ASSESSING TREMOR SEVERITY

A Clinical Handbook

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INTRODUCTION

The purpose of this manual is to provide quick and simple ways of measuring and recording the severity of essential tremor. These methods do not require any specialist equipment and can be easily performed in the outpatient clinic as part of a routine assessment.

It is important that the techniques used to assess tremor severity produce results that reflect the effect of tremor on patients' everyday lives. Otherwise the results become abstractions with no relevance to patients. It is recommended that the following methods of assessment are used:

1. A clinical rating scale
2. Scoring Archimedes spirals
3. Rating tremor in handwriting
4. A volumetric method
5. An Activities of Daily Living Questionnaire
6. An assessment of handicap

These methods have all been extensively evaluated. The scores obtained using the clinical rating scale and by rating spirals and handwriting have been shown to have good inter-rater and intra-rater reliability and to provide valid indices of tremor induced disability\(^1\). Furthermore, the scores obtained with these techniques correlated both with each other and with the magnitude of tremor (RMS acceleration) as measured by accelerometry\(^1\).

The results of the volumetric method (the amount of water split from a cup in one minute) were also highly correlated with the impairment caused by tremor in drawing spirals, a joy-stick controlled computer tracking task and the RMS acceleration and frequency as recorded by accelerometry\(^6\). These methods are ideally suited for routine assessments, clinical trials and documenting the natural history of tremor\(^3\).
PROBLEMS WITH PREVIOUS APPROACHES

In the past scant attention has been paid to the reliability and validity of the methodology involved in assessing tremor severity. During the last two decades the routine assessment of tremor has relied heavily on accelerometry as the objective method and numerous clinical rating scales as the subjective methods of assessment. Furthermore, the use of video tapes has become increasingly popular amongst movement disorder specialists for monitoring patients and evaluating the effects of drugs. Indeed, an entire journal, *Movement Disorders*, has been developed around the video tape format.

The following problems and disadvantages have been found in using these techniques for the clinical assessment of tremor sensitivity\(^{(12)}\).

Accelerometry

1. The magnitude (RMA acceleration) and frequency of postural tremor measured by linear accelerometry did not correlate with patient disability\(^{(1)}\). In part this reflects the problems involved in capturing the complex four-dimensional behaviour of tremor with a linear device attached to one part of the body.

2. Accelerometers are biased towards high frequency components, whereas intermittent large amplitude displacements may actually be more functionally disruptive and are ubiquitous in patients with tremor.

3. They are more expensive and not readily available in most clinics.

4. They introduce a systematic bias, or 'training effect' which results from making serial measurements involving apparatus with which the patient is not initially familiar in a hospital based environment.

Previous Clinical Rating Scales

1. Previous clinical tremor rating scales have not been assessed for inter-rater and intra-rater reliability or been demonstrated to provide valid indices of tremor induced disability\(^{(1)}\).
2. These scales fail to relate the magnitude of tremor to the anatomical site affected.

3. They average the magnitude of tremor seen in different parts of the body.

4. They fail to distinguish between the different components of tremor (ie the rest, postural, kinetic and intention components), which may have very different implications for the patient in terms of disability.

5. Most tremor scales use insufficient gradations within the scale. (A broader scale increases precision and reliability. As the number of steps in the scale increases so does the difficulty of consistent judgement. However, by also decreasing the significance of 'unit' error, true score variance is altered advantageously for reliability).†

6. Several tremor rating scales wrongly include measures of both impairment and disability within the same scale.

Videotapes

1. There are major problems with the qualitative and quantitative assessment of tremor from video tapes. These difficulties are caused by the fact that most standard VHS video recorders present the viewer with a fresh image at a rate of 25 Hz (alternate lines on the monitor are changed at 50Hz). This produces a filtering effect so that here is a greater reduction in the apparent amplitudes of high as compared to low frequency tremors.

2. The magnitude of a tremor seen on a video screen depends on the size of the image on the observer’s retina. This in turn is a function of both the distance of the observer from the monitor and the actual size of the image, influenced by the amount of zoom used by the cameraman.

3. Further difficulties are introduced by variations in the lighting conditions and in both the depth and plane of focus used whilst filming.
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DEFINITIONS

The International Tremor Foundation Tremor Investigation Group have recommended the following definitions of tremor and the various components of tremor.

**tremor**
a rhythmical oscillatory movement of a body part

**rest tremor**
tremor which is present when a limb is fully supported against gravity and the relevant muscles are not voluntarily activated.

