From Guidelines to Action: Movement Disorders Care Through Regional & Multidisciplinary Collaboration
Miami, Florida, USA | November 7-8, 2026
International Parkinson and Movement Disorder Society Pan American Section
In collaboration with: Baptist Health

# Update on Essential Tremor:

## Diagnosis, Pathophysiology, Epidemiology, and Medical Management

**Diego Torres-Russotto, MD, FAAN**
Professor and Chair.
Florida International University / Baptist Health

**DiegoTorresMD.com**
@Diego_Torres_MD | Instagram + X

# COI disclosures

- Dr. Torres-Russotto is a consultant for AbbVie, Amneal, Neurocrine, Revance and Teva.

# Learning Objectives

- List challenges in the identification of tremor phenomenology
- Review current epidemiology and classification of tremor
- Review pathophysiological mechanism in ET.
- Identify best treatment options for different patients with ET

# Definition of Tremor

*“Tremor is an involuntary, rhythmic, oscillatory movement disorder of a body part”*

*Bhatia et al. 2018*

# Tremor Epidemiology

- **Prevalence in the general population:**
  - **Tremor: >90%**
  - **Pathologic Tremor: >10%**
- **Prevalence of essential tremor (ET) is 4.6–6.3% in population over 65 years of age** and, prevalence of Parkinson's disease (PD) is about 1% of the population over the age of 60 years
- Estimate number of ET cases (2014) ranged from 6.38 to 7.63 million, which corresponds to 2.2% of the US population
- Estimate number of  Parkinson's disease (PD) cases in the U.S. is about one million
- Approximately 60,000 Americans are diagnosed with PD each year. About 60% have tremors

*Louis et al. 2014*
*https://www.parkinson.org/Understanding Parkinsons/Statistics*

# Tremor risk and prevalence increases with age

- ET risk rises about **74% for each decade of age**.
- ET Prevalence:
  - All ages : 1.33%
  - > 65: 5.89%
  - > 80: 11.4%
  - >95: 21.7%

Papp, A.K., Berki, Á.J., Vinnai, P. *et al.* . *Sci Rep* **15**, 28560 (2025)

Tremor is terribly UNDER-RECOGNIZED

Tremor is commonly MISSDIAGNOSED

# Misdiagnosis of tremor is common

- A study reported that **one out of three tremor patients were misdiagnosed as Essential tremor** {Jain,S. 2006}
  - Reevaluated 71 patients with prior diagnosis of ET
  - 37% were misdiagnosed: The most common correct diagnoses were Parkinson's disease (15%), Dystonia (8%)
  - Factors associated with misdiagnosed ET included unilateral arm tremor, dystonic postures, and other unusual features (isolated thumb tremor, isolated leg tremor, and nonrhythmic tremor)
- **Another study reported that overdiagnosis of essential tremor was 50%** {Schrag,A. 2000}

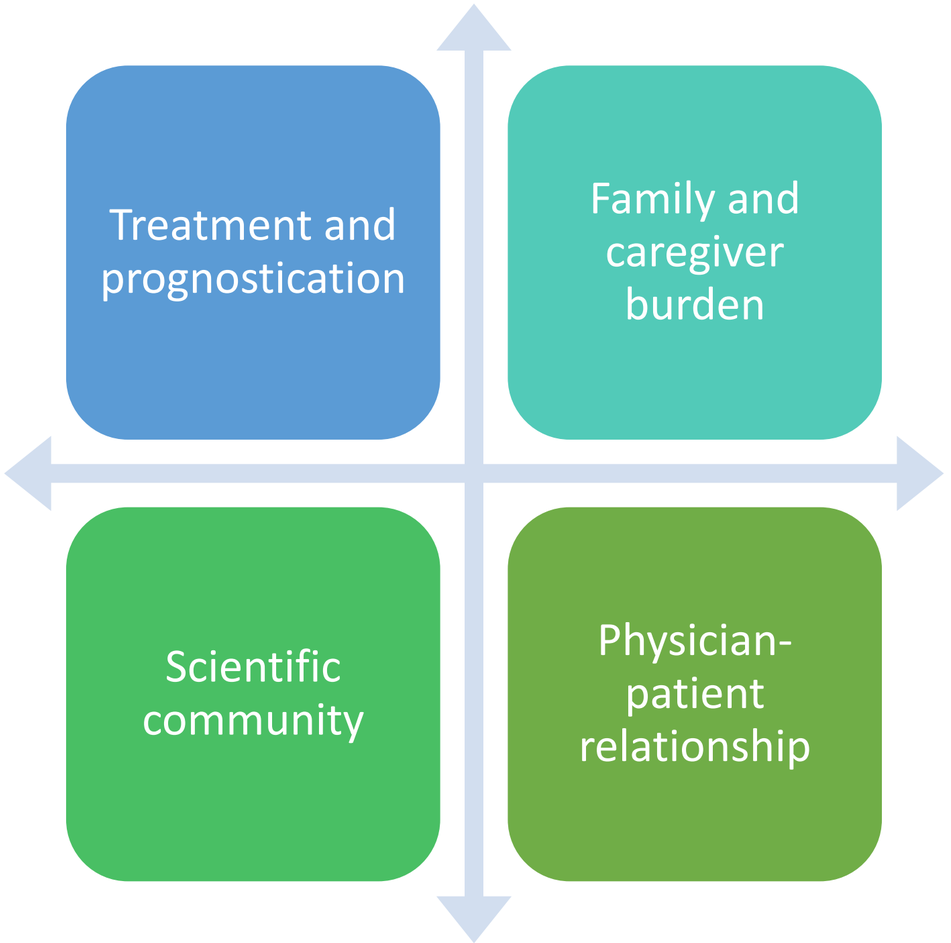
Front Neurol. 2020; 11: 172.
Published online 2020 Mar 25. doi: 10.3389/fneur.2020.00172
PMCID: PMC7109309
PMID: 32269548

# Essential Tremor as a "Waste Basket" Diagnosis: Diagnosing Essential Tremor Remains a Challenge

Christian J. Amlang,[1] Daniel Trujillo Diaz,[2] and Elan D. Louis[1,2,3,*]

- Included 104 patients who were referred with a diagnosis of ET
- **Only 47 (45.2%) had actual diagnosis of ET**, 29 (27.9%) had a diagnosis of dystonia, and 28 (26.9%) had other diagnoses, including PD (5.8%)
- **Factors associated with an alternative post-evaluation diagnosis: pre-evaluation diagnosis made by a non-neurologist, shorter tremor duration, irregular tremor, abnormal limb postures**

# Importance of correct diagnosis




*Amlang et al. 2020*

# NOT EVERY SHAKING IS DUE TO TREMOR

Therefore, **THE FIRST STEP** ON THE EVALUATION OF THE PATIENTS IS TO **DETERMINE IF THE SHAKING IS DUE TO TREMOR** OR SOMETHING ELSE.

