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Chronic pain disability exaggeration/malingering and submaximal effort research.

Fishbain DA[1], Cutler R, Rosomoff HL, Rosomoff RS.

Author information

Abstract

OBJECTIVE: This is the first review of chronic pain (CP) malingering/disease simulation research. The purpose of this review was to determine the prevalence of malingering within CP patients (CPPs), whether evidence exists that malingering can be detected within CPPs, and to suggest some avenues of research for this topic.

DESIGN: A computer and manual literature search produced 328 references related to malingering, disease simulation, dissimulation, symptom magnification syndrome, and submaximal effort. Of these, 68 related to one of these topics and to pain. The references were reviewed in detail, sorted into 12 topic areas, and placed into tabular form. These 12 topic areas addressed the following: existence of malingering within the CP setting; dissimulation, identification simulated (faked) facial expressions of pain; identification of malingering by questionnaire; identification of malingered sensory impairment; identification of malingered loss of hand grip strength; identification of submaximal effort by isometric strength testing; identification of submaximal or malingered effort by isokinetic strength testing; identification of submaximal or malingered effort by the method of coefficient of variation; self-deception; symptom magnification syndrome; and miscellaneous malingering identification studies. Each report, in each topic area, was rated for scientific quality according to guidelines developed by the Agency for Health Care, Policy and Research (AHCPR) for rating the level of evidence presented in the reviewed study. The AHCPR guidelines were then used to rate the strength and consistency of the research evidence in each topic area based on the type of evidence the reports represented. All review conclusions were based on the results of these ratings.

SETTING: Any medical setting reporting on either malingering or disease simulation, or dissimulation, or submaximal effort and pain.

PATIENTS: Normal volunteers, CPPs, or any group asked to produce a submaximal or malingered effort or a malingered test profile.

RESULTS: The reviewed studies indicated that malingering and dissimulation do occur within the CP setting. Malingering may be present in 1.25-10.4% of CPPs. However, because of poor study quality, these prevalence percentages are not reliable. The study evidence also indicated that malingering cannot be reliably identified by facial expression testing, questionnaire, sensory

testing, or clinical examination. There was no acceptable scientific information on symptom magnification syndrome. Hand grip testing using the Jamar dynamometer and other types of isometric strength testing did not reliably discriminate between a submaximal/malingering effort and a maximal/best effort. However, isokinetic strength testing appeared to have potential for discriminating between maximal and submaximal effort and between best and malingered efforts. Repetitive testing with the coefficient of variation was not a reliable method for discriminating a real/best effort from a malingered effort.

CONCLUSIONS: Current data on the prevalence of malingering within CPPs is not consistent, and no conclusions can be drawn from these data. As yet, there is no reliable method for detecting malingering within CPPs, although isokinetic testing shows promise. Claims by professionals that such a determination can be made should be viewed with caution.

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Prevalence of surreptitious laxative abuse in patients with diarrhoea of uncertain origin: a cost benefit analysis of a screening procedure

P BYTZER, M STOKHOLM, I ANDERSEN, N A KLITGAARD, AND O B SCHAFFALITZKY DE MUCKADELL

From the Department of Medical Gastroenterology and the Department of Clinical Chemistry, Odense University Hospital, Odense, Denmark

SUMMARY **The costs and medical benefits of an early, routine laxative screening test in patients with diarrhoea of uncertain origin was evaluated. During a two year period 200 consecutive, unselected patients complaining of diarrhoea were considered for the study in whom a three day faecal collection was undertaken. Fifty four patients denying laxative consumption had diarrhoea (mean daily stool weight >200 g) of uncertain origin at their initial visit of whom 47 were screened to detect ingestion of anthraquinones, bisacodyl, phenolphthalein, and magnesium salts. Seven patients had positive tests. No single clinical feature could have predicted the outcome of the test. The possible cost savings of the programme were estimated by not releasing the results of the test to the clinicians until the patient's investigations were complete. The seven patients with laxative abuse spent a total of 35 days in hospital and were seen on 29 occasions in the outpatient clinic after the laxative screening test was positive. The cost of the screening programme was cheaper than the costs of the diagnostic procedures in patients with laxative abuse. We recommend the use of a comprehensive, early laxative screening programme in all patients with diarrhoea of uncertain origin as a cost effective procedure.**

Patients who surreptitiously ingest laxatives in order to cause diarrhoea represent a special diagnostic challenge to the clinical gastroenterologist. Many patients undergo expensive, unnecessary, and even risky investigations before the diagnosis is considered.[1-3]

The diagnosis can be confirmed either by a screening for laxatives in the patients faeces[4 5] or by a search of the patient's room and belongings.[6] Both methods, however, imply a suspicion of drug abuse, and unfortunately this suspicion often arises very late in the diagnostic process, and is usually provoked by the negative outcome of an extensive workup.[7-9]

Address for correspondence: Dr P Bytzer, Department of Medical Gastroenterology S, Odense University Hospital, DK-5000 Odense C, Denmark.

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A toxicological screening for laxatives in all patients with diarrhoea of uncertain origin, at an early stage, might be cost effective provided that the condition is not extremely uncommon. Unfortunately, valid data on the prevalence rate of laxative abuse among unselected patients are lacking, but the syndrome has been considered the leading cause of chronic diarrhoea of unknown origin in patients studied prospectively.[9]

In order to determine the prevalence rate of concealed laxative drug consumption, we decided to construct a comprehensive screening programme, taking into account the diversity of available laxative preparations.

