To investigate the effect of auditory alerting on sustained attention and executive function, and of auditory alerting and left-limb exercise on spatial ability, in an adult male with multiple brain lesions.

research design: Single case experimental designs, with reversal or partial reversal.

methods and procedures: 3 main tasks were used to assess the effects of the interventions: semantic classification with counting (sustained attention), Controlled Word Association (COWA, executive function), and dot-location (spatial ability). Control tasks were run concurrently.

experimental interventions: Auditory alerting stimuli were applied to all 3 main tasks, and left-limb exercise to the spatial task.

results: Alerting improved speed and accuracy on the sustained attention task, and had no effect on COWA. Neither alerting nor limb activation improved spatial performance.

conclusions: Auditory alerting may be useful in improving sustained attention, but effects of limb activation on spatial neglect demonstrated by others may not generalise to other spatial abilities.

KEY TERMS: brain damage sustained attention spatial ability rehabilitation

APPENDIX A

Appendix A1

Table 1.1: Industries, Professions and Substances Involving Mercury

Table 1.2: Equivalence Ratios of Various Hg Measures

Table 1.3a: Summary of 44 studies on psychological effects of mercury: Details of participants

Table 1.3b: Summary of 44 studies on psychological effects of mercury: Details of test results

Appendix A2

'Instructions to Authors' for selected journal: Occupational and Environmental Medicine

Appendix A1

Table 1.1: Industries, Professions and Substances Involving Mercury

Hg mining and extraction

dentistry

dental materials production

chloralkali (chlorine + sodium hydroxide production)

other chemical manufacture (eg acetaldehyde)

gold mining

paper production

electroplating

mercury batteries

photographic materials

fluorescent lighting

electrical equipment(eg tilt switches)

medicines

fungicides

textiles (especially felt)

pigments

taxidermy

scientific instruments
(e.g. thermometers, barometers, glass etching, gas measurements, strain gauges)

Appendix A1 (cont.)

Table 1.2: Equivalence Ratios of Various Hg Measures

(used for conversions to HgU values in Table 1.3)

['≅' means approximately equivalent to, and superscripts 'x' refer to the source of the data used to obtain the conversion factor]

atomic/molecular weight Hg^0 = 200.6

molecular weight creatinine = 112

1 μg Hg = 4.985 nmol = 0.005 μmol

1 μg/l urine ≅ 0.3 μg/l blood[a] ≅ 1 to 2 μg/m^3 inspired air[a]

1 μg/l urine ≅ 0.45 nmol/mmol creatinine in urine[b] = 0.80 μg/g creatinine[c]

1 ppm hair ≅ 3.3 ppm blood[d] ≅ 3.3 μg/l blood ≅ 11 μg/l urine[a]

[a] Foà 1985 [1]
[b] Ritchie et al. [in press]
[c] Langworth et al. 1992 [11]
[d] Dolbec et al. 2000 [12]

Appendix A1 (cont.)

Table 1.3a: Summary of 44 studies on psychological effects of mercury: Details of participants

Table 1.3b: Summary of 44 studies on psychological effects of mercury: Details of test results

code	refer-ence	authors	year	participants	controls	N Hg	N controls	ages Hg	ages controls	type Hg exposed to	country	Hg (urine equiv µg/l)
A	[28]	Bittner,ACJr et al.	1998	dental workers	(correlational, meta-analysis)	230		50		Hg0	USA	20
B	[29]	Camerino,D et al.	1981	Hg exposed workers (ore processing)	unexposed (+correlatonal)	12 (33 for corrlns)		22		Hg0,Hg++	Italy	139
C	[30]	Echeverria,D et al.	1995	dentists (low Hg)	dentists (very low Hg)	19	20	52	45	Hg0	USA	36
D	[27]	Echeverria,D et al.	1998	dental workers	none(correlational)	48		49		Hg0	USA	1
E	[18]	Gonzalez-Ramirez,D et al.	1995	dental techns/dentists	non-dental personnel	10/5	13	20/30	36	Hg0	Mexico	30/20
F	[31]	Kishi,R et al.	1993	ex Hg miners	unexposed, matched	76	76	60	60	Hg++	Japan	1000
G	[11]	Langworth,S et al.	1992	Hg exp.workers (chloralkali)	other industrial workers	89	75	42	43	Hg0	Sweden	32
H	[32]	Liang,Y-X et al.	1993	Hg exp.workers (lamps)	unexposed	88	70	34	35	Hg0	China	24
I	[33]	Ngim,CH et al.	1992	dentists	unexposed	98	54	32	34	Hg0	Singapore	37
J	[34]	Piikivi,L et al.	1984	Hg exp.workers (chloralkali)	paper & cable workers	36	36	40	40?	Hg0	Finland	58
K	[35]	Richie,K et al.	1995	dentists	GPs	20	20	40	44	Hg0	Scotland	8
L	[10]	Richie,K et al.	in press	dentists	academics	180	180	41	34	Hg0	Scotland	6
M	[36]	Saxe,SR et al.	1995	nuns (with amalgam) 3 groups	nuns (less/no amalgam) 2 groups	32/44/15	10/28	82/85/85	83/88	Hg0	USA	?
N	[37]	Shapiro,IM et al.	1982	dentists (higher Hg)	dentists (lower Hg)	26	17	50	51	Hg0	USA	?
O	[38]	Siblerud,RL	1989	students (with amalgam)	students (no amalgam)	50	51	23	22	Hg0	USA	4
P	[39]	Siblerud,RL	1992	MS patients (with amalgam)	MS pats (no amalgam)	47	50	41	44	Hg0	USA	?
Q	[40]	Siblerud,RL et al.	1994	women (with amalgam)	women (no amalgam)	25	23	35	35	Hg0	USA	?
R	[41]	Siblerud,RL et al.	1998	bipolar disorder(amalgams removed)	bipolar (amalgams remain)	11	9	41	36	Hg0	USA	?
S	[42]	Smith,PJ et al.	1983	Hg exp.workers (chloralkali) 3 groups	none(correlational)	28/26/60		39/37/33		Hg0	USA	175/195/108
T	[43]	Soleo,L et al.	1990	Hg exp.workers (lamps) 2 groups	less exposed workers	8/20	22	40/40	39	Hg0	Italy	?
U	[44]	Triebig,G & Schaller,K-H	1982	Hg exp.workers (chemical/thermometer)	unexposed	21/18	39	41/20	30	Hg0,Hg++,orgHg	Germany	279/158
X	[45]	Uzzell,BP & Oler,J	1986	dental assts (higher Hg)	dental assts (lower Hg)	13	13	41	41	Hg0	USA	?
Y	[46]	Vroom,FQ & Greer,M	1972	Hg exp.workers(thermometer)	none	9		51		Hg0	USA	269
Z	[47]	Williamson,AM et al.	1982	Hg exp.workers (fungicide, gold refining)	unexposed,age etc.matched	12	12	age matched		Hg++,orgHg,Hg0	Australia	130
A'	[48]	Piikivi,L & Hänninen,H	1989	Hg exp.workers (chloralkali)	woodprocessing workers(matched)	60	60	38	38	Hg0	Finland	17
B'	[49]	Forzi,M et al.	1976a	Hg exp.workers (chloralkali)	none(correlational)	64		42		Hg0	Italy	100
C'	[50]	Forzi,M et al.	1976b	Hg exp.workers (chloralkali) 2 groups	none(correlational)	57/73		41/35		Hg0	Italy	184/39
H'	[51]	Valciukas,JA et al.	1986	Mohawk Indians (fish eaters)	none(correlational)	400		adult		MeHg	USA/Canada	10
I'	[52]	Triebig,G et al.	1984	Hg exp.workers (chemical)	correlational+age-matched	11	11	45	45	Hg0,Hg++,orgHg	Germany	186
J'	[53]	Roels,H et al.	1985	Hg exp.workers (chloralkali/zinc/electrical)	unexposed	185	162	31	32	Hg0	Belgium	59
K'	[54]	Smith,PJ & Langolf,GD	1981	Hg exp.workers (chloralkali)	none(correlational)	26		38		Hg0	USA	150
L'	[55]	Miller,JM et al.	1975	Hg exp.workers (chloralkali/magnetic)	less exposed(HgU 63mug/l)	77	65	36	36	Hg0	USA	374
M'	[56]	Schuckmann,F	1979	Hg exp.workers (chloralkali)	unexposed(matched)	39	39	?		Hg0	Germany	108
N'	[57]	Langolf,GD et al.	1978	Hg exp.workers (chloralkali)	less exposed(HgU 30mug/l)	79	51	37	39	Hg0	USA	240
O'	[58]	Langolf,GD et al.	1979	Hg exp.workers (chloralkali)	none(longitudinal)	54		37		Hg0	USA	210
Q'	[59]	Fawer,RF et al.	1983	Hg exp.workers (chloralk/glass/acetaldehyde)	unexposed workers	26	25	44	45	Hg0	Switzerland	25
R'	[60]	Verberk,MM et al.	1986	Hg exp.workers (chloralkali)	(correlational)	21		51		Hg0	Netherlands	45
T'	[61]	Haut,MW et al.	1999	construction(acute exp.to vapourised paint)	unexposed	13	13	45	41	Hg0	USA	161
U'	[62]	Powell,T	2000	Hg exp.workers (Hg acetate)	hotel & garden workers(matched)	15	15	37	35	Hg++,Hg0,orgHg	S.Africa	>200
V'	[63]	Urban,P et al.	1996	Hg exp.workers (ore processing)	none	77		39		Hg0,Hg++	Czech/Slovak	210
W'	[12]	Dolbec,J et al.	2000	Amazon Basin residents(fish eaters)	none(correlational)	68		32		MeHg	Brazil	119
X'	[64]	Fiedler,N et al.	1999	residents of former lamp factory	none(correlational+intragroup)	19		39		Hg0	USA	28
Y'	[65]	Mathiesen,T et al.	1999	Hg exp.workers (chloralkali)	nitrate fertilizer workers	75	52	45	46	Hg0	Norway	108
Z'	[66]	Bluhm,RE et al.	1992	construction(acute exp.to high Hg vapour)	co-workers+population norms	26	7	?		Hg0	USA	60-200