# Tremor phenomenology mimickers

| MOVEMENT PHENOMENOLOGY | REASONS WHY IT LOOKS LIKE A TREMOR | CLUES THAT DIFFERENTIATE FROM TREMOR |
|---|---|---|
| **Seizure** | Convulsions can produce oscillations causing shaking | Comes in spells. Duration is short. Frequency and amplitude tends to change during spell. Consciousness could be impaired. It's not altered by passive/active movements or changes of posture |
| **Myoclonus (particularly cortical or poly-micro-myoclonus)** | Involves muscles across a joint, can flex or extend fingers repetitively, continual | There is lack of symmetric velocity on both directions. Due to myoclonus causing simple movements (jerk-release), there is absence of a midpoint for the oscillation. Movements are faster and less predictable. |
| **Shivering** | Involuntary shaking | Usually episodic. Amplitude fluctuates over time and within a single spell. Usually involves trunk muscles which is unusual on tremors |
| **Myokymia** | There is skin quivering, repetitive, continual | Movement can occur about a joint axis. |
| **Shuddering** | Fine Shaking | Episodic. Usually in <5 yo. Trunk and proximal involvement. Could proceed into ET. |
| **Tics** | Some tics can involve oscillations, particularly head shaking | Episodic, usually accompanied by other tics, fast frequency. Presence of premonitory feelings, ability to hold the tic. distractible |
| **Akathisia** | Often akathisia involves oscillatory movements | Irregular movement, episodic, can be held by patient, distractible. |
| **Stereotypic movements** | Often involves oscillatory movements | Episodic. Most commonly while mind wandering. They stop when patient is made aware of movement or surroundings. |

# Clinical Tip




ET tremor is usually constant.

Many **tremor mimickers are episodic** in nature.

(also, dystonic and ataxic tremors can present intermittently)

# THERE ARE CURABLE AND HIGHLY TREATABLE TREMORS

Therefore, **THE SECOND STEP** ON THE EVALUATION IS TO **RULE OUT CURABLE/TREATABLE TREMORS**

| Condition | Test to consider running | Comments |
|---|---|---|
| **Thyroid disorders** | TSH, T3, T4 | Both hypo and hyperthyroidism |
| **Wilson Disease** | Ceruloplasmin, 24-hr urine copper | Any tremor type possible. Presents with liver dysfunction often. |
| **Dopamine-Responsive Dystonia (DYT5)** | Levodopa trial might serve as a screening test. Rarely genetic or CSF functional testing is used. | Usually resting tremor, although postural, dystonic, and kinetic tremors possible. |
| **Vitamin Deficiencies: Vit E** | Vitamin E level, consider lipoprotein measurement | Dystonia, ataxia, and/or action/intention tremors |
| **Vitamin Deficiencies: Vit B12** | MMA and Homocysteine. Also B12 level. | Ataxia, dystonia, neuropathy. Tremor is usually action or intention. |
| **Zinc or Magnesium Deficiencies** | Check levels | Mostly action and intention tremors |
| **Structural lesions, stroke, trauma, malformations and tumors** | Imaging if: any focality, sudden onset, or trauma | Mostly action, midbrain, intention or dystonic tremors |

# Clinical Tip




Consider a **levodopa trial** in every patient with resting tremor, parkinsonism, dystonia or dystonic tremors

Also, in cases with diurnal variations

# Some Drugs that cause Tremor

- **Beta-adrenergic agonists**
  Terbutaline
  Metaproterernol
  Isoetharine
  Epinephrine