In this paper, we present the results of a prospective two year laxative screening test on consecutive patients with diarrhoea of uncertain origin and a cost-benefit analysis of the screening programme.

Methods

PATIENTS

Over a two year period (1986–88) all patients referred to the Department of Medical Gastroenterology S, Odense University Hospital, because of diarrhoea were candidates for the study. The department serves a population of 500 000 in the county of Funen, and receives approximately 2000 new patients a year.

Before entry each patient was interviewed and symptoms related to the bowel disorder were recorded. A three day quantitative stool collection without marker correction and without dietary advice or control was completed and patients with stool weights >200 g per day were questioned about laxative consumption. Patients denying ingestion of laxatives were asked to participate in the study, and informed that the diagnostic programme would include tests of urine and faeces for substances that might influence stool weight. The patients were informed that they had the right to refuse. Patients with normal stool weight or with diarrhoea of obvious – for example, profuse bloody diarrhoea – or well known origin, and patients with steatorrhoea more than 10 g of fat per day were not included in the study. The study was conducted in accordance with the Helsinki II declaration and was approved by the regional ethics committee for Funen and Vejle counties.

SCREENING PROGRAMME

In the study period 41 different laxatives were registered for over the counter sale in Denmark. Twenty seven drugs contained stimulant laxatives (anthraquinones or bisacodyl and combinations of these with phenolphthalein). The main active ingredient was mineral oils with trace amounts of phenolphthalein in three drugs. Two preparations contained lactulose, and two contained magnesium salts. One contained dioctylsodium sulphosuccinate and the remaining were dominated by bulk producing ingredients. A preparation containing potassium and sodium sulphates as the only laxative ingredients was registered in the first part of the study period only. During this period approximately 500 packages of the drug were sold per year. Consequently, an analysis of sulphates in faecal water was not included in the programme. Stimulant laxatives and preparations containing magnesium salts accounted for 70% of the total sale defined as equipotent doses. Based on these facts we decided to construct a screening programme to detect excretion of bisacodyl, phenolphthalein, and anthraquinones in urine and excessive magnesium in faecal water.

Screening was planned for all patients, as soon as they entered the study. Ideally three screening episodes were to be done in all patients with continuing diarrhoea, as long as the bowel disorder was unexplained. Screening was done on different days and was postponed for one week in patients who received laxatives before diagnostic procedures (barium enema, colonoscopy etc).

URINE AND FAECAL WATER ANALYSES

At each screening episode 50 ml urine was collected and kept at −20°C until analysed to detect ingestion of anthraquinones, bisacodyl, and phenolphthalein.[4 10] Briefly, 20 ml urine was adjusted to pH 5 with 0·1 M hydrochloric acid, added 2 ml acetate buffer pH 5 and 10 000 Fishmann units of mixed glucuronidase/sulphate (from Helix pomatia, Sigma) and left overnight at 37°C. The urine was poured on to a Tox Elut® column (Merck) and eluted with a mixture of chloroform:isopropanol 9:1. The eluate was evaporated to dryness under a stream of nitrogen and the residual taken up in 100 µl chloroform before thin layer chromatography (TLC).

The TLC was performed using silica gel coated plates (HPTLC, Merck) with fluorescent indicator and concentration zone. As mobile phases we used m-xylene:isobutyl methyl ketone: methanol 10:10:1 and hexane:toluene:acetic acid 3:1:1. The compounds were located by immersing the plates into a 6 M sodium hydroxide solution. As reference compounds we used phenolphthalein, bisacodyl, danthron, and an extract of senna leaves.

The qualitative test for anthraquinone, bisacodyl and phenolphthalein ingestion has been validated previously.[4 10] Anthraquinones was found in all urine specimens from 16 patients known to take anthraquinone containing laxatives in doses ranging from one to six tablets a day. All urine tests made before laxative ingestion were negative.[4] During multiple dosing anthraquinones could be detected in urine until 96 hours after ingestion of the last dose.[4] At least 32 hours after a single dose of bisacodyl, phenolphthalein, or anthraquinone the drug could be detected in the urine. None of 73 non-laxative drugs interfered with the detection.[10]

In the case of fluid or semifluid faeces 10–50 ml stool water was collected and pH and osmolality (5100 Vapor pressure osmometer, Wescor Inc) were measured. In addition sodium, potassium, and magnesium concentrations were obtained using flame photometry and atomic absorption spectrophotometry.

COST BENEFIT ANALYSIS

In an attempt to evaluate the possible costs and medical benefits of a routine laxative screening programme the results of the present laxative screening were not disclosed to the participating clinicians

until after the patient had finished the diagnostic workup, and a definitive or provisional diagnosis had been established. For all patients with a positive laxative screening test the monetary costs of diagnostic procedures aimed at the bowel disorder, and the monetary costs of days in hospital and ambulatory visits that were potentially unnecessary – that is, had been carried out after the first positive screening test, were compared with the monetary costs of screening in the entire population of patients with diarrhoea. Prices are given in Danish kroner (DKK) (£1 sterling = 13 DKK).