**action tremor**
any tremor occurring on voluntary contraction of muscle. Includes postural, kinetic, intention, isometric and task specific tremor:

*postural tremor* - tremor apparent during the voluntary maintenance of a particular posture against gravity.

*kinetic tremor* - tremor evident during any type of movement

*intention tremor* - the pronounced exacerbation of kinetic tremor towards the end of a goal-directed movement.

*isometric tremor* - tremor occurring as the result of muscle contraction against a rigid stationary object.

*task specific tremor* - tremor which only occurs to any significant extent during the performance of highly skilled activities such as writing, playing a musical instrument or using a jeweller's screwdriver.
METHODS

This manual provides the clinician with simple and effective ways of documenting tremor severity. The recommended methods have all been shown to be reliable and to reflect tremor induced disability. A significant advantage of assessing handwriting and spirometry is that it allows data to be collected from patients by post. The same applies to the disability and handicap self-questionnaires.

1. A Clinical Rating Scale

The approved clinical rating scale is shown in Figure 1. It was chosen after experimentation with several other designs because it proved to be both reliable and user-friendly. It is a combination of a discrete step verbal scale and a numerical (0 - 10) analogue scale. The rater should note the following:

i Tremor magnitude should be related to specific anatomical sites and tremor of the head and of each arm and leg should be scored separately. Maximum information about the natural histories and differential behaviour of the tremor components seen in different parts of the body are retained by not amalgamating the scores.

ii The severity of the different tremor components (e.g. rest, postural and intention tremor) are scored separately.

iii The rater should decide whether each tremor component at a given anatomical site is mild, moderate or severe and then ascribe a numerical score to it.

An example of the use of the scale is given in Figure 2, which shows the results from a patient who had grade 5 postural (P) and grade 1 rest (R) tremor of the right arm.
Right Upper Limb

Extremely Severe 10
Severe
Moderate
Mild
None

Key:  Tremor Components
R  Rest
P  Postural
K  Mid-movement (kinetic)
I  Intention
TS  Task specific
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We would recommend scoring each component in the following way:

**Head Tremor:**

*rest component* - while the patient is lying flat on the couch with the head supported by pillows.

*postural component* - while the patient is sitting without head support looking straight ahead.

**Tremor of the upper limbs:**

*rest component* - while the patient is sitting with the arms relaxed in the lap and fully supported.

*postural component* - while the subject's hands are held prone in front of the nose with the arms abducted.

*kinetic component* - in the middle of the transit phase of the finger-nose test with the target object held at arm's length from the patient

*intention component* - in the terminal 25% of the finger-nose test as the finger approaches the target object.

**Tremor of the lower limbs:**

*postural component* - while the patient is sitting with the relevant leg fully extended at the knee.

*rest component* - while the patient is sitting with the feet on the floor.
2. Spirography

The severity of tremor apparent in an Archimedes spiral is rated from 0 - 10. The patient should be instructed to draw a spiral from inside to out with at least five turns in it. The pen should be held in a normal way and the writing hand should not be steadied by the other arm. The forearm may rest on the table.

In order to facilitate scoring, examples of spirals exhibiting tremors of varying severity are shown in the following pages. These spirals were scored independently by four 'blind' raters and we have used the median grades from the raters' scores. Consequently by matching actual examples of spirals obtained in practice with those in this manual, the clinician can obtain a reliable assessment of tremor severity.

The critical factors in determining the grade of a particular spiral are the degree of perpendicular displacement of the track from the intended trajectory and the extent to which tremor persists during each turn. In general the spirals show a centrifugal tendency, with tremor becoming more prominent as the number of turns increases and the distance from the centre grows. Tremor is more obvious in drawings of spirals than in handwriting specimens.

95% of a normal population drew spirals of grade 1 or lower. This was assessed by examining 100 healthy control subjects aged between 3 and 80 years\(^{(3)}\).

No example of Grade 10 is shown because a tremor of this severity should completely disrupt an attempt to draw a spiral.
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Grade 0
Assessing Tremor Severity

Grade 1

11
Assessing Tremor Severity

Grade 2
Assessing Tremor Severity

Grade 3

13
Assessing Tremor Severity

Grade 4
Grade 5
Assessing Tremor Severity

Grade 6
Grade 7
Assessing Tremor Severity

Grade 8
Assessing Tremor Severity

Handwriting

The scores obtained by rating the severity of tremor in handwriting correlated with those obtained by methods 1 and 2\(^{(1)}\).

Although this method adds little further information to that obtained from the previous methods, it is included because handwriting samples are readily available in the patient's medical records, old letters and other personal writings. The examples illustrated below were graded from the median scores obtained from four independent 'blind' raters.