- **Psychiatric drugs**
  Lithium
  **Neuroleptics** - Antipsychotics
  SSRI

- **Stimulants**
  Amphetamine
  methylphenidate
  midodrine
  cocaine

- **Heavy metals**
  Mercury, Lead
  Arsenic, Bismuth
  Methyl bromide

- **Anticonvulsants**
  **Valproate sodium**

- **Methylxanthines**
  Caffeine
  Theophylline

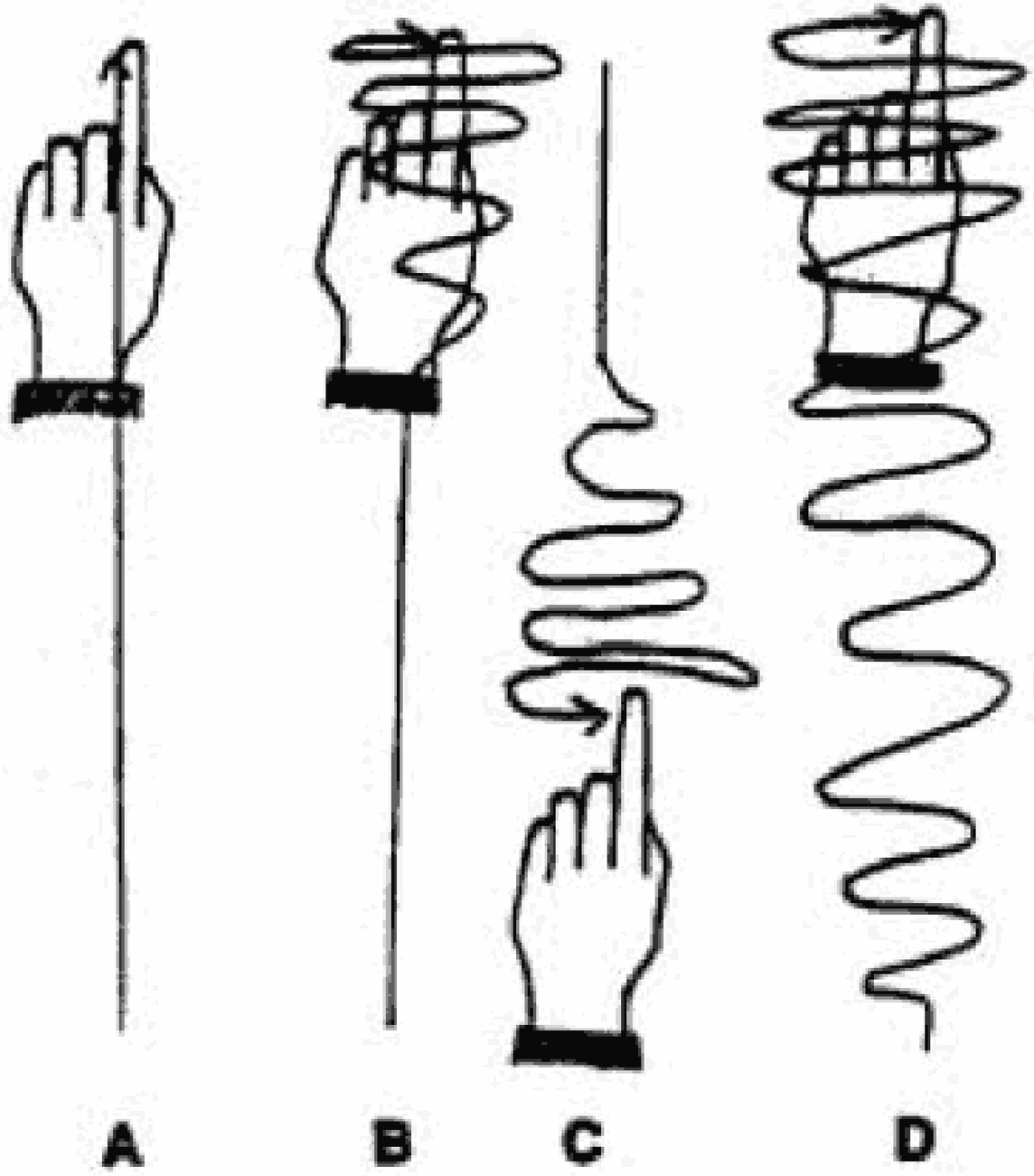
- **Anti-arrhythmics**

  Amiodarone / Fleicanide

# THERE ARE MANY TYPES OF TREMORS

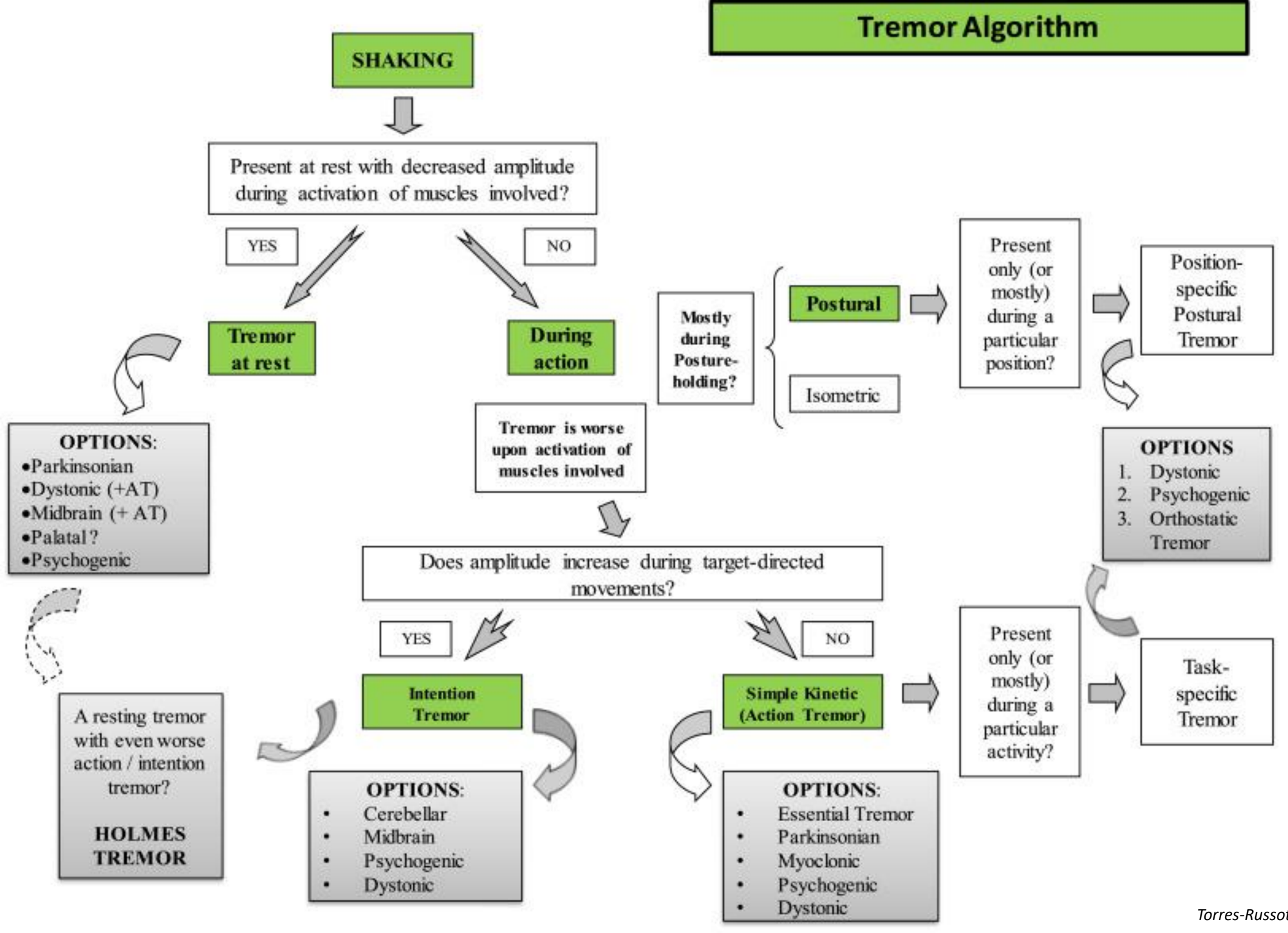
Therefore, THE **THIRD STEP** ON THE EVALUATION IS TO DETERMINE **WHICH TYPE OF TREMOR** THE PATIENT HAS.

| Type of tremor | Shaking muscle state | Examples |
|---|---|---|
| **Rest** | The shaking muscle is not being activated volitionally. Volitional activation of this muscle would stop or decrease the amplitude of the tremor | Hypokinetic disorders<br>Medication-induced<br>Functional |
| **Action (kinetic, postural, isometric)** | The tremor is induced or its amplitude increases by the volitional contraction of the shaking muscle. | Most pediatric tremors cases. |
| **Postural (position-specific vs position-independent)** | Tremor appears while holding body part in a position against gravity. | Less specific etiologically speaking. |
| **Kinetic (can be initial, dynamic (simple kinetic) or terminal/intention tremor)** | Usually during a multi-joint movement, tremor occurs. | Essential Tremor<br>Medication-induced<br>Functional |
| **Intention** | This is an action tremor which amplitude increases upon reaching a specific target. | Characteristic of cerebellar dysfunction. |
| **Isometric** | A tremor that occurs during isometric contraction of the muscle (no shortening of the muscle) | Often shares etiologies with enhanced physiologic tremors. |
| **Posture-specific** | Tremor only occurs when body is in a particular posture. Could be associated with dystonic tremor | Orthostatic tremor is rare in children. |
| **Task-specific** | Occurs while performing skilled tasks. This could become a form of Task-Specific Dystonia [15] | Primary writing tremor<br>Task-specific tremor of musicians |




A.Normal
B.Cerebellar
C.Parkinsonian
D.Action Tremor

Ref: From AAN Website




*Torres-Russotto D. j.parkreldis 2019;59:111-116.*

# Challenges with diagnosis of tremor

- **Difficult to differentiate rest tremor and action tremor from each other**
- **Rest, postural and kinetic tremor can be present in advanced ET and Parkinson disease**
- Impairment of handwriting is not specific for one type of tremor
- ET is not always bilaterally symmetrical, mild-moderate asymmetry is common
- **ET can have tremor that looks “resting”, and >20% of PD patients have an action/postural tremor.**
- **No specific ancillary test to help with diagnosis of ET**
- More studies needed to assess the sensitivity, specificity and reliability of bedside physical examination of tremor

Torres-Russotto D. Clinical approach to tremor in children. Parkinsonism Relat Disord. 2019 Feb;59:111-116. doi: 10.1016/j.parkreldis.2019.03.015. Epub 2019 Mar 23. PMID: 30952437.
*Thenganatt et.al 2012*

Editorial > J Neurol Neurosurg Psychiatry. 2020 Aug;91(8):809-810.
doi: 10.1136/jnnp-2020-323189. Epub 2020 May 26.