In this analysis the estimated additional costs of a positive test – for example, additional screening episodes, were not included, as they were thought to vary for different 'types' of surreptitious laxative abusers.

STATISTICAL ANALYSIS

The statistical methods used were Fisher's exact test and the Mann-Whitney U test. Only two-tailed tests were used. Values of $p<0.05$ were considered significant.

Results

During the study period 200 patients complaining of diarrhoea were considered for the study. Fifty four patients (34 women) had stool weights >200 g/day without an obvious cause. Of the remaining 146 patients, 138 had normal stool weight and eight patients had significant steatorrhoea. Seven of the 54 patients with diarrhoea of uncertain origin at first visit were not screened: in two patients (one woman) the symptoms disappeared before screening could be done, four women refused to participate, and one woman was not investigated by a mistake.

Thus 47 patients (28 women) were screened for evidence of laxative abuse during the study period. Urine was examined in 47 patients (median two episodes, range 1–7). Stoolwater was investigated in 12 patients. In the remaining patients the test was made impossible by stool consistency.

Seven patients (15%) had positive tests on one or more occasions. In five patients an anthraquinone excretion product was found in the urine at ½, ⅖, ⅓, ¼, and ⅕ screening episodes, respectively. In two patients bisacodyl was detected in the urine at ¼ and ⅕ screening episodes, respectively.

No differences in faecal water composition were observed between laxative abusers and the others in the 12 patients so studied, with the single exception of a high Mg++ output of 31 mmol/day (normally <20 mmol/day).[8] This suggested ingestion of a magnesium containing purgative in a female patient, who was also found to ingest bisacodyl at a different screening episode.

Table 1 *Characteristics of patients screened for laxative abuse (range in parentheses)*

	Positive test n=7	*Negative test n=40*	*p value*
Sex ratio (M:F)	1:6	18:22	NS
Median age (yr)	43 (21–74)	46 (15–75)	NS
Median faecal weight, g/day	523 (219–1200)	297 (205–2075)	NS
Median maximal bowel movements, n/day	6 (2–15)	6 (2–40)	NS
Median length history (mths)	10 (5–420)	10·5 (0·3–360)	NS
Nocturnal diarrhoea (n)	5/7	17/40	NS
Median stool consistency*	4 (3–4)	4 (1–4)	NS
Psychiatric disorders (n)	4/7	4/40	0·02
Melanosis on rectal biopsy (n)	1/5	0/20	NS
Non-specific inflammatory changes on rectal biopsy (n)	4/5	12/20	NS
Hypokalaemia (n)	1/7	4/40	NS
Radiological signs of cathartic colon (n)	1/7	1/38	NS

NS denotes not significant.
*Stool consistency was graded into four categories: formed=1; soft=2; viscous=3; watery=4.

In patients with a positive urine test the possibility of interference from any non-laxative medication the patients were known to take at the time of the screening episodes was ruled out by a TLC of these drugs.

Organic disease was eventually excluded in 116 out of the 200 patients evaluated for the study. A final diagnosis could not be established in seven (five women) of the 40 patients tested for laxatives with negative results.

Table 1 compares various characteristics of patients stratified according to the result of the screening test. The two groups were comparable with regard to age, length of history, and reported characteristics concerning nocturnal diarrhoea, maximal number of bowel movements per day, and stool consistency. Patients with a positive test tended to have larger daily faecal weights (523 *v* 297 g/day), but this difference was not statistically significant. A history of psychiatric disorders was found significantly more often in patients with a positive test, and we confirmed the well known female preponderance of laxative abuse (Table 1).

A survey of potentially preventable costs in the seven patients with a positive screening test is given in Table 2. These patients spent 35 days in hospital worth DKK 88 515, and were seen at 29 visits in the outpatient clinic (DKK 19 633) after the time when a laxative screening test was found positive. Furthermore, diagnostic procedures worth a total of DKK 24 371 were done in the same period of time

Detection of laxatives in urine or faeces is the most efficient way to establish a suspected diagnosis of laxative abuse beyond doubt.[4,5] Repeated analyses are necessary as patients may use laxatives intermittently.[11] Thus, five of seven urine specimens in one of the laxative abusers were normal, and a correct diagnosis may not have been reached by a single testing of this patient.

Because the majority of the patients in this study were only tested twice, we cannot exclude the possibility that we have underestimated the real prevalence of concealed laxative abuse. In most of these patients, however, the laxative screening procedure was stopped either because a diagnosis was found or because the diarrhoea ceased.

The diversity of laxative preparations makes it very cumbersome to establish a clinically relevant screening procedure, and we have previously suggested the addition of an indicator – for example, the free anthraquinone danthron, which is easily detected in urine, to all registered laxatives.[4] In this way the screening process might be simplified, although an analysis of faecal water would still be recommended in special cases in order to reveal patients who deliberately add tap water or urine to their stools to increase their bulk.[8] Furthermore, non-registered laxatives often contain large amounts of highly effective purgatives and a screening for the various chemical principles (usually anthraquinones) is still the best way to establish the surreptitious intake of these cathartics that are sold without any pharmaceutical control.