Table 1.3a Characteristics of 44 studies on psychological effects of mercury: details of participants ('code' refers to Table 3b)

	Hg urine level:	very low (<10 µg/l)		low (10-50 µg/l)		moderate (50-200 µg/l)		high (>200 µg/l)	
predominant function assessed	**Test**	impairment not shown	impairment shown	impairment not shown	impairment shown	impairment not shown	impairment shown	impairment not shown	impairment shown
perception/ early processing	flicker fusion			J'		Z J'			
	visual evoked potentials								V'
	iconic memory					Z			
	pattern matching			H A'			I'		
	visual form discrimination						T'		
	Judgement of Line Orientation					T'			
	colour vision			J'		J' M'			
	tactile vibration			X'					
	auditory discrimination			I					
attention/ information processing	simple reaction time	D K L		A E G H T J' X'	C	Z J' M'	B Y'		F
	choice reaction time	K L		H			B	L'	
	vigilance	K	L			Z	I'		
	2-digit search				H				
	Embedded Figures	H'							
	Stroop						T' Z'		
	Trail Making Test		D	X'	I		T' Y' Z'	U'	
	attentional switching		D	C	E H				
	Wisconsin Card Sorting Test						T'		
	Test of Everyday Attention(subtests)								U' U'
	Continuous Performance Test(NES)			A' X'		Y'			
	AMIPB Info.Proc. Task A(speed)								U'
	PASAT(attentn/working mem.)			X					
perceptual-motor	visual-motor tracking				G	M' Y'	Z		
	other eye-hand coordination			A	X'			N'	F Y L'
	Grooved Pegboard			I N X'	X		T' W' Y' Z'		U'
	One-holeTest	D		A C	E				
	other dexterity tests			T	J		W'		F J
	copy line drawings	M							
	Rey Complex Figure copy					T'		U'	
	Bender-Gestalt			X	I(time) N			Y	
	Digit Symbol/symbol-digit(NES)	D H'		C G H T X A'	E I		B T' Y'		F U'
	block design	H'		I X		Y'	B		F

Table 1.3b: Characteristics of 44 studies on psychological effects of mercury: details of test results

	Hg urine level:	very low (<10 µg/l)		low (10-50 µg/l)		moderate (50-200 µg/l)		high (>200 µg/l)	
predominant function assessed	Test	impairment not shown	impairment shown	impairment not shown	impairment shown ,	impairment not shown	impairment shown	impairment not shown	impairment shown
motor	grip strength					T'			F
	tremor/hand steadiness	D	D	A G J'	A R' Q'	I M Y'	Z J'	F	Y L' N' O'
	finger tapping/limb tapping		D	A N X A' X'	G H I	Z'	T' W'		F Y L' N'
memory/ learning	STM (unspecified)								U
	Sternberg memory scanning	K	L		G		Z K'		
	WMS Digit Span			E X	C I T	T' Y'	B J	F(backwd)	F(forwd) U'
	other digit span tests			G		S	S		
	Serial Digit Learning(NES)			A'		Y'			
	word list recall - immed	L	K						
	word list recall - delay	L M	K						
	word list recall - recogn	D K L M							
	word list learning	M							
	Rey AVLT, word list learning			X J'		J'			U'
	California Word Learning Test			X'			T'		
	paired associates, verbal			H A' X'			Z Y'		
	WMS Logical Memory				I(delay) /(immed)		J T'(imm) T'(del)		J
	"WMS verbal"								Y
	Rey PRM1						B		
	WMS Visual Reproduction				I(immed) I(delay)	T'	J		
	Rey Complex Figure recall					T'			U'
	'visual retention'		D	H T			B Y'		
	Warrington RMT,face recognition					T'			
	visual recognition mem.		D						Y (faces)
	Pattern Memory(NES)			A'					
	Spatial Memory(CDR)	K L							
	Kimura Continuous Recognition				X	Y'			
language	vocabulary			X X'	C	Y'	I'		
	word fluency	M					T'		
	reading speed								F
	confrontation naming	M					T'		

Table 1.3b: Characteristics of 44 studies on psychological effects of mercury: details of test results

	Hg urine level:	very low (<10 µg/l)		low (10-50 µg/l)		moderate (50-200 µg/l)		high (>200 µg/l)	
predominant function assessed	**Test**	impairment not shown	impairment shown	impairment not shown	impairment shown	impairment not shown	impairment shown	impairment not shown	impairment shown
arithmetic	arithmetic, mental			X	H				
intelligence	Ravens Progressive Matrices			X'			**B B'**	U'	
	WAIS PIQ			X				Y	
	WAIS FSIQ			N X				Y	
	WAIS VIQ			X				Y	
	WAIS Similarities			X	I	Y'	**J**		**J**
	WAIS Picture Completion			I		J Y'			
	WAIS Comprehension				I				
mental health	SCL-90-R/Brief Symptom Inventory		[P] [R]	X'	N X		Z'		U'
	GHQ-12	L							
	BDI		[P] Q						
	POMS		D	A' X'	C E G H I				
	STAXI		[P] Q						
	STAI-state		Q						
personality	STAI-trait		Q						
	16PF						**B**		
	EPI neuroticism			C'	G	C'	**B'**		
	EPI extraversion			C' G		C' B'			
	MMPI-II		[R]				T'		
	Millon CMI-II		[R]						
miscellaneous	Mini Mental State Exam.	M							
	miscel. mood/behaviour		O		G I				U U'
	miscel. physical symptoms		L						F U'
	nerve conduction				N	I'		U	Y [U] V'

KEY: **IMPAIRMENT:** **A** =p<0.001 **A** = p<0.01 A = p<0.05 *A* = p<0.1 [A] = data questionable
NO IMPAIRMENT: A = n.s. **A** = higher Hg sig. better than control
Single capital letters refer to studies in Table 3a
NES = Neurobehavioral Evaluation System CDR = Cognitive Drug Research (computer batteries)

Table 1.3b: Characteristics of 44 studies on psychological effects of mercury: details of test results

Appendix A2 – 'Instructions to Authors' for selected journal:

Occupational and Environmental Medicine

Instructions for Contributors

Occupational and Environmental Medicine is intended primarily for the publication of original contributions relevant to occupational and environmental medicine, including epidemiological studies and toxicological studies of chemicals, industrial, agricultural, and environmental importance. Articles may be submitted as full papers (up to 5000 words) reporting original research, short papers (up to 1500 words) or case reports. We publish few case reports and those we do cover important new ground, rather than emphasising previously known associations. Editorials, leaders and articles in the Continuing Professional Development (CPD) and World at Work series are usually commissioned. Authors wishing to submit such an article or any other review article should first contact the Editor to discuss the suitability of the proposed submission. We also welcome the submission of black and white photographs and short accompanying text for Images in OEM, and short fillers (up to 300 words) covering interesting or instructive experiences in the general field of occupational and environmental medicine. Letters to the Editor are always welcome, and authors should initially submit their letter on the OEM's website using the e-letter (rapid resonse) facility.