# Tremor: so common, so difficult

María Carolina Sepúlveda Soto [1], Alfonso Fasano [2 3 4 5]

- **Common false beliefs and pitfalls with tremor**
  - **Any patient with mild tremor has ET.**
  - Electrophysiology in patients with tremor is only used for research purposes.
  - ET always responds to alcohol (ie, it is an ET-specific feature).
  - ET is always familial.
  - Functional tremor cannot coexist with other tremor disorders.
  - Functional tremor is a diagnosis of exclusion.
  - **Isolated voice and/or head tremor are usually caused by ET.**
  - Jerky/variable tremor always indicates dystonic tremor (ie, it might be functional or myoclonus).
  - Lower limbs and/or trunk tremor always indicate ‘orthostatic tremor’.
  - **Tremor is always a benign condition.**
  - **Tremor is indicative of PD.**

# Classification of Tremor

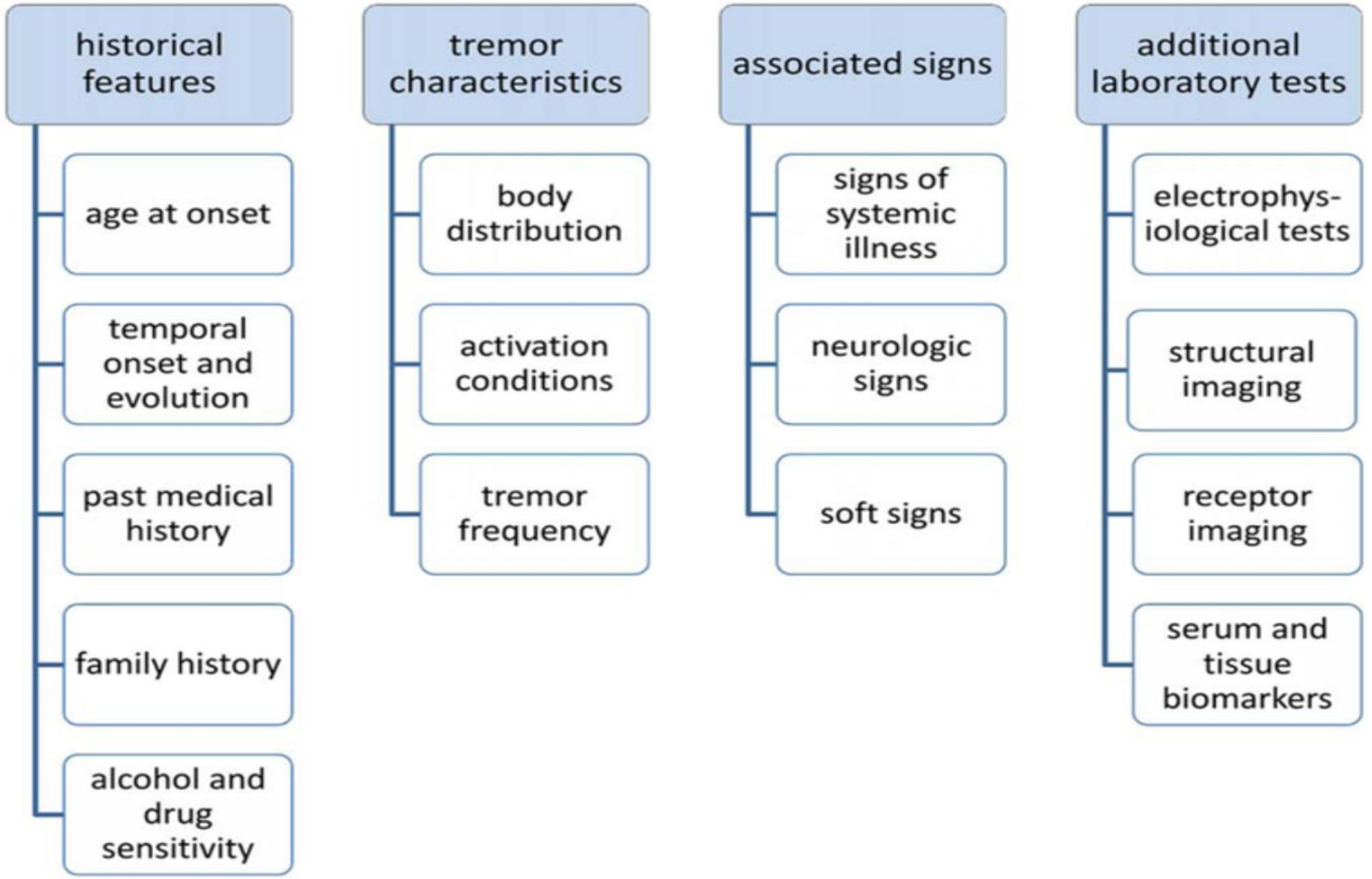
Published in final edited form as:
*Mov Disord*. 2018 January ; 33(1): 75–87. doi:10.1002/mds.27121.

**Consensus Statement on the Classification of Tremors. From the Task Force on Tremor of the International Parkinson and Movement Disorder Society**

**Kailash P. Bhatia, MD, FRCP[1], Peter Bain, MD, PhD[2], Nin Bajaj, MD, PhD, FRCP[3], Rodger J. Elble, MD, PhD[4], Mark Hallett, MD, PhD[5], Elan D. Louis, MD[6], Jan Raethjen, MD, PhD[7], Maria Stamelou, MD, PhD[8], Claudia M. Testa, MD, PhD[9], Guenther Deuschl, MD, PhD[7,*], and Tremor Task Force of the International Parkinson and Movement Disorder Society**

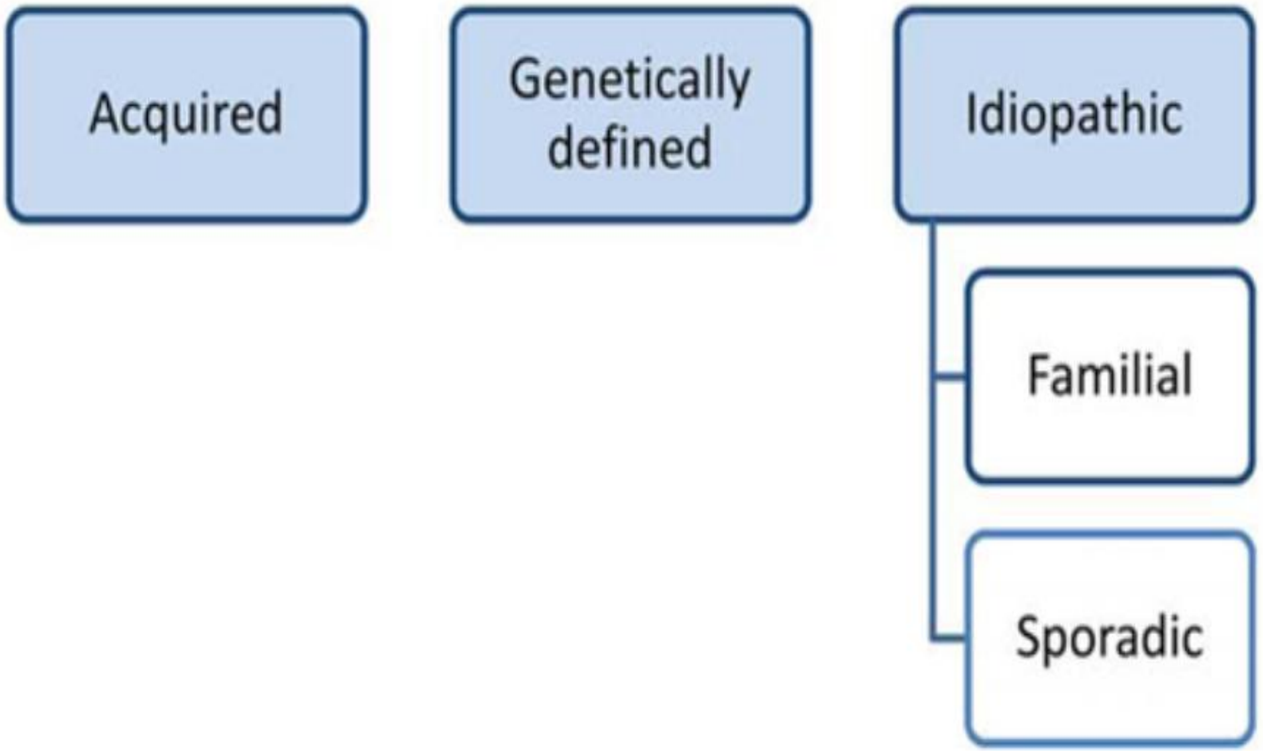
- Axis I-
  - Clinical feature
- Axis II-
  - Etiology