Before a final decision of establishing this laxative screening test as an early, routine test in all patients with diarrhoea of uncertain origin, we wanted to estimate the possible costs and medical benefits of this diagnostic strategy. The potential cost savings of introducing the test were estimated by keeping the results secret to the clinicians. The costs of specific diagnostic procedures and the number of days in hospital and visits to the outpatient clinic that were redundant in patients with positive tests could then be calculated. In evaluating these figures, summarised in Table 2, it is important to recognise that some of the patients had been carefully investigated before being referred to our hospital. The cost of these tests are not potentially redundant, and consequently have not been registered.

Given a prevalence rate of 15% it is obvious that the screening programme is very cost effective, at least in a narrow monetary sense of the term.[12] Thus, the price for screening the whole population of patients with diarrhoea of uncertain origin is more than balanced by what can be saved in specific diagnostic procedures in the laxative abusers.

In evaluating the possible medical benefits of the screening strategy, one must recognise that in four of the seven patients the participating clinicians did not suspect self-induced diarrhoea. Therefore, the correct diagnosis was missed or postponed in the normal diagnostic strategy, where a chemical detection of laxatives is restricted to cases in which clinical findings specifically suggest factitious diarrhoea. Consequently, some of the patients detected here did not show the classical features of the syndrome.[1,2]

Even though the treatment of patients with laxative abuse is generally unsuccessful, and follow up has shown relatively poor results,[11,13] most clinicians would agree that establishing the diagnosis early is an overall benefit to the patient, who may then be spared further unpleasant or risky investigations. In that sense the screening programme proved beneficial, as these patients could have been spared the relative risks of 10 roentgenographic contrast investigations (four barium enemas, five barium meals with follow through and one abdominal angiography) and 13 investigations involving intubation of the gastrointestinal tract (nine sigmoidoscopies, two upper endoscopies, one small bowel biopsy, and one jejunal aspirate) (Table 2).

We conclude that in at least 15% of unselected patients with diarrhoea of uncertain origin the bowel disorder can be explained by surreptitious laxative intake. We recommend the use of a comprehensive, early laxative screening programme of all patients with diarrhoea of uncertain origin as a cost beneficial and cost effective procedure.

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Prevalence of surreptitious laxative abuse in patients with diarrhoea of uncertain origin: a cost benefit analysis of a screening procedure.

P Bytzer, M Stokholm, I Andersen, N A Klitgaard and O B Schaffalitzky de Muckadell

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CORTICAL EVOKED RESPONSE AUDIOMETRY IN NOISE INDUCED HEARING LOSS CLAIMS

FIELD W. RICKARDS, SANDRA DE VIDI and DON S. McMAHON

Deafness Studies Unit
Department of Learning, Assessment and Special Education
University of Melbourne
Victoria

The relationship between cortical evoked response audiometry (CERA) and pure tone audiometric (PTA) thresholds at 500-, 1000-, 1500-, 2000-, 3000- and 4000 Hz was examined in 500 adult subjects, who had submitted noise induced hearing loss (NIHL) claims between 1984-1994. Subjects were considered to have reliable pure tone audiograms, and had hearing thresholds ranging from normal to profound. Results showed a close relationship between PTA and CERA thresholds ($r = .96$), with a mean difference between the two tests of 0.9 dB (Standard Deviation = 5.0 dB). Overall, for all the frequencies tested, CERA thresholds were within 10 dB of the PTA threshold for 97.9% of cases. The results suggest that CERA can be used as an objective test to estimate hearing thresholds across a range of frequencies in NIHL claims.

The incidence of exaggerated hearing loss in noise induced hearing loss (NIHL) claims is well established. The percentage of workers who exaggerate hearing thresholds in NIHL claims has been estimated to be in the range of 9% (Barrs et al 1994) to 30% (Gleason 1958). In Victoria, the number of exaggerators is at least 17.7% (Rickards and De Vidi 1995). Undetected exaggerated hearing levels will lead to a substantial increase in compensation payouts. Although conventional diagnostic audiology can usually detect exaggeration of hearing levels, subjective hearing tests cannot accurately ascertain the degree of the true hearing loss in the individual who refuses to respond reliably (Hyde et al 1986).

Cortical Evoked Response Audiometry (CERA) has been widely used as an objective test to estimate hearing thresholds across a range of frequencies in alert adults and older children when reliable subjective hearing test results cannot be obtained (Gibson 1978). In estimating hearing thresholds, CERA involves the presentation of tone bursts to each ear at different frequencies, subjectively analysing the averaged brain patterns in order to determine the presence or absence of a response. The presence of a response implies that the ear, associated neural pathways, and the auditory cortex has processed the sound. It is therefore assumed that the subject has hearing at this particular intensity level and frequency (Hall 1990).

Figure 1 shows a set of five cortical evoked responses (CER) at decreasing stimulus levels in an awake adult. The response commences approximately 50 ms after the onset of the stimulus, and is characterised by three main peaks, P1, N1 and P2. The latency of the main peak (N1) is around 150 ms. It can be seen that the amplitude of the response decreases while the latency of the response increases with decreasing stimulus intensity.