Three hard copies of all submissions, plus an electronic copy of text, tables and figure on disk, should be sent to:

The Editor
Occupational and Environmental Medicine
BMJ Publishing Group
BMA House
Tavistock Square
London WC1H 9JR
UK
Tel: +44 (0)20 7383 6561
Fax: +44 (0)20 7383 6668
E-mail: oemeditorial@bmjgroup.com

All authors should sign the covering letter as evidence of consent to publication. Papers reporting results of studies on human subjects must be accompanied by a statement that the subjects gave written, informed consent and by evidence of approval from the appropriate ethics committee. These papers should conform to the principles outlined in the Declaration of Helsinki (BMJ 1964;ii:177). Contact details of the corresponding author, including a telephone number, fax number and e-mail address, must be provided at submission.

Authors are asked to declare any conflict of interest. If requested, authors shall produce the data on which the manuscript is based, for examination by the Editor. All authors are required to grant *Occupational and Environmental Medicine* an exclusive licence for publication.

Authors are asked to submit with their manuscript the names and addresses of three people who they consider would be suitable independent reviewers. They will not necessarily be approached to review the paper.

Papers
Papers are considered on the understanding that they are submitted solely to this Journal and do not duplicate material already published elsewhere. In cases of doubt, where part of the material has

been published elsewhere, the published material should be included with the submitted manuscript to allow the Editor to assess the degree of duplication. The Editor cannot enter into correspondence about papers rejected as being unsuitable for publication, and the Editor's decision in these matters is final.

Papers should not normally exceed about 5000 words and should include a structured abstract of not more than 300 words, under headings of Objectives, Methods, Results, and Conclusions. Please include up to three keywords or key terms to assist with indexing.

Papers should follow the requirements of the International Committee of Medical Journal Editors (*BMJ* 1991;**302**:338-41). Papers and references must be typewritten in double spacing on one side of the paper only, with wide margins. SI units should be used. Revised manuscripts should be as hard copy and on disk. Detailed instructions will be provided on invitation to revise.

Short reports

Short reports (including case reports) should be not more than 1500 words including a brief abstract. They should comprise sections of Introduction, Methods, Results, and Discussion with not more than one table or figure and up to 10 references. The format of case reports should be Introduction, Case report, and Discussion.

Main Messages

Authors of papers and short reports should include with their submission a summary box of up to five **main messages** from the work and a box of up to three **policy implications** of the work.

Illustrations

Black and white illustrations (artwork) can be supplied as (or exported as) EPS files. Our preferred formats are Illustrator or Corel Draw. Black and White images (photographs) can be supplied as TIFF files, to a minumum of 300 dpi. This will ensure the quality of the final image. Our preferred format is Photoshop. Digital graphics supplied in formats other than thase listed above may be refused due to quality considerations. Wherever possible colour images should be supplied digitally. These should be on formatted floppy disks as TIFF files, preferably at a minimum resolution of 600 dpi or high quality JPEG files. All graphics should be supplied along with three hard copies of the figure. Legends to figures should be supplied on a separate sheet of paper, and included in the electronic text file with the manuscript and references.

Abbreviations

Authors should submit a list of the abbreviations used in their paper or short report.

References

References will not be checked by the editorial office; responsibility for the accuracy and completeness of references lies with the authors. Number references consecutively in the order in which they are first mentioned in the text. Identify references in texts, tables, and legends by Arabic numerals enclosed in square brackets. References cited only in tables or in legends to figures should be numbered in accordance with a sequence established by the first identification in the text of a particular table or illustration. Include only references essential in the argument being developed in the paper or to the discussion of results, or to describe methods which are being used when the original description is too long for inclusion. Information from manuscripts not yet in press or personal communications should be cited in the text, not as formal references.

Use the Vancouver style, as in this issue for instance, for a standard journal article: authors list all authors when three or fewer, when four or more list only three and add *et al*), title, abbreviated title of journal as given in *Index Medicus* (if not in *Index Medicus* give in full), year of publication, volume number, and first and last page number.

Proofs
Contributors will receive one proof. Only minor corrections can be made at this stage; corrections other an printer's errors may be charged to the author.

Reprints
Reprints will be charged for. The number of reprints required should be stated on the form provided with the proofs.

APPENDIX B

Appendix B1

Initial pilot contact letter and return form, sent to 20 dentists in December 1999 to assess level of response prior to ethical committee submission.

Appendix B2

Information sheet and consent form approved by ethics committee, and sent to all dentists contacted for the study.

Appendix B3

Letter from Dental Ethics Committee giving approval to project.

Division of Clinical Psychology

Direct line: 0141-211
Fax: 0141-357 4899
E-mail:

UNIVERSITY *of* GLASGOW

December 1999

Dear Dentist,

You recently participated in a study of occupational exposure to mercury carried out by Dr. Karen Ritchie and colleagues in the Glasgow University Department of Public Health. I am currently planning a complementary research study which would provide additional data on cognitive function and psychological wellbeing. This would involve recruiting dentists who took part in the original study, and giving them a further test battery and some questionnaires.

Prior to submission of my research proposal to the Ethical Committee, I would like to obtain an estimate of how many dentists would be willing to participate. I am therefore writing to you, via Dr. Ritchie, to ask if you would agree in principal to take part. I am not at this stage asking for a definite commitment to participate.

You may wish to consider the following information before you decide:-

(1) The test battery would comprise mostly paper-and-pencil tests taking approximately 45 minutes, and would be administered by myself. In addition, there would be some questionnaires which you could complete at some other time convenient to yourself, which would be likely to take another 20 minutes or so.

(2) Unfortunately I am not able to pay you for your time, but would be happy to visit you for the testing at whatever time and location are convenient to you.

(3) Data will be anonimised and kept confidential; they will only be matched up with Dr. Ritchie's data if you give explicit consent.

If you would like to help in this research I would be grateful if you would return the enclosed form to me in the s.a.e provided, preferably within the next two weeks. Many thanks for your help.

Yours sincerely,

David Martinage, B.A., Dip.Clin.Psychol.
Consultant Clinical Psychologist

p.s. This research study is part of my part-time Doctorate in the Department. My supervisor is the Professor of Clinical Neuropsychology, Tom McMillan.

I **am / am not** interested in participating in the research study on occupational exposure to mercury to be conducted by Mr. David Martinage. I understand that this is not a consent form, merely an expression of interest, and that I will be contacted at a later date with further information.

Signed ..... Date .....

Name in capitals .....

Address for contact .....

.....

.....

Telephone no. .....

PLEASE RETURN TO: Mr. David Martinage, c/o Professor Tom McMillan, Department of Psychological Medicine, Academic Centre, Gartnavel Royal Hospital, Glasgow G12 0XH

Research study on the effect of low level mercury exposure on psychological health of dental surgeons

INFORMATION FOR PARTICIPANTS

Purpose of Study

This study is designed to assess whether there are any effects of low levels of mercury in the body on various cognitive and psychological functions. It extends and complements the study recently carried out by Dr. Karen Ritchie and colleagues in Glasgow University Department of Public Health, in which you have already participated.

What is involved?

If you agree to take part, you will be asked to complete a battery of paper-and-pencil-type tests and hand-movement tests administered by the researcher face-to-face. These tests are quite pleasant, perhaps even interesting to experience, and carry no risks. The tests will take approximately 45 minutes and can be conducted where and when it is convenient to you. The most likely place would be your surgery. However, because some of the tests require writing or drawing, and all of them require concentration, we would need access to a fairly quiet room with a table, and would need not to be interrupted during the testing (you would however be able to stop between tests if you need to).