# Axis I- Clinical Features




*Bhatia et al. 2018*

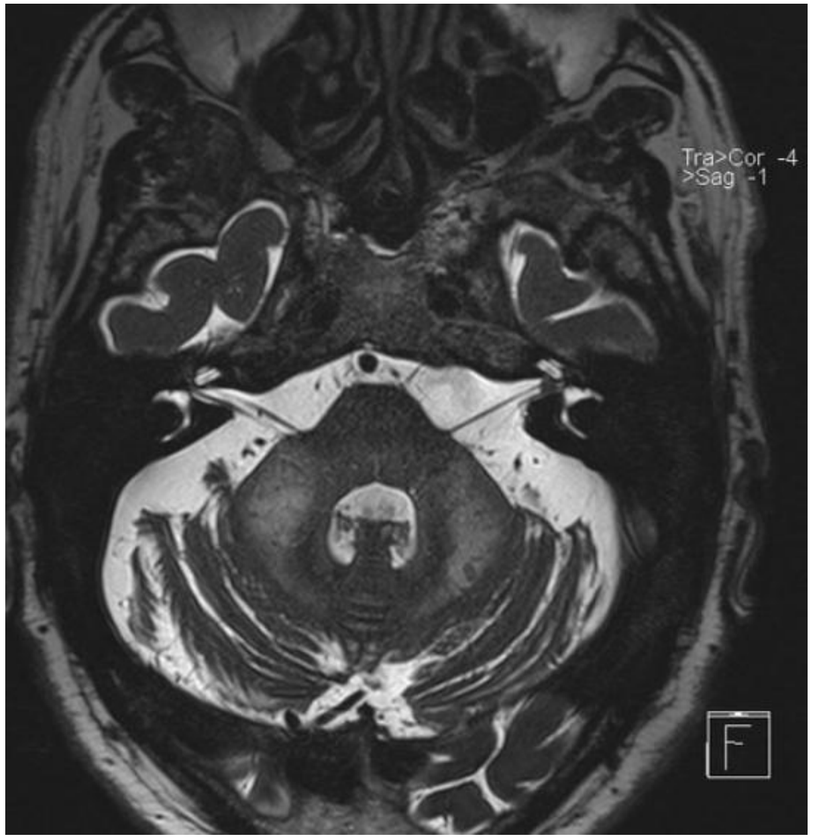
# Axis II- Etiology

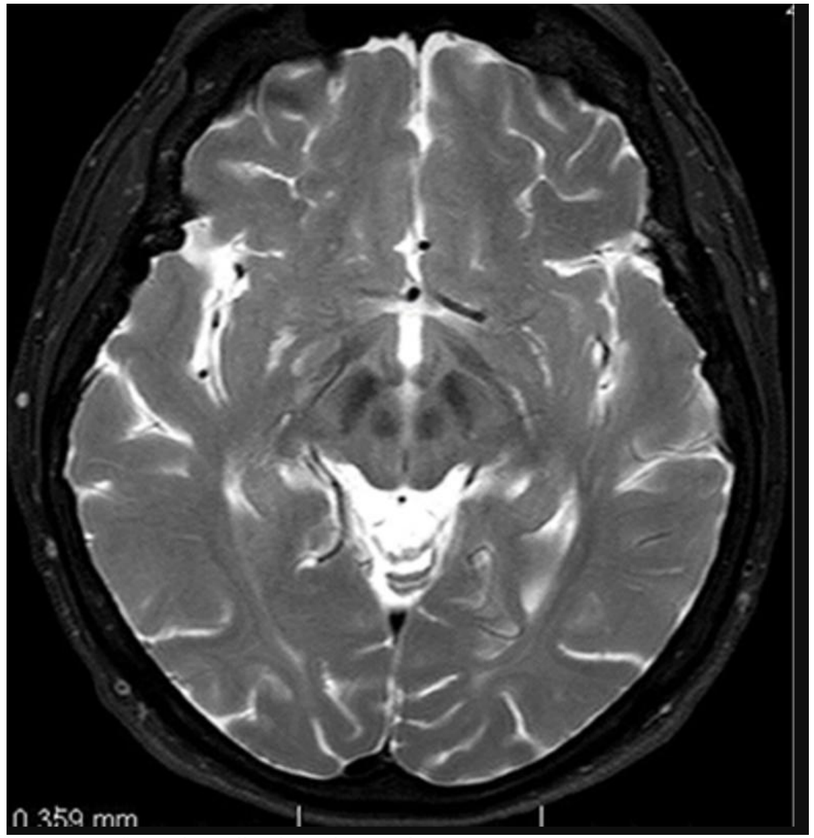


# Additional Tests: MRI – Structural Imaging

**My personal opinion: Every tremor patient needs to be considered for a Brain MRI**





Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 5465; 44196;, rID: 44196

Zigari et al. 2020

# Additional Tests

- Receptor imaging
- Dopamine transporter scan
  - DaT scan was FDA approved in 2011 to differentiate ET and neurodegenerative parkinsonian tremor
  - **An MDS expert was the gold standard for the study.**

**Figure 1**

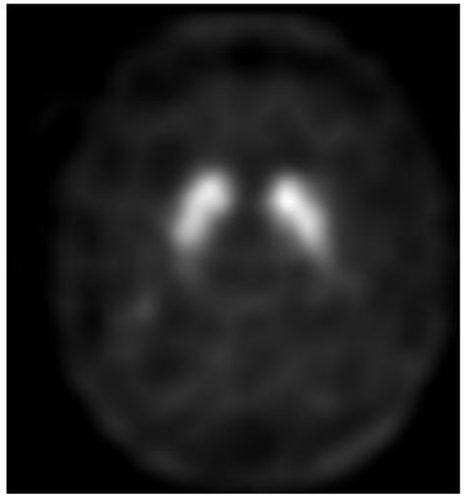
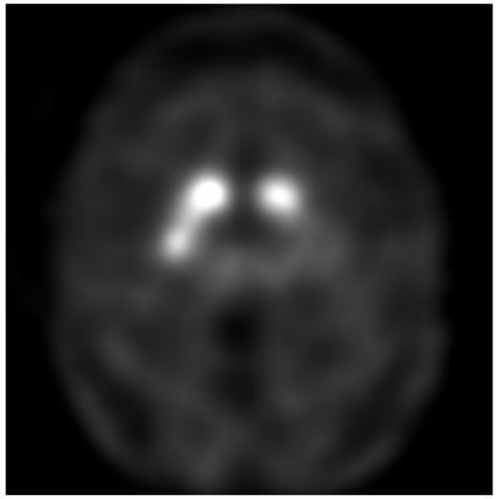