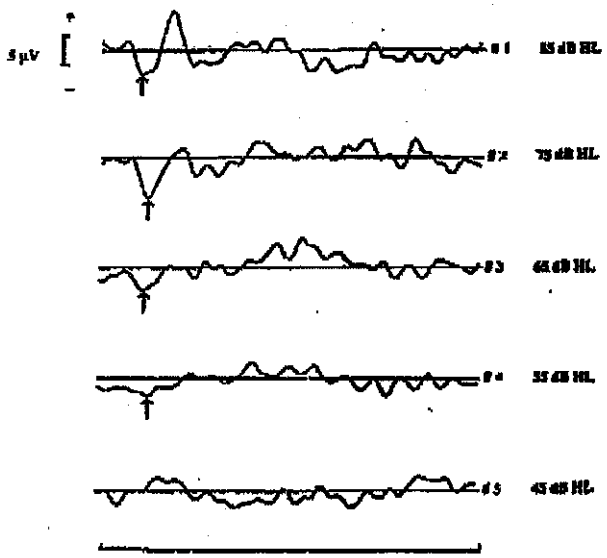

FIG. 1. Cortical evoked responses at 2000 Hz from an adult male with a subjective hearing threshold of 55 dB HL. Responses were elicited at stimulus levels above threshold (#1-#3), and at threshold (#4). No response is evident below the subject's true subjective threshold (#5). The N1 peak in responses #1-#4 is marked by an arrow.

Professor Field W. Rickards
B.Sc. (Hons), M.Ed., Ph.D.
Ms Sandra De Vidi
B.Sc., Dip.Aud.
Mr. Don S. McMahon
M.B., B.S., F.R.A.C.S., DLO

Correspondence:
Professor Field W. Rickards
Deafness Studies Unit
Department of Learning, Assessment and Special Education
University of Melbourne
Parkville, Vic. 3052
Tel: +61 3 9344-7876
Fax: +61 3 9349-1915

CERA has been extensively used to estimate hearing thresholds in individuals undergoing NIHL assessments. It has been used in Victoria in cases of suspected exaggerated hearing loss in NIHL claims for more than 15 years. Currently, up to 18% of all NIHL claimants in Victoria are referred for CERA each year.

The accuracy of CERA has been examined in a number of studies, usually by comparing CERA thresholds to Pure Tone Audiometric (PTA) thresholds. For example, Jones et al (1980) found identical PTA and CERA thresholds in 81%, 70%, and 68% of adult subjects with normal hearing at 250-, 1000- and 4000 Hz respectively. Coles and Mason (1984) examined PTA and CERA thresholds on a group of medico-legal cases and separated the subjects into organic and non-organic hearing losses. In the cases of organic hearing loss, the mean difference between PTA and CERA thresholds was found to be 0 dB, with only 3.2% of cases having a mean difference between PTA and CERA that exceeded 15 dB. Further, 37% of cases with non-organic hearing loss had PTA thresholds which were more than 30 dB greater than the CERA thresholds. In a study by Hyde et al (1986), on a group of medico-legal cases who were considered to have reliable conventional audiometry, PTA and CERA thresholds were found to be within 10 dB for almost all 254 cases. Similar results were found in a recent study by Prasher et al (1993). These researchers compared PTA and CERA thresholds at 1000- and 4000 Hz on a group of compensation cases and a group of Meniere's disease subjects. Prasher et al (1993) found CERA and PTA thresholds to be within 10 dB for 84% and 92% of the workers compensation and Meniere's disease groups respectively. In the workers compensation group, the majority of cases where the difference between PTA and CERA thresholds exceeded 10 dB were usually cases where the subject was considered to be exaggerating his PTA thresholds.

In spite of these findings, and early recommendations for the use of CERA in NIHL assessments (McCandless and Lentz 1968, Alberti 1970), the acceptance of the reliability of CERA has not been universal. This may in part be due to the reliance on subjective interpretation of response tracings during the test, and the high level of skill and training that is required of the tester (Hyde et al 1986, Hoth 1993). As CERA is currently being used in a number of specialist clinics, this paper investigates the accuracy of a CERA procedure in predicting hearing thresholds at the frequencies used in the determination of the percentage loss of hearing (PLH) in NIHL claims in Australia.

Method

Subjects

Five hundred adult male subjects (mean age = 55 years, Standard Deviation = 8.44) who were referred for CERA as part of a NIHL claim in Victoria were chosen for analysis. The subjects were referred for CERA by Insurance Companies or Otologists, and were selected from a pool of over 5000 subjects that were tested by the one tester over a period of more than 10 years between 1984-1994. The subjects were selected randomly, on the basis of having reliable subjective PTA thresholds either at the commencement or conclusion of the CERA test. This reliability was determined primarily using speech threshold testing where the audiogram was accepted as reliable if the 1000 Hz PTA threshold was less than the speech Half Peak Level (HPL) using AB words (Boothroyd 1968). Subjects had hearing thresholds ranging from normal to profound. All losses were sensorineural in nature, with no subject showing any evidence of retrocochlear pathology.

Procedures and apparatus

All subjects were given a thorough audiological examination involving an otological/noise history, impedance audiometry with reflexes, speech audiometry, an initial subjective PTA test, CERA, and a final subjective PTA test after CERA. The order of presentation of these tests remained constant between subjects. For all tests, subjects were seated in a sound attenuated room which was adjacent to the tester. In the speech testing, AB Words were presented live voice via a microphone into headphones using an ascending method. This procedure was followed for all subjects prior to the commencement of PTA. PTA thresholds were measured using a Starkey Acoustic Analyser AA30 audiometer. The procedure for determining thresholds in the initial PTA test involved an ascending method followed by a standard threshold seeking procedure. The procedure for determining thresholds in the final PTA test involved an ascending method only. For both PTA tests, thresholds were normally determined for each ear at each of the frequencies, 500-, 1000-, 1500-, 2000-, 3000-, 4000-, 6000- and 8000 Hz for all of the subjects. In most cases, thresholds obtained in the final PTA were accepted as the true thresholds, since the initial PTA thresholds were often elevated.