In addition, you will be asked to complete some questionnaires. Since this does not need the researcher to be present, you can complete them at your convenience at any time within one week of the face-to-face tests (it should take approximately 20-30 minutes). These comprise questions on physical and psychological symptoms and abilities, as well as some personal data and details of habits such as eating, drinking and sleeping. You are free to omit any information you consider too personal, although the more complete the information the more useful it will be for the research. You can of course discontinue your involvement with this research at any time.

You may be asked to provide a urine sample for determination of mercury content.

Unfortunately I do not have any funds to pay you for taking part, and am reliant on your goodwill and your wish to further knowledge about occupational safety.

Confidentiality

All the information you give will be anonymised, and the data will be assigned a code number which will be used to identify it in analyses. Your name will not be recorded on any questionnaire, test form, data sheet or database. At no time will any individual be identified in any report or publication.

A key linking your name to the identity code number will be kept in written form (non-electronic) separate from the data, and under secure conditions. The key is necessary in case we need to contact you again (for instance, if there are ambiguities in the data), or if you wish to know your results.

It would be very valuable for us to be able to link the information you provide with that already collected by Dr. Ritchie and colleagues. However, this will only be done if you give explicit permission (see attached consent form). (The exception to this is the urinary mercury level measured by Dr. Ritchie. This information is essential for the analysis of the present study, and your consent to sharing this information is assumed if you agree to take part).

Feedback

If you are asked to provide a urine sample for mercury assay in this study, the result will be available to you on request (although there may be a delay before the sample is analysed). Other individual test results will also be available to you on request along with a summary of the final report (due Summer 2001).

Who are the researchers?

I am David Martinage, Consultant Clinical Psychologist at Ravenscraig Hospital, Greenock, and part-time doctoral research student, Glasgow University Dept. of Psychological Medicine. This study will form part of my submission for the degree of Doctor of Clinical Psychology (University of Glasgow), and is under the supervision of the Professor of Clinical Neuropsychology, Tom McMillan.
Dr. Karen Richie, Glasgow University Dept. of Public Health, has kindly been acting as advisor.

If you wish to take part in the study, please sign the enclosed consent form an return it to me in the envelope provided. I will then telephone you some time in the next few months to arrange a convenient time for the tests.

If you have any queries about any aspect of the study, you are very welcome to telephone me at 01475-633777 Ext.5113.
Thank you in advance for your time and help with this research,

David Martinage

Consultant Clinical Psychologist

Research study on the effect of low level mercury exposure on

psychological health of dental surgeons

CONSENT FORM

I have read the information sheet provided to me on this research study,

and I agree to take part.

Signed _____ Date _____

Name in capitals _____

Address for contact _____

_____

_____

Telephone No. _____

(Although this study is designed to extend and complement the earlier study by Dr. Ritchie and colleagues, the two studies have been independently submitted to the Dental Ethics Committee. In order to comply with confidentiality requirements, we therefore need your permission to share data between the studies. If you agree to this, please sign below; if not, please cross out the paragraph below. We would still like you to take part in the study even if you do not want us to share data.)

I agree to data on myself being shared between this study and the one recently conducted by

Dr. K. Ritchie and colleagues. Confidentiality rules will apply to all the researchers involved.

Signed _____

PLEASE RETURN TO: Mr. David Martinage, Dept. of Clinical Psychology, Ravenscraig

Hospital, Greenock PA16 9HA.

NORTH GLASGOW UNIVERSITY HOSPITALS NHS TRUST
GLASGOW DENTAL HOSPITAL AND SCHOOL
378 SAUCHIEHALL STREET, GLASGOW, G2 3JZ
TELEPHONE: 0141-211 9600 FAX: 0141-211 9800

****

AREA DENTAL ETHICS COMMITTEE ☎ **Direct Dial: Chairman (0141) 211 9855**
Secretary (0141) 211 9791

HAC/MSW. 17th April 2000

Mr David P Martinage
Consultant Clinical Psychologist
Ravenscraig Hospital
Inverkip Road
GREENOCK
PA16 9HA

RECEIVED

Dear Mr Martinage

Re: "Effect of low level mercury exposure on psychological health of dental surgeons".

I write to inform you that your protocol for the clinical research project has been approved by the Area Dental Ethics committee.

The committee would be grateful if you would inform them of the results of your project and any ethical problems encountered when the project is complete.

Yours sincerely

H A Critchlow
Chairman

APPENDIX C

Appendix C1

Test Instructions.

Appendix C2

Questionnaires.

Appendix C1

Test Instructions

Visual Reproduction As WMS-III Manual [24]

Digit Span As WAIS-R Manual [25]

Digit Symbol As WAIS-R Manual [25]

Spot-the-Word As printed on published answer booklet [28]

Trail Making Test A and B As on page 553 of Spreen & Strauss [27].

Rey Auditory-Verbal Learning Test Instructions as given on page 423 of Lezak [23]. Scores are for number of words correct on each trial. Data recorded were number of words correctly recalled, number of repetitions of words in a list, and number of incorrect words recalled (intrusions). Dentists' responses were tape recorded for greater accuracy.

Grooved Pegboard These were slightly modified from the manual so as to be clearer and more accurate (specifically the mention of the pegs as having a groove (which is untrue) was changed to them having a ridge.) [29]

Intentional Hand Steadiness The present author devised his own instructions since no detailed standard instructions were available at the time. Apparatus comprises a metal plate with 9 holes of diminishing size, and a thin metal stylus which is inserted into the holes and has to be held there without touching the plate. Plate and stylus are electrically attached to a bleeper which gives auditory feedback when the stylus is in contact with the plate; and to an electronic timer, which records the amount of time the stylus is in contact with the plate.

In this version of the test, hole 3 was used for demonstration, and data was collected for holes 4 to 9, beginning with the dominant hand, and followed by the non-dominant hand. The diameters of the holes were 4.75, 4.0, 3.2, 2.8, 2.35, and 2mm, and the diameter of the stylus was 1.6mm. For each hole there was a 15 second data collection period, when the author started the timer and the stopwatch simultaneously and stopped them after 15 seconds.

The full instructions are as follows:-

Equipment: IHST apparatus
stopwatch
record form
mains extension cable

Seat subject with metal hole-plate in front of dominant hand.
Say:

This is a test of hand steadiness. I want you to hold this stylus like this.

Demonstrate holding stylus like a pen.

I want you to insert the tip of the stylus half-way into the hole like this (demonstrate) and hold it there without touching the sides. If you do touch the sides, you will hear a bleep,
like this (demonstrate).
Now, I want you to hold the stylus in your [dominant] **hand and insert it into hole 3. This is a practice. Do not let any part of your hand or arm touch the table or your body. Try not to touch the sides of the hole.**

Check the subject complies with the instructions.
Make sure the stylus flex goes behind the plate, not in front.
Make sure the subject holds the stylus at right angles to the plate, by checking the stylus is in line with its reflection.

Good. Now hold it there for 15 seconds while I time how long the bleep goes on for.

Press red reset button on timer.
Start stopwatch while simultaneously pressing white button on black box.
After 15 seconds precisely, press white button again to stop timer, and record reading.

Good. Now do the same with the next smallest hole. [Hole 4]

Repeat as for previous hole. Do not start timing until subject has inserted stylus into hole and is holding it steady.

Repeat for the remaining holes 5 to 9.

Repeat holes 4 to 9 for nondominant hand.

Appendix C2

<u>Questionnaires</u> (on following pages)

Introduction

SCL-90-R (presented here by subscale, rather than in questionnaire form)

CFQ

FIS

lifestyle questionnaire (including life-events)

Code No. _____ **Date** _____

Dentists' Psychological Health Study

QUESTIONNAIRES

Thank you for agreeing to take part in this research project. Through these questionnaires we aim to look at psychological and physical well-being, what influences mercury levels in the body, and what else may influence your test results. This set of questionnaires has been specifically designed for the project and it is important that as many as possible of the questions are answered, as the information is relevant to your score in the tests and to the potential level of mercury in your body. The questionnaires should take about 30 minutes to complete. The data will be anonymised and analysed at the University of Glasgow; names of participants will be kept strictly confidential. Please do not write your name on any part of the questionnaires.