**Figure 2**



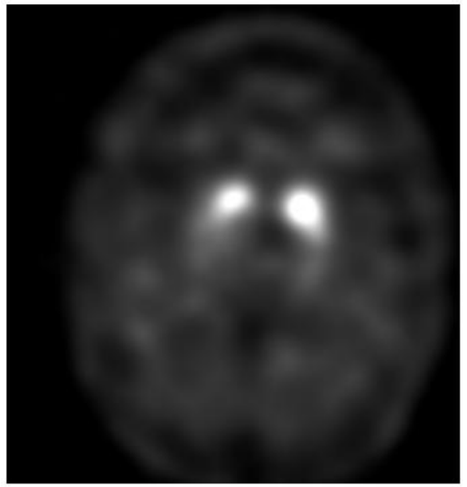


**Figure 3**

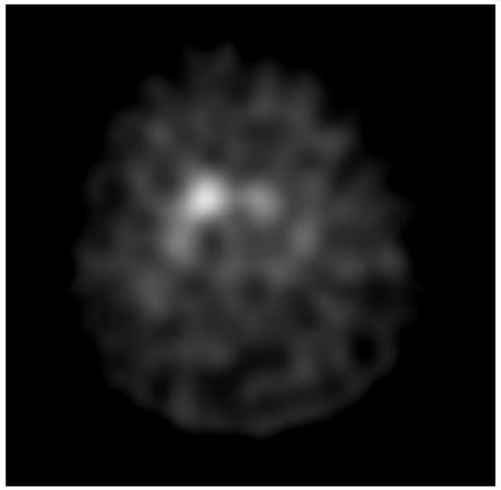


**Figure 4**

*https://www.accessdata.fda.gov/drugsatfda_docs/nda/2011/022454sOrig1s000Lbl.pdf*

# •Additional Tests: Electrophysiological study

- Indications
  - Distinction between tremor and myoclonus
  - Objective assessment of functional tremor
  - Differentiation of ET from EPT
  - Selecting muscles for botulinum toxin injection for tremor

- **Should we use Electrophysiology to diagnose every tremor case?**
  - **My personal bias is YES,**
    - it would help us advance Tremor science tremendously
    - (due to current lack of knowledge on phenomenology accuracy)

Torres-Russotto D, Elble RJ. Slow Orthostatic Tremor and the Case for Routine Electrophysiological Evaluation of All Tremors. Tremor Other Hyperkinet Mov (N Y). 2019 Nov 26;9. doi: 10.7916/tohm.v0.740. PMID: 31832264; PMCID: PMC6886495.

*Wardt et al. 2019*

# Essential Tremor

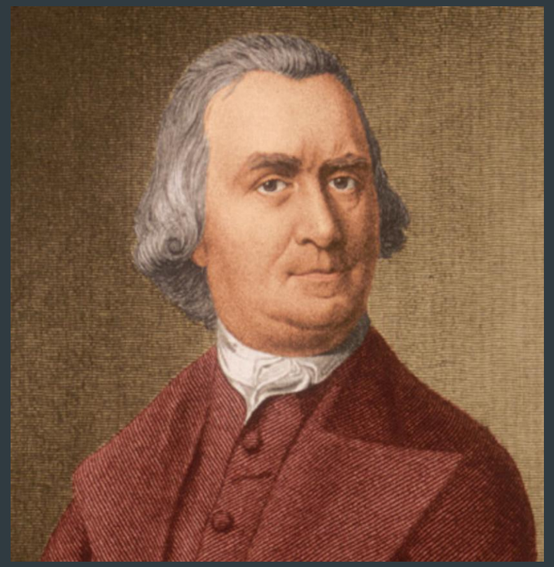
Bill Clinton



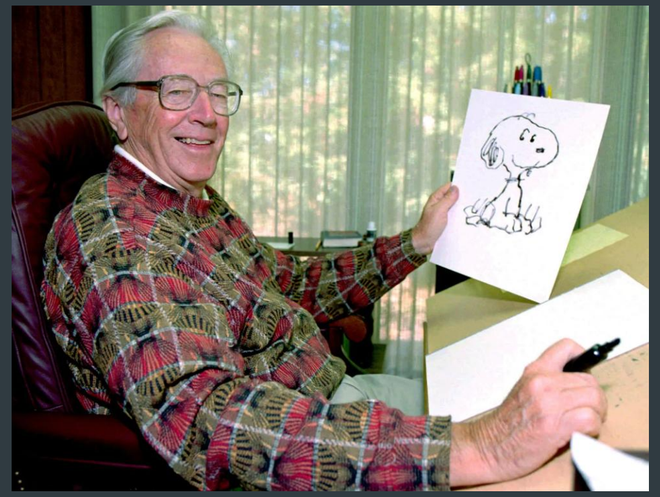
Katharine Hepburn



Samuel Adams



Charles Schulz

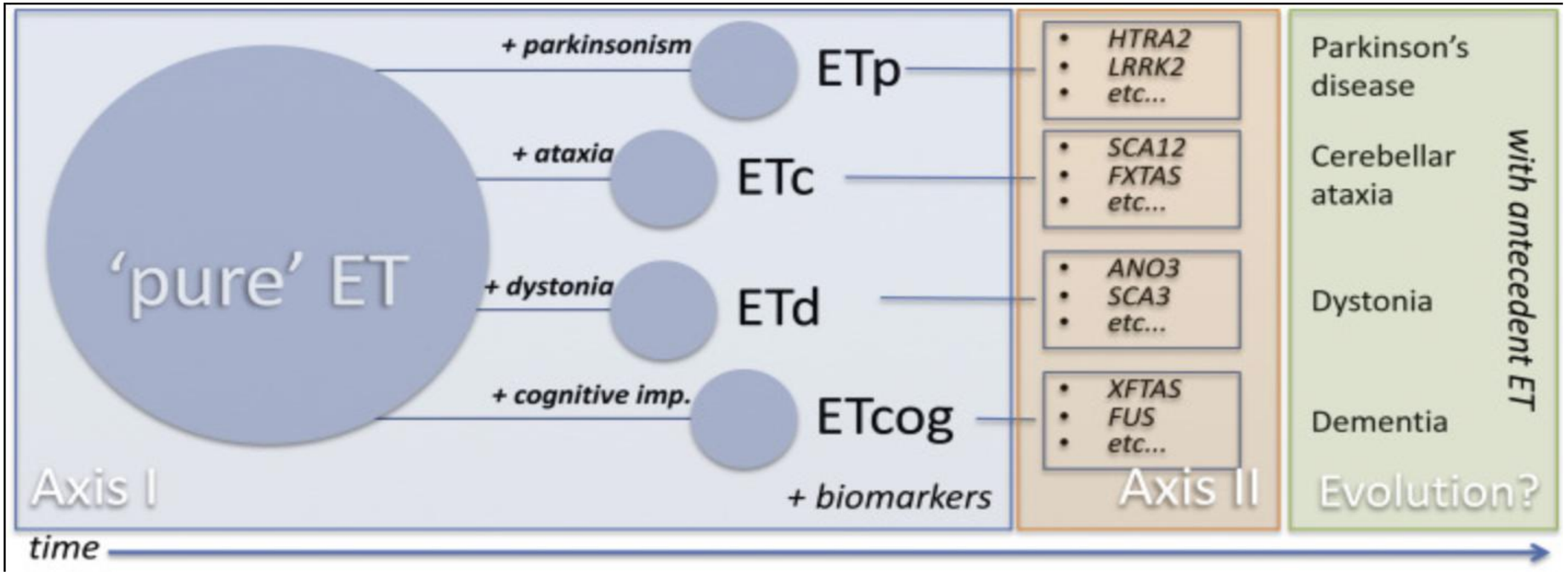


# Essential Tremor - based on Axis I

- Tremor syndrome of bilateral **upper extremities action tremor of at least 3 years duration**, with or without tremor in other body location
- Bimodal age of onset in the 2nd and 6th decade
- Action , postural > rest tremor
- Frequency usually 4-12 Hz
- Amplitude increases with age while frequency decreases
- Commonly has a positive family history and responds to alcohol
- Can get worse with stress, fatigue or caffeine

*fahn-principles-practice-movement-disorders-2nd Bhatia et.al 2018*

ET plus- MDS task force recognized that ET is often present with “soft neurological signs.” ET with “soft sign” grouped under ET plus




*Soto et al. 2019*
*Bhatia et al. 2018*

# Challenges with the 2018 Taskforce Classification

- The definition of tremor should acknowledge that tremor is a symptom
- ET should be redefined
- Severity is an important characteristic for classifying and diagnosing tremor
- **The terms 'essential tremor plus' and 'orthostatic tremor plus' should be abandoned**
- Classification of tremor requires rules for creating a hierarchy of terminology.