CERA was normally carried out for all subjects for each ear at each of the frequencies 500-, 1000-, 1500-, 2000-, 3000- and 4000 Hz. The cortical responses were recorded using silver-silver chloride electrodes. An active electrode was placed at the vertex and a ground and reference electrode on each mastoid. Narrow-band masking was used in the contralateral ear when required. The EEG signal was amplified using a Madsen BIA77 preamplifier with a filter bandwidth of .25-15 Hz, and a rejection rate of 12 dB per octave and 24 dB per octave in the low and high frequency slopes respectively. Stimuli were 100 ms tone bursts with a rise/fall time of 5 ms for all frequencies.

Sampling, averaging, stimulus initiation and response display were controlled using a Hewlett Packard 9816S scientific computer. The system had three non-standard features designed to enhance the response and aid in its recognition. Firstly, stimuli were presented with random inter-stimulus intervals every 1.5 to 2.5 ms (mean = 2.0 ms). Random inter-stimulus intervals have been found to enhance response amplitude (Tyberghein and Forrez 1969). Secondly, 128 samples with 10 ms intervals were recorded following each stimulus presentation, producing a total time window of 1.28s. This long time window enabled easy comparison between the response (<400 ms) and non-response (>400 ms) sections of the tracings. Thirdly, the detection of the response was aided with a template response that remained at the top of the computer

screen. This template was obtained at the beginning of the test for each subject at a high sensation level (80 - 90 dB HL) at 2000 Hz.

Once the template response for a particular subject was obtained, stimuli were presented at 5 dB below the subject's best PTA threshold at 2000 Hz. Stimuli were decreased in 10 dB steps following each response, or increased in 10 dB steps if no response was identified. This was continued until no response was present or until 20 dB HL was reached. Presentation of stimuli below 20 dB HL was rarely attempted as thresholds below this level indicated hearing within normal limits, and hence a PLH of 0% at this frequency. The subject's threshold was taken to be equivalent to the lowest level where a CER was obtained or 5 dB less than this level. The subtraction of 5 dB occurred when the response at the lowest level had an N1 amplitude of greater than 50% of the template and a latency within 20 ms of the response 10 dB above. For example, in Figure 1, response #4 was considered to be at threshold. Had no response been recorded at this level, threshold would have been taken as 5 dB below the stimulus level for response #3. Response thresholds were subsequently obtained at each of the other frequencies. Each CER was analysed at the time of testing by the same tester.

For an averaged response tracing to be accepted as a true response, certain amplitude and latency criteria had to be satisfied. Specifically, N1 had to be the largest negative peak, and/or P2 had to be the largest positive peak, and/or N1 to P2 had to be the largest peak to peak amplitude. Further, the latency of any peak could not be less than the latency of the peaks in the template.

During CERA, subjects were instructed to sit quietly and remain as relaxed as possible. These instructions remained constant between subjects. The time taken to complete the CERA test varied between 15-30 minutes.

Results

Figure 2 demonstrates the relationship between the subjective PTA and CERA thresholds at each of the frequencies for the right and left ears. It can be seen that most values cluster closely around the regression line indicating a close relationship between PTA and CERA thresholds regardless of frequency, ear, or hearing threshold. A t-test for dependent samples comparing the PTA and CERA thresholds for the right and left ears showed there was no significant difference in results between ears. Consequently, results from both ears for all subjects were combined for subsequent analysis.