Many thanks for your help,

Dave Martinage

SCL-90-R subscales

Symptom
Somatization
1. Headaches
4. Faintness or dizziness
12. Pains in heart or chest
27. Pains in lower back
40. Nausea or upset stomach
42. Soreness of your muscles
48. Trouble getting your breath
49. Hot or cold spells
52. Numbness or tingling in parts of your body
53. A lump in your throat
56. Feeling weak in parts of your body
58. Heavy feelings in your arms or legs
Obsessive-Compulsive
3. Repeated unpleasant thoughts that won't leave your mind
9. Trouble remembering things
10. Worried about sloppiness or carelessness
28. Feeling blocked in getting things done
38. Having to do things very slowly to insure correctness
45. Having to check and double-check what you do
46. Difficulty making decisions
51. Your mind going blank
55. Trouble concentrating
65. Having to repeat the same actions such as touching, counting, or washing
Interpersonal Sensitivity
6. Feeling critical of others
21. Feeling shy or uneasy with the opposite sex
34. Your feelings being easily hurt
36. Feeling others do not understand you or are unsympathetic
37. Feeling that people are unfriendly or dislike you
41. Feeling inferior to others

Symptom
Interpersonal Sensitivity (continued)
61. Feeling uneasy when people are watching or talking about you
69. Feeling very self-conscious with others
73. Feeling uncomfortable about eating or drinking in public
Depression
5. Loss of sexual interest or pleasure
14. Feeling low in energy or slowed down
15. Thoughts of ending your life
20. Crying easily
22. Feeling of being trapped or caught
26. Blaming yourself for things
29. Feeling lonely
30. Feeling blue
31. Worrying too much about things
32. Feeling no interest in things
54. Feeling hopeless about the future
71. Feeling everything is an effort
79. Feelings of worthlessness
Anxiety
2. Nervousness or shakiness inside
17. Trembling
23. Suddenly scared for no reason
33. Feeling fearful
39. Heart pounding or racing
57. Feeling tense or keyed up
72. Spells of terror or panic
78. Feeling so restless you couldn't sit still
80. The feeling that something bad is going to happen to you
86. Thoughts and images of a frightening nature

(continued on next page)

SCL-90-R subscales (cont)

Symptom
Hostility
11. Feeling easily annoyed or irritated
24. Temper outbursts that you could not control
63. Having urges to beat, injure, or harm someone
67. Having urges to break or smash things
74. Getting into frequent arguments
81. Shouting or throwing things
Phobic Anxiety
13. Feeling afraid in open spaces or on the streets
25. Feeling afraid to go out of your house alone
47. Feeling afraid to travel on buses, subways, or trains
50. Having to avoid certain things, places, or activities because they frighten you
70. Feeling uneasy in crowds, such as shopping or at a movie
75. Feeling nervous when you are left alone
82. Feeling afraid you will faint in public
Paranoid Ideation
8. Feeling others are to blame for most of your troubles
18. Feeling that most people cannot be trusted

Symptom
Paranoid Ideation (continued)
43. Feeling that you are watched or talked about by others
68. Having ideas or beliefs that others do not share
76. Others not giving you proper credit for your achievements
83. Feeling that people will take advantage of you if you let them
Psychoticism
7. The idea that someone else can control your thoughts
16. Hearing voices that other people do not hear
35. Other people being aware of your private thoughts
62. Having thoughts that are not your own
77. Feeling lonely even when you are with people
84. Having thoughts about sex that bother you a lot
85. The idea that you should be punished for your sins
87. The idea that something serious is wrong with your body
88. Never feeling close to another person
90. The idea that something is wrong with your mind

CEQ

DATE_____ CODE NO._____

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to you in the last six months. Please circle the appropriate number.

	Very often	Quite often	Occasionally	Very rarely	Never
1. Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
2. Do you find you forget why you went from one part of the house to the other?	4	3	2	1	0
3. Do you fail to notice signposts on the road?	4	3	2	1	0
4. Do you find you confuse right and left when giving directions?	4	3	2	1	0
5. Do you bump into people?	4	3	2	1	0
6. Do you find you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
7. Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
8. Do you say something and realize afterwards that it might be taken as insulting?	4	3	2	1	0
9. Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
10. Do you lose your temper and regret it?	4	3	2	1	0
11. Do you leave important letters unanswered for days?	4	3	2	1	0
12. Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0
13. Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
14. Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0
15. Do you have trouble making up your mind?	4	3	2	1	0
16. Do you find you forget appointments?	4	3	2	1	0
17. Do you forget where you put something like a newspaper or a book?	4	3	2	1	0
18. Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	4	3	2	1	0
19. Do you daydream when you ought to be listening to something?	4	3	2	1	0
20. Do you find you forget people's names?	4	3	2	1	0
21. Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
22. Do you find you can't quite remember something although it's 'on the tip of your tongue'?	4	3	2	1	0
23. Do you find you forget what you came to the shops to buy?	4	3	2	1	0
24. Do you drop things?	4	3	2	1	0
25. Do you find you can't think of anything to say?	4	3	2	1	0

FATIGUE IMPACT SCALE

Date:_____ Code No: _____

These are questions about the effects of fatigue. Even if you do not generally suffer from fatigue, you may find some of the questions relevant, so please answer them all. Where a question does not apply, circle the zero.

Please answer with respect to fatigue, not with respect to sleepiness (i.e. tendency to fall asleep during the day).

How much of a problem has fatigue caused you during the past month?

Because of my fatigue:	no problem	small problem	moderate problem	big problem	extreme problem
1) I feel less alert	0	1	2	3	4
2) I feel that I am more isolated from social contact	0	1	2	3	4
3) I have to reduce my workload or responsibilities	0	1	2	3	4
4) I am more moody	0	1	2	3	4
5) I have difficulty paying attention for a long period	0	1	2	3	4
6) I feel like I cannot think clearly	0	1	2	3	4
7) I work less effectively (this applies to work inside or outside the home)	0	1	2	3	4
8) I have to rely more on others to help me or do things for me	0	1	2	3	4
Because of my fatigue:					
9) I have difficulty planning activities ahead of time	0	1	2	3	4
10) I am more clumsy and uncoordinated	0	1	2	3	4
11) I find that I am more forgetful	0	1	2	3	4
12) I am more irritable and more easily angered	0	1	2	3	4
13) I have to be careful about pacing my physical activities	0	1	2	3	4
14) I am less motivated to do anything that requires physical effort	0	1	2	3	4
15) I am less motivated to engage in social activities	0	1	2	3	4
16) My ability to travel outside my home is limited	0	1	2	3	4
17) I have trouble maintaining physical effort for long periods	0	1	2	3	4

Because of my fatigue:	no problem	small problem	moderate problem	big problem	extreme problem
18) I find it difficult to make decisions	0	1	2	3	4
19) I have fewer social contacts outside of my own home	0	1	2	3	4
20) Normal day-to-day events are stressful for me	0	1	2	3	4
21) I am less motivated to do anything that requires thinking	0	1	2	3	4
22) I avoid situations that are stressful for me	0	1	2	3	4
23) My muscles feel much weaker than they should	0	1	2	3	4
24) My physical discomfort is increased	0	1	2	3	4
25) I have difficulty dealing with anything new	0	1	2	3	4
26) I am less able to finish tasks that require thinking	0	1	2	3	4
27) I feel unable to meet the demands that people place on me	0	1	2	3	4
28) I am less able to provide financial support for myself and my family	0	1	2	3	4
29) I engage in less sexual activity	0	1	2	3	4
Because of my fatigue:					
30) I find it difficult to organize my thoughts when I am doing things at home or at work	0	1	2	3	4
31) I am less able to complete tasks that require physical effort	0	1	2	3	4
32) I worry about how I look to other people	0	1	2	3	4
33) I am less able to deal with emotional issues	0	1	2	3	4
34) I feel slowed down in my thinking	0	1	2	3	4
35) I find it hard to concentrate	0	1	2	3	4
36) I have difficulty participating fully in family activities	0	1	2	3	4
37) I have to limit my physical activities	0	1	2	3	4
38) I require more frequent or longer periods of rest	0	1	2	3	4
39) I am not able to provide as much emotional support to my family as I should	0	1	2	3	4
40) Minor difficulties seem like major difficulties	0	1	2	3	4

For parts 1 to 4 of this section, please circle or underline your answer for the multiple-choice questions.