Louis ED, Bain PG. Problems and controversies in tremor classification. J Neurol Sci. 2022 Apr 15;435:120204. doi: 10.1016/j.jns.2022.120204. Epub 2022 Feb 19. PMID: 35279635.

# Essential Tremor

A man with essential tremor exhibits a severe kinetic tremor while pouring water between two cups. The tremor is slightly asymmetric and is worse on the right.

Continuum®

AMERICAN ACADEMY OF NEUROLOGY.

HOW TO DO IT

OPEN ACCESS

# How to use pen and paper tasks to aid tremor diagnosis in the clinic

Jane Alty,[1] Jeremy Cosgrove,[1] Deborah Thorpe,[2,3] Peter Kempster[4,5]

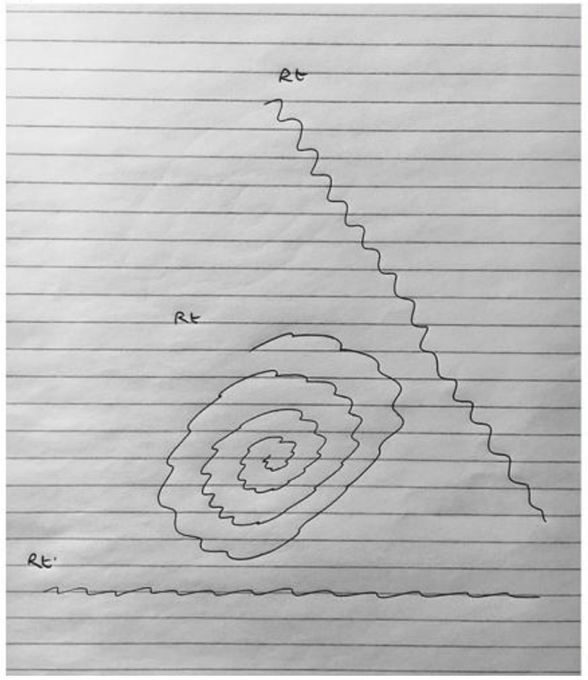
- To write “Mary had a little lamb” with the dominant hand
  - Dystonic posturing of the wrist and fingers may become more obvious
  - Decrementing micrographia becomes apparent in Parkinson’s disease
- To copy Archimedes spiral, first with the dominant hand and then the nondominant
- To draw horizontal and vertical lines with each hand at least 10 cm long
- If nothing is visible, it may help to ask the patient to lift their hand off the paper while performing each task

*Alty J, et al. Pract Neurol 2017;17:456–463. doi:10.1136*

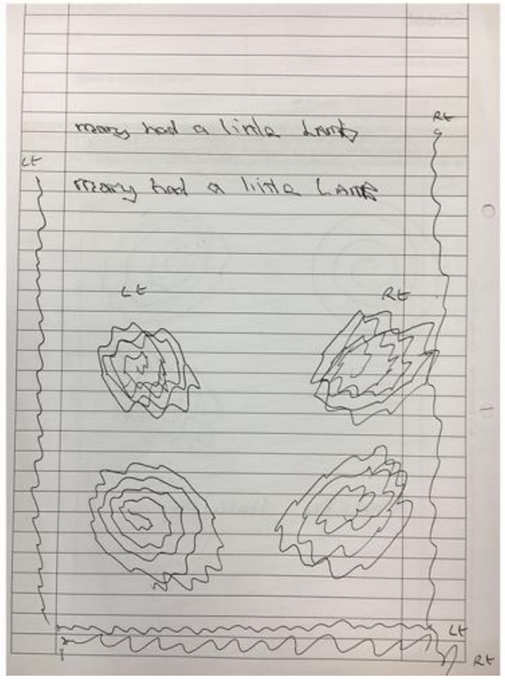
| | Essential tremor | Dystonic tremor | Parkinson's disease | Functional tremor |
|---|---|---|---|---|
| Handwriting | | | | |
| Size | Normal or large | Normal | Usually small | Variable |
| Tremor features | Regular amplitude and frequency | Irregular jerky amplitude and frequency | Regular amplitude and frequency | Variable; often no tremor in writing |
| Tremor intrusion in letter sections | Vertical letter strokes; unidirectional axis | All sections of letters; multidirectional axis | Vertical letter strokes; unidirectional axis | Variable |
| Progressive deterioration | No | Yes—shape of letters worsens due to posturing | Sometimes—size of letters may decrement | Not usually |
| Pen pressure | Normal | Hard pressure | Normal | Normal |
| Spirals | | | | |
| Size | Normal | Normal | Small | Variable |
| Spacing of turns | Normal (maybe wider) | Normal (maybe tighter) | Tighter | Variable |
| Tremor axis | Unidirectional | Multidirectional | Unidirectional | Variable |
| Tremor frequency | Regular | Irregular/jerky | Regular | Variable |
| Progressive deterioration | No | Sometimes—more tremor and pressure | No | Variable tremor frequency, axis and amplitude |
| Straight lines | | | | |
| Tremor axis | Unidirectional Right: 8–2 o'clock Left: 10–4 o'clock | Multidirectional | Unidirectional Right: 8–2 o'clock Left: 10–4 o'clock | Variable |
| Tremor frequency | Regular | Irregular | Usually regular | Variable |
| Tremor amplitude | Small, regular | Small, irregular | Small, regular | Large, irregular |
| Symmetry | Symmetrical | Asymmetrical | Asymmetrical | Variable |
| Other features | | Writing may be worse than drawing tasks | Longer duration to compete task (bradykinesia) | Straight lines usually most impaired task |