Grade 0  A B C D E  The National Hospital

Grade 1  A B C D E  The National Hospital

Grade 2  A B C D E  The National Hospital

Grade 3  A B C D E  The National Hospital

Grade 4  A B C D E  The National Hospital

Grade 5  A B C D E  The National Hospital

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Grade 6 ACDE NATIONAL HOSPITAL

Grade 7 A B C D E NATIONAL Hospital

Grade 8 A B C E

NATIONAL HOSPITAL

Grade 9

Grade 10 No example is given as a tremor of this severity should completely disrupt an attempt to write.
4. Volumetric method

The patient is asked to hold a 100ml polystyrene beaker of water between the thumb and fingers for one minute. The patient should be seated and the beaker held over a basin. The forearm should be resting on the edge of the basin while rest tremor is scored and unsupported with the shoulder abducted and elbow flexed to about 90° (as if about to drink) while postural tremor is being rated.

Two parameters can be measured:

1. The amount of water left in the cup after sixty seconds (X60 ml). This allows the amount of water spilt to be calculated (100-X60 ml) which correlates well with tremor severity (2, 7). The result provides some indication of the patient's capacity to suppress tremor amplitude for a period of 60 seconds.

2. The time taken (seconds) from initially gripping the beaker to the moment when water is spilt. This provides an index of the patient's capacity to suppress tremor in the temporal dimension.

The volumetric method therefore provides two useful indices of tremor suppressability: the extent to which tremor amplitude can be suppressed while performing manual tasks and the period of time that this suppression can be maintained. These two factors may be critical in determining the degree of disability caused by individual factors.

5. Activities of Daily Living Questionnaire

The activities of daily living (ADL) self-questionnaire is illustrated on the following page. It takes about ten minutes for the patient to complete. The patient is instructed to circle the number which describes how easy or difficult it is for them to perform the relevant activity. The scores for the individual items are then summed to give a total score (maximum 75) which is converted into a percentage. This self-questionnaire was adapted from a similar one developed for patients with parkinsonism which has been previously evaluated (8, 9). The results obtained with this ADL questionnaire are a valuable indicator of tremor-induced disability and were shown to correlate with the scores obtained by methods 1, 2 and 3 (1, 3).
Activities of Daily Living Self-questionnaire

1 cut food with a knife and fork 0 1 2 3
2 use a spoon to drink soup 0 1 2 3
3 hold a cup of tea 0 1 2 3
4 pour milk from a bottle or carton 0 1 2 3
5 wash and dry dishes 0 1 2 3
6 brush your teeth 0 1 2 3
7 use a handkerchief to blow your nose 0 1 2 3
8 take a bath 0 1 2 3
9 use the lavatory 0 1 2 3
10 wash your face and hands 0 1 2 3
11 tie up your shoe laces 0 1 2 3
12 do up buttons 0 1 2 3
13 do up a zip 0 1 2 3
14 write a letter 0 1 2 3
15 put a letter in an envelope 0 1 2 3
16 hold and read a newspaper 0 1 2 3
17 dial a telephone 0 1 2 3
18 make yourself understood on the telephone 0 1 2 3
19 watch television 0 1 2 3
20 pick up change in a shop 0 1 2 3
21 insert an electric plug into a socket 0 1 2 3
22 unlock your front door with the key 0 1 2 3
23 walk up and down stairs 0 1 2 3
24 get up out of an armchair 0 1 2 3
25 carry a full shopping basket 0 1 2 3

Key: 0 able to do the activity without difficulty
      1 able to do the activity with a little effort
      2 able to do the activity with a lot of effort
      3 cannot do the activity by yourself
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6. Assessment of Handicap

The handicap self-questionnaire is shown below and provides a useful qualitative insight into the social consequences of having tremor\(^{(2)}\).

The patient is asked to answer the following questions by putting a circle around the appropriate letter.

Assessment of Handicap Self-questionnaire

Has your tremor stopped you

1. working? 
2. applying for a job or promotion? 
3. shopping by yourself? 
4. doing a favourite hobby or sport? 
5. travelling by public transport? 
6. driving a car? 
7. eating out? 
8. going on holiday? 
9. accepting a party invitation?

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Key:  
A  no
B  yes because you are embarrassed by the tremor
C  yes because of the physical difficulties produced by the tremor
D  yes because of BOTH the physical difficulties and the embarrassment produced by the tremor
REFERENCES


4 Cleeves L, Findley LJ. Variability in amplitude of untreated essential tremor. *Journal of Neurology Neurosurgery and Psychiatry* 1987; **50**: 704-708