(Please note that this section is modified from that used in Dr. Richie's study, and I apologise that you may be answering some of the questions again. Any missing question numbers are deliberate.)

DEMOGRAPHICS

Please provide some details about yourself.

1.1 Gender: male female

1.2 Age: _____ years old

WORK

Please state your job title and briefly describe the main duties you do (i.e. Partner, Associate, Assistant, VDP)

2.1 Job title:

2.2 Main duties:

2.3 How long have you been working in practice as a dentist ? ____years

2.4 How many hours do you work in an average week ? ____hours

2.5 Please estimate how many hours you work within the surgery ? ____hours

2.6m How many days leave (including study leave, sick leave etc., but not including weekends) have you had in the past four weeks? ____days

2.7 Please estimate how many days you have been off due to sickness in the past year: ____days

2.8 Do you do any other work outside general dental practice ?

yes no

If you do, please tell us what:

2.9 Have you ever experienced a mercury spillage, e.g. from a thermometer or sphygmomanometer or when transferring mercury in the surgery especially when filling an amalgamator ?

yes no

If yes, please give some brief details such as **when** and **what happened**:

2.10 Please tell us about the current use of mercury within your practice.

self-contained amalgamator e.g. Dentomat

single use capsules

2.16 Please estimate, in an average week, how many mercury amalgam fillings you personally place or remove. (if you are removing an old mercury amalgam filling and replacing it with a new one, that would count as one in each category)

place per week _____

remove per week _____

HEALTH

3.1m Have you ever had any neurological problem, head injury, or other illness or injury which might affect the results of the psychological tests or questionnaires? yes no

If yes, please give brief details:

3.2 Are you taking, or have you taken (in the last month), any medication whether prescribed or bought over the counter? yes no

If yes, please give brief details (name or type of medication):

3.4m In the last six months, have you experienced any of the following ? (ignore brief occurrences)

loss of appetite	yes	no
hand tremor	yes	no
poor concentration	yes	no
gastro-intestinal disturbance	yes	no
problems with sleeping	yes	no
memory disturbance	yes	no
tiredness	yes	no
depression	yes	no
anxiety	yes	no
feeling shy or unsociable	yes	no
headache	yes	no
other physical or psychological problem	yes	no

please specify.....

3.6 Have you had any dental treatment in the past month ? yes no

If so, please describe briefly what it consisted of:

3.10m How many of your teeth currently have mercury amalgam fillings ?

____ number of teeth

____ number of occlusal surfaces

____ total number of surfaces

3.15 When did you last have a mercury amalgam filling placed in or removed from your mouth?

3.17 Do you have any gold or other metal fillings (not mercury amalgam) in a tooth next to a mercury amalgam filling ? yes no

3.18a If female, are you subject to mood or other changes attributable to a monthly cycle? yes no

3.18b If "yes", where are you in this cycle today?

____in best part

____approaching worst part

____in worst part

____leaving worst part

3.18c If applicable, number of days since first day of last menstrual period _____

3.19a Considering the various risks to health (e.g. smoking, alcohol, transport accidents, occupational hazards, sports injuries, diet, infectious disease etc.),
What do you perceive as the main risk to your future health ?

3.19b If the risk above is rated as a score of 100, and no risk is rated as 0,
what rating would you give to the risk from your past and likely future exposure to mercury ? _____

3.19c Do you think you have already been affected by mercury? yes no
If "yes", in what way?

3.20a Tick if you wear glasses for reading___ your work___ computer screens___

LIFESTYLE

4.0a How often do you chew gum?
several times a day once a day or less once a week or less

4.1m How would you describe your diet?
a) high fibre medium fibre low fibre

b) high fat medium fat low fat

4.2 How many of your meals, in a typical week, would include seafood / fish ? _____

4.4m Please indicate how much of the following sources of caffeine you take daily:
(exclude any decaffeinated versions)

tea ____cups ____mugs **strength**: weak/medium/strong

coffee ____cups ____mugs **strength**: weak/medium/strong

cola	____cans	____bottles (75 ml)	____bottles(1 litre)
Irn Bru	____cans	____bottles (75 ml)	____bottles(1 litre)
other caffeine-containing drinks (eg Red Bull)	____cans	____bottles (75 ml)	____bottles(1 litre)

other sources of caffeine (eg Pro Plus; Anadin; Solpedeine) _____

4.5m On average, how many units of alcohol do you drink per week ?
(one unit = a small glass of wine, a pub measure of spirits, half a pint of beer/cider)

_____ units per week

4.6m If you smoke, how many/much of the following do you smoke per day ?

Cigarettes no. per day _____

Cigars no. per day _____

Pipe tobacco weight per week_____

4.9 Do you have any hobbies which involve working with metals or chemicals (e.g. car maintenance, 'dark-room' photography, gardening, DIY, electronic work) ?

yes no

If you do, please tell us what

4.16a Please read the following list and underline any event which has occurred in your life in the last 6 months.

Death of marital partner
Divorce
Marital separation
Jail sentence or being institutionalized
Death of close member of family
Illness or injury
Marriage
Loss of job
Reconciliation with marital partner
Retirement
Change in health of member of family
Pregnancy
Sex problems
Addition to family
Made to change at work
Change of financial status
Death of close friend
Change in line of work
Change in number of marital arguments
Large mortgage taken out
Mortgage or loan foreclosed
Change in responsibilities at work
Child leaves home
In-law problems
Personal achievement realized
Wife starts or stops work
Begin or end school/university etc.
Change in living conditions
Change in personal habits
Trouble with employer
Change in working hours or conditions
Change in residence
Change in recreation
Change in church activities
Change in social activities
Small mortgage taken out
Change in sleeping habits
Change in number of family get-togethers
Major change in eating pattern
Holiday
Christmas
Minor violation of the law

4.17a Please note here any other life-change-event or important emotional upset which has occurred in the last 6 months

4.18a What other stresses are you currently under?

5a OPINIONS ABOUT MERCURY

Please place a cross somewhere along each line below according to your opinion

EXAMPLE

Levels of boredom from listening to politicians:

pose no risk at all |——————X——————| are very likely to cause physical or mental problems

5.1 Levels of mercury in dentists from occupational exposure:

pose no risk at all |——————————————| are very likely to cause physical or mental problems

5.2 Levels of mercury in dental nurses/assistants from occupational exposure:

pose no risk at all |——————————————| are very likely to cause physical or mental problems

5.3 Levels of mercury from eating fish:

pose no risk at all |——————————————| are very likely to cause physical or mental problems

5.4 Levels of mercury absorbed from the environment:

pose no risk at all |——————————————| are very likely to cause physical or mental problems

5.5 Levels of mercury from people's own dental fillings:

pose no risk at all |——————————————| are very likely to cause physical or mental problems

---

Please feel free to use the space overleaf to make any comments you feel are relevant to the project or on any other matter.

Thank you for your time and patience in completing these questionnaires. Please check that you have answered all applicable questions, and post the questionnaires in the envelope provided.