*Alty J, et al. Pract Neurol 2017;17:456–463. doi:10.1136*

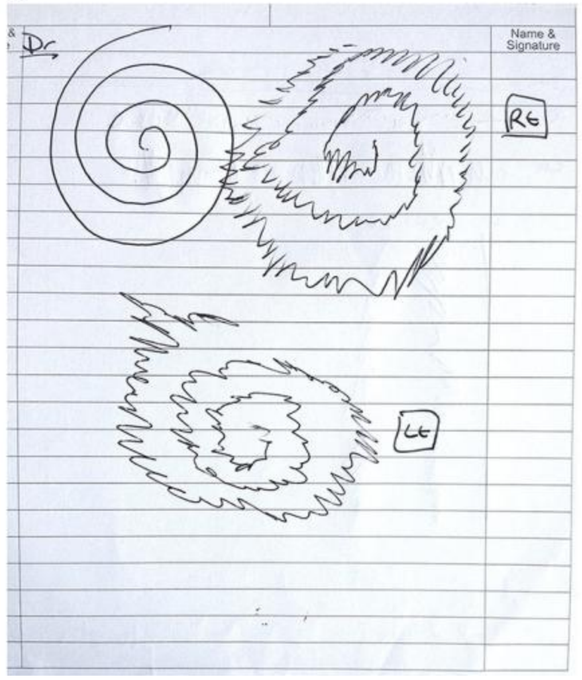
A




B

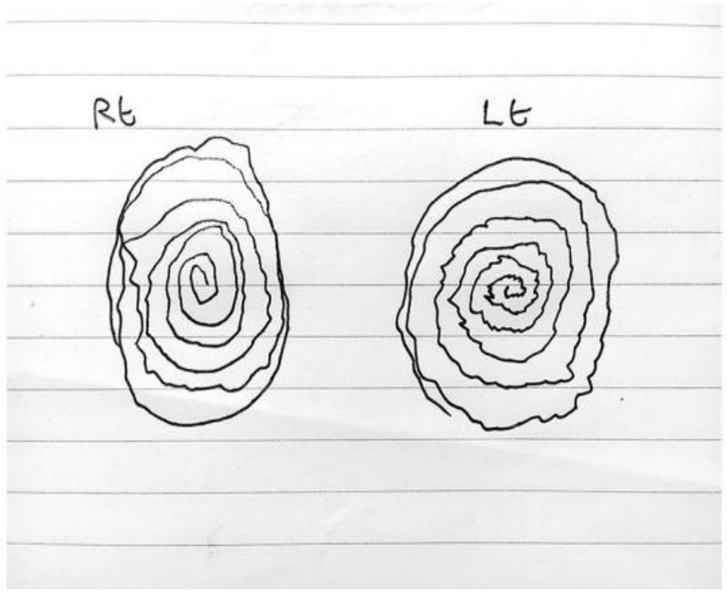



C

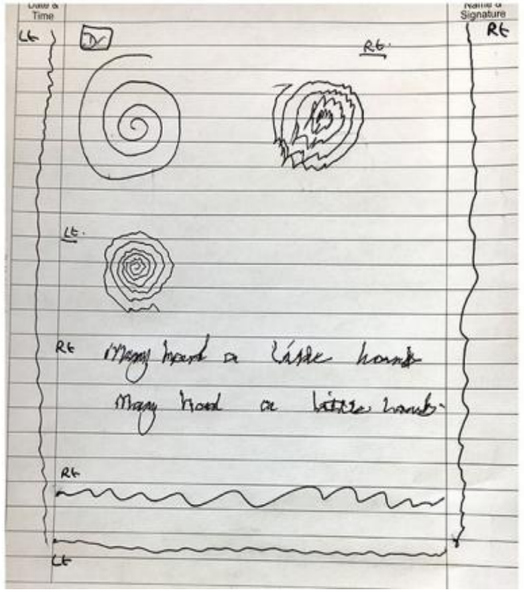



Examples of essential tremor shown as unidirectional tremor with regular frequency

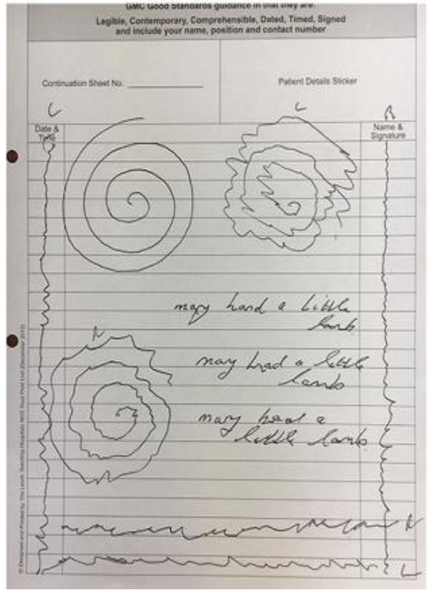
A




B




C

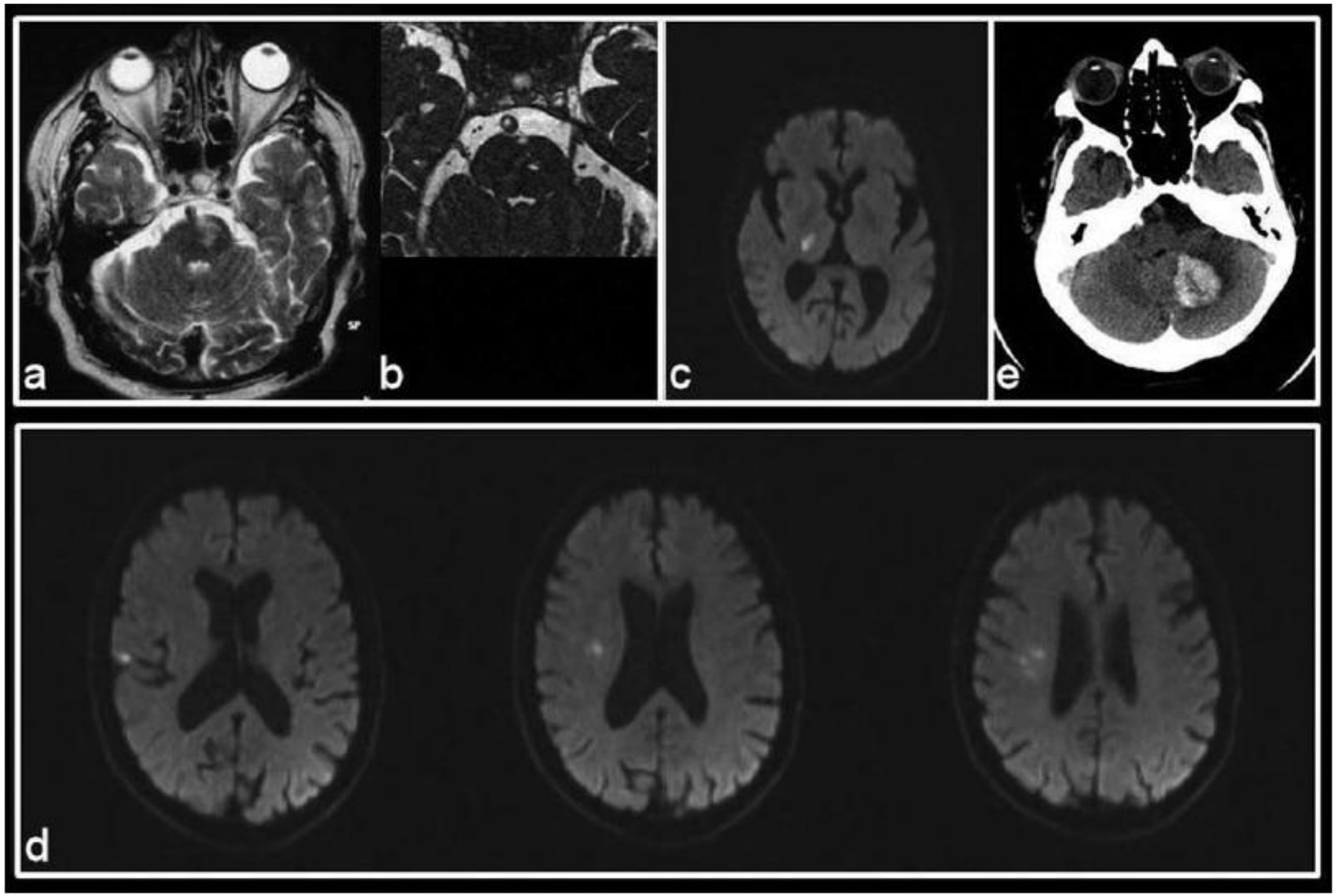



Dystonic tremor has multidirectional axis, variable tremor frequency and amplitude, forceful pen pressure

# PATHOPHYSIOLOGICAL MECHANISMS IN ET