As CERA thresholds were not normally attempted

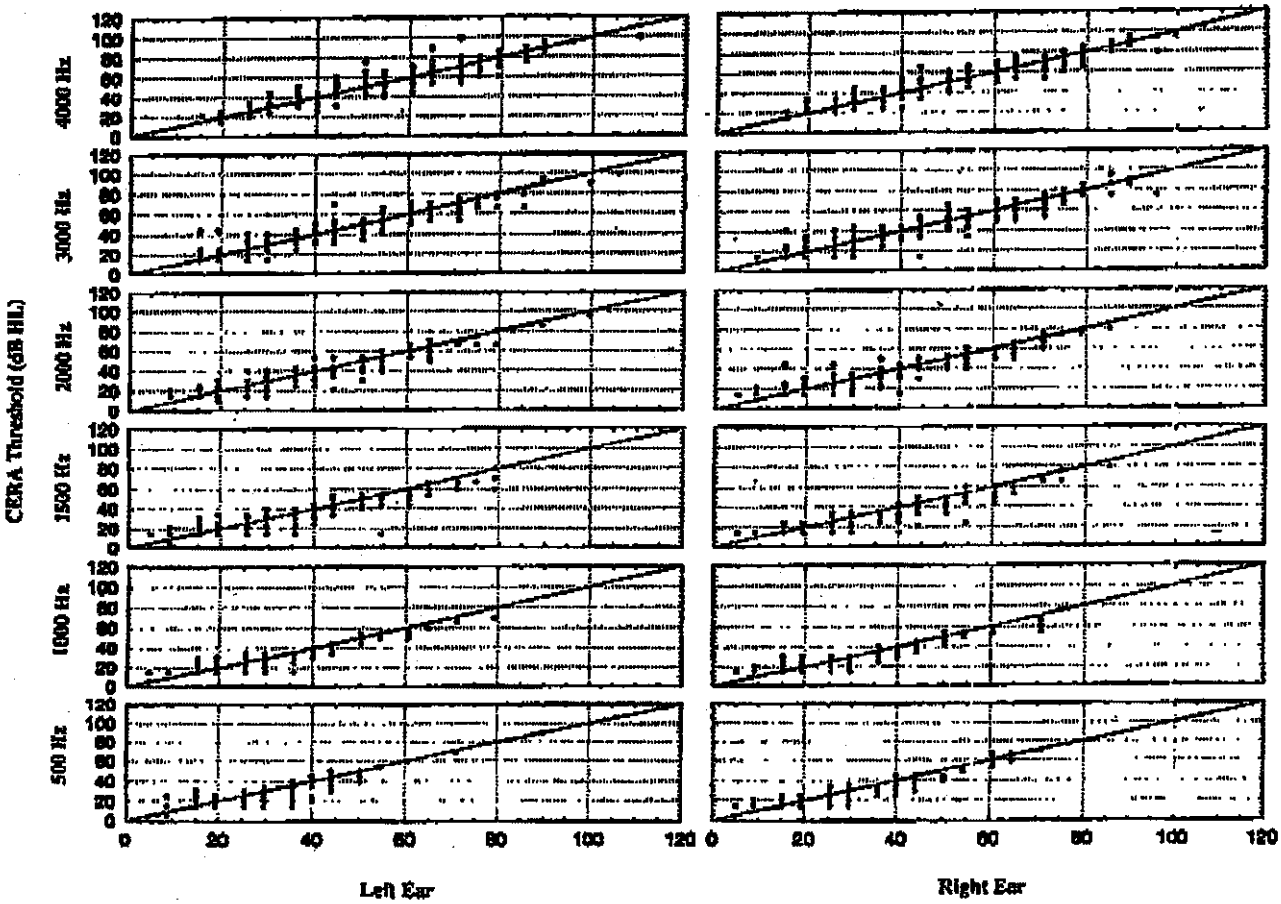

FIG. 2. Regression lines showing the relationship between PTA and CERA thresholds at 500-, 1000-, 1500-, 2000-, 3000- and 4000 Hz for all subjects for the right and left ears.

below 20 dB HL, comparisons with subjective thresholds less than 20 dB HL were not possible. The data were therefore re-analysed by eliminating the comparative data when the CERA thresholds were less than 20 dB HL. After the elimination of these data points, 4304 threshold comparisons remained. The mean differences between PTA and CERA thresholds at each of the frequencies in the remaining data are shown in Table 1. The differences are all less than 2.0 dB. Overall, the mean difference between PTA and CERA thresholds was 0.9 dB (standard deviation = 5.0 dB).

Table 1.
Differences between PTA and CERA thresholds at each frequency.

	Frequency					
	500	1000	1500	2000	3000	4000
Mean difference (dB HL)	1.131	1.310	1.530	1.508	0.498	0.087
Standard Deviation	4.644	4.334	5.172	5.008	5.230	5.184
Number of ears	513	496	624	776	913	982

The correlation between PTA and CERA thresholds at each of the frequencies are listed in Table 2. There is a close relationship between CERA and PTA thresholds at each of the frequencies tested. Overall, a correlation of .96 was obtained.

Table 2.
Pearson product-moment correlation coefficients at each frequency.

	Frequency					
	500	1000	1500	2000	3000	4000
r	.89	.93	.93	.95	.95	.95
Number of ears	513	496	624	776	913	982

The differences between PTA and CERA thresholds for each frequency for all of the subjects is illustrated in Figure 3. Overall, 47.0% of the PTA and CERA thresholds were identical, while 88.5% and 97.9% of cases fell within 5 dB and 10 dB of the subjective PTA threshold respectively. Of the 500 subjects, 62% had initial pure tone audiograms which were confirmed as exaggerated as indicated by an elevated PTA 1000 Hz threshold compared to the speech HPL. In these cases, the tester performing CERA was obtaining thresholds without knowledge of the true PTA values. The percentage of PTA and CERA thresholds that were within 10 dB of each other in this subgroup was 97.1%, similar to the overall value.

Discussion

The close agreement between PTA and CERA thresholds

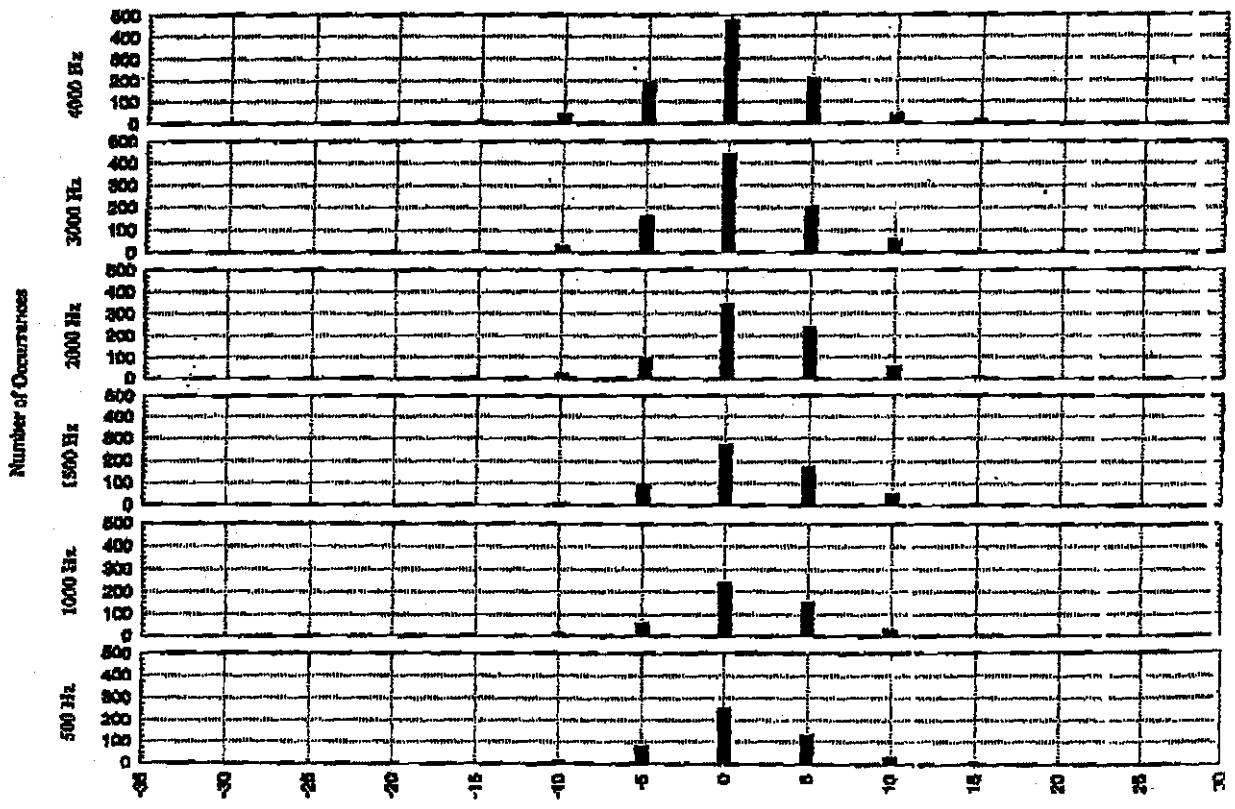

FIG. 3. The difference between PTA and CERA thresholds (PTA - CERA) at 500-, 1000-, 1500-, 2000-, 3000- and 4000 Hz for subjects where CERA thresholds less than 20 dB HL are eliminated.

obtained in this study implies that the CERA procedure can be used to estimate subjects hearing thresholds at a range of frequencies and stimulus levels. The accuracy of the CERA procedure used in this study is similar to that found by other researchers (Coles and Mason 1984, Hyde et al 1986, Prasher et al 1993). This accuracy is contingent upon consistent response identification protocols. Specifically, a random inter-stimulus interval was used to provide larger responses which were easier to detect; a template response was displayed to facilitate recognition of responses at lower levels and especially at threshold; an extended time window enabled the tester to examine the CER with respect to the residual background EEG activity. These protocols appeared to enhance the accuracy of the detection of the response, and helped to remove the subjective aspect of response interpretation. The difficulties in subjective response detection has been highlighted in a number of studies (Hyde et al 1986, Hoth 1993). The results in this study suggest that these difficulties have been minimised using the protocols described. The use of these protocols is further supported by the maintenance of accuracy when CER were obtained without prior knowledge of the true audiogram.

Conclusion

The results of this study show that there is a close relationship between CERA and PTA thresholds at all of the frequencies that are assessed in NIHL claims. This suggests that the CERA procedure used in this study is an accurate and objective test for determining hearing levels in NIHL claims.

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PubMed

Abstract

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Exaggerated hearing loss in noise induced hearing loss compensation claims in Victoria.

Rickards FW[1], De Vidi S.

Author information

Abstract

OBJECTIVE: To determine the incidence of exaggerated hearing loss in people claiming workers compensation for noise induced hearing loss, as well as the ability of a range of testers to detect this exaggeration.

SUBJECTS: 333 people who claimed compensation for noise induced hearing loss between 13 September 1993 and 31 July 1994 in Victoria and who had undergone two independent subjective hearing tests.

METHOD: The hearing test results and referral decisions made by testers were examined in the light of the results of a single objective hearing test (cortical evoked response audiometry).

RESULTS: The incidence of exaggerated hearing loss was 17.7%. Testers performing the first subjective hearing test detected only 2.2% of claimants who exaggerated. The audiologist performing the second subjective test detected 94.2% of claimants who exaggerated.

CONCLUSIONS: The high incidence of exaggerated hearing loss and the large difference in ability to detect this exaggeration by the two groups of testers demonstrate the need for appropriate test procedures to be followed and a second hearing test to be reintroduced. Without accurate testing, there will be overpayment for noise induced hearing loss claims.

Comment in

Exaggerated hearing loss in noise-induced hearing loss compensation claims in Victoria. [Med J Aust. 1996]

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MeSH Terms