APPENDIX D

Appendix D1

Tables 4.1 to 4.8 and Figures 4.3 and 4.4

Appendix D2

Patient contact record form

Appendix D3

'Instructions to Authors' for selected journal: Clinical Psychology

Appendix D1 – Tables 4.1 to 4.8 and Figures 4.3 and 4.4

Table 4.1: PROBLEM TYPE BY YEAR OF REFERRAL

count of cases

problem group	1993	1994	1995	1996	1997	1998	1999
anxiety	59	37	32	34	28	26	26
phobias	12	14	10	5	2	3	4
trauma	24	19	15	9	19	16	17
affective	20	28	19	18	18	22	16
adjustment to loss	11	13	9	7	5	10	8
relationship problems	8	16	8	3	3	6	4
physical health	20	21	18	5	6	4	9
other	29	27	26	19	19	23	18
total	**183**	**175**	**137**	**100**	**100**	**110**	**102**

percent

anxiety	32	21	23	34	28	24	25
phobias	7	8	7	5	2	3	4
trauma	13	11	11	9	19	15	17
affective	11	16	14	18	18	20	16
adjustment to loss	6	7	7	7	5	9	8
relationship problems	4	9	6	3	3	5	4
physical health	11	12	13	5	6	4	9
other	16	15	19	19	19	21	18
	100	**100**	**100**	**100**	**100**	**100**	**100**

Table 4.2: NUMBER OF PROBLEMS IDENTIFIED PER PATIENT, BY YEAR

		1993	1994	1995	1996	total
count of cases						
	1 problem	93	107	78	29	307
	2 problems	77	56	58	18	209
	3 problems	24	18	15	3	60
	4 problems	14	14	5	2	35
	total	208	195	156	52	611
percent						
	1 problem	45	55	50	56	50
	2 problems	37	29	37	35	34
	3 problems	12	9	10	6	10
	4 problems	7	7	3	4	6
	total	100	100	100	100	100

Table 4.3: NUMBER OF PREVIOUS EPISODES WITH PSYCHOLOGY SERVICE BY YEAR

count of No. of referrals

no. of previous episodes	1993	1994	1995	1996	1997	1998	1999
0	219	222	206	131	148	144	183
1	71	62	56	58	47	51	49
>1	31	24	30	19	24	36	33
total	321	308	292	208	219	231	265

percent of referrals

no. of previous episodes	1993	1994	1995	1996	1997	1998	1999
0	68	72	71	63	68	62	69
1	22	20	19	28	21	22	18
>1	10	8	10	9	11	16	12
total	100	100	100	100	100	100	100

Table 4.4: NUMBER OF CASES REFERRED BY GP OR OTHER PROFESSIONS

count of No. of referrals

	1993	1994	1995	1996	1997	1998	1999
GP	260	248	219	150	166	175	211
other profession	55	47	59	51	50	43	48
total	315	295	278	201	216	218	259

percent of referrals

	1993	1994	1995	1996	1997	1998	1999
GP	83	84	79	75	77	80	81
other profession	17	16	21	25	23	20	19
total	100	100	100	100	100	100	100

Table 4.5: DURATION OF PROBLEM BY YEAR OF REFERRAL, (simplified)

count of cases

	1993	1994	1995	1996	1997	1998	1999
1 year or less	61	65	46	39	37	56	40
> 1 year	120	100	83	61	58	54	61
total	**181**	**165**	**129**	**100**	**95**	**110**	**101**

percent

1 year or less	34	39	36	39	39	51	40
> 1 year	66	61	64	61	61	49	60
total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 4.6: NUMBER OF APPOINTMENTS KEPT BY YEAR OF REFERRAL
(cases with treatment completed)

year	mean	sd	mean after 5% trim	M-estimate (Tukey)	N
1993	8.17	15.46	5.65	4.07	105
1994	6.92	7.28	5.85	4.22	97
1995	6.28	7.14	5.13	3.86	92
1996	6.19	4.52	5.79	4.53	48
1997	6.92	6.93	5.94	4.72	51
1998	5.98	4.09	5.59	4.63	42
1999	6.11	3.54	6.01	5.12	45

Table 4.7: PERCENT OF APPOINTMENTS MISSED

year	mean percent	mean after 5% trim	N
1993	12	10	105
1994	11	9	97
1995	9	7	92
1996	8	7	48
1997	14	13	51
1998	11	10	42
1999	14	13	45

Table 4.8: PERCENT OF CASES WITH MORE THAN ONE TYPE OF INTERVENTION

year	percent	N
1993	75	182
1994	66	177
1995	64	138
1996	71	101
1997	69	101
1998	63	112
1999	50	103

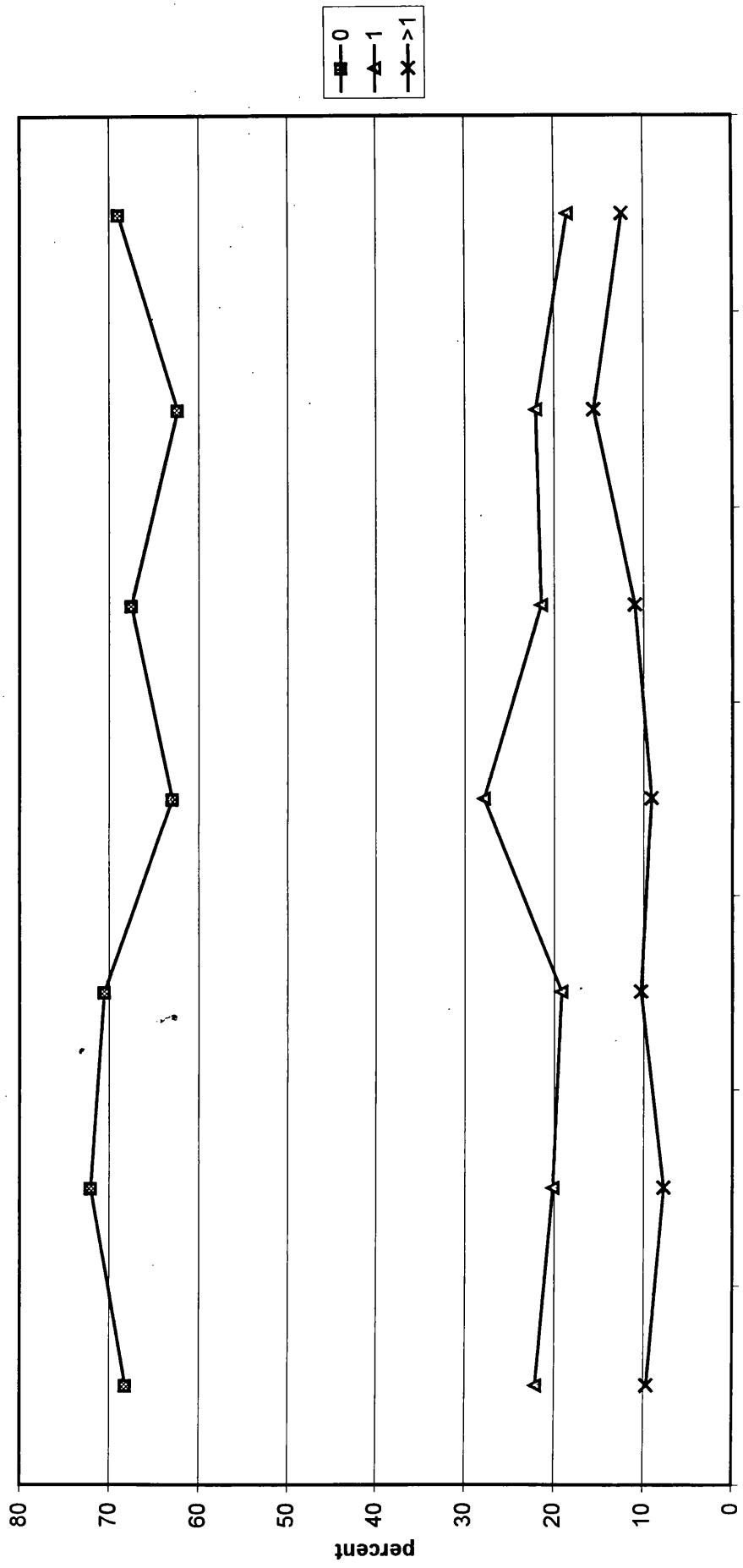


Figure 4.3: NUMBER OF PREVIOUS EPISODES WITH PSYCHOLOGY SERVICE
% of referrals each year

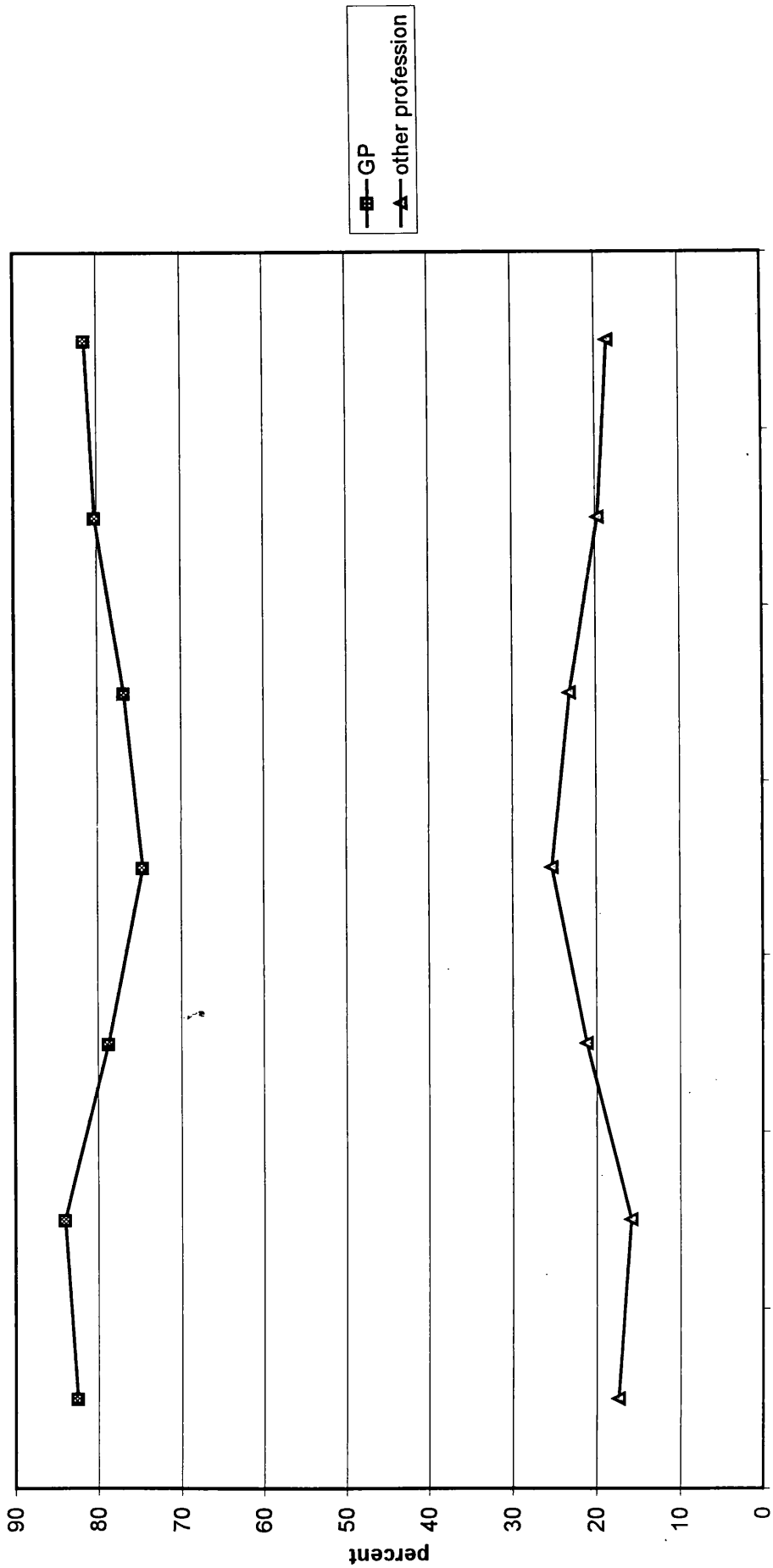


Figure 4.4: SOURCE OF REFERRAL, PERCENT BY YEAR

Appendix D2 – Patient contact record form

A

Argyll & Clyde Health Board: Inverclyde Cowal & Bute Unit

CLINICAL PSYCHOLOGY SERVICE -- PATIENT CONTACT RECORD

(A) Receipt of Referral:
-Complete this section when the referral is received.

1. Clinical Psychology Record No. /_/ /_/_/_/_/_/ /_/ g
2. Ravenscraig Unit No. (for M files) /_/_/_/_/_/
3. IRH Unit No. (for P files) /_/_/_/_/_/_/
4. Patient's Postal Code (first part only) /_/_/_/_/
5. Age at referral /_/_/
6. Sex (1=male 2=female) /_/
7. Patient Type (OP, IP or DP) /_/_/ g
8. Referred by: _____ Code: /_/_/_/_/
9. G.P. _____ Code: /_/_/_/_/
10. Consultant _____ Code: /_/_/_/_/
11. Other Agencies Involved _____ Code: /_/_/_/_/ g
_____ Code: /_/_/_/_/ g
_____ Code: /_/_/_/_/ g
_____ Code: /_/_/_/_/ g
12. Date Referral Received /_/_/_/_/_/_/
13. Problem referred _____ Code: /_/_/_/_/
_____

++

19.5.92

B

Argyll & Clyde Health Board: Inverclyde Cowal & Bute Unit

CLINICAL PSYCHOLOGY SERVICE -- PATIENT CONTACT RECORD

(A) Receipt of Referral
(superceded for adult service by printout headed "ENTER NEW REFERRAL")

(B) Start of Episode of Care :
-Psychologist completes this section at the time of first contact OR when it becomes clear that contact will not be made.

1. Clinical Psychology Record No. /_/ /_/_/_/_/_/ /_/ g

14. Psychologist (main) /_/_/ g

15. Additional Psychologists /_/_/ /_/_/ /_/_/ g

16. Date First Contact Offered (this episode) /_/_/_/_/_/_/ g

17. Site First Contact Offered (this episode) /_/_/ g

18. Problems at First Contact: Formulated
(most important first)

a) _____ Code: /_/_/_/_/

b) _____ Code: /_/_/_/_/

c) _____ Code: /_/_/_/_/

d) _____ Code: /_/_/_/_/

19. Problems at First Contact: Underlying
(most important first)

a) _____ Code: /_/_/_/_/

b) _____ Code: /_/_/_/_/

20. Duration of Main Problem(s) (this episode) /_/

21. Other Agencies Involved (complete only if changed from Section A)

_____ Code: /_/_/_/_/ g

_____ Code: /_/_/_/_/ g

_____ Code: /_/_/_/_/ g

_____ Code: /_/_/_/_/ g

++

19.5.92

C

(C) End of Episode of Care:
-Psychologist completes this section on closing case OR on technical discharge.

1. Clinical Psychology Record No. /_/ /_/_/_/_/_/ /_/ 9

22. Most Frequent Contact Site /_/_/ 9

23. No. Direct Contacts Offered /_/_/_/ 9

24. No. Direct Contacts Kept /_/_/_/ 9

25. No. Indirect Contacts /_/_/_/

26. Date of Discharge (ie date last seen) /_/_/_/_/_/_/ 9

26a. Date of Discharge Letter /_/_/_/_/_/_/

26b. Date of Technical Discharge /_/_/_/_/_/_/

27. Reason for Discharge /_/ 9

28. Problems at Discharge: Formulated
(most important first)

a) _____ Code: /_/_/_/_/

b) _____ Code: /_/_/_/_/

c) _____ Code: /_/_/_/_/

d) _____ Code: /_/_/_/_/

29. Problems at Discharge: Underlying
(most important first)

a) _____ Code: /_/_/_/_/

b) _____ Code: /_/_/_/_/

30. Type of Intervention (Main) /_/ 9

31. Type of Intervention (Supplementary) /_/ 9

32. Mode of Intervention (Main) /_/ 9

33. Mode of Intervention (Supplementary) /_/ 9

34. Outcome: Patient's/Carer's Estimate /_/

35. Outcome: Psychologist's Estimate /_/

36. Date of Future Follow-up (if arranged) /_/_/_/_/_/_/ 9

36a. Outcome of Follow-up (complete after date above) /_/

19.5.92

Appendix D3 – 'Instructions to Authors' for selected journal:

Clinical Psychology

Clinical Psychology

Clinical Psychology is produced by the Division of Clinical Psychology of The British Psychological Society. It is edited by Steve Baldwin, Lorraine Bell, Jonathan Calder, Lesley Cohen, Simon Gelsthorpe, Laura Golding, Helen Jones, Craig Newnes, Mark Rapley and Arlene Vetere, and circulated to all members of the Division monthly. It is designed to serve as a discussion forum for any issues of relevance to clinical psychologists. The editorial collective welcomes brief articles, reports of events, correspondence, book reviews and announcements.

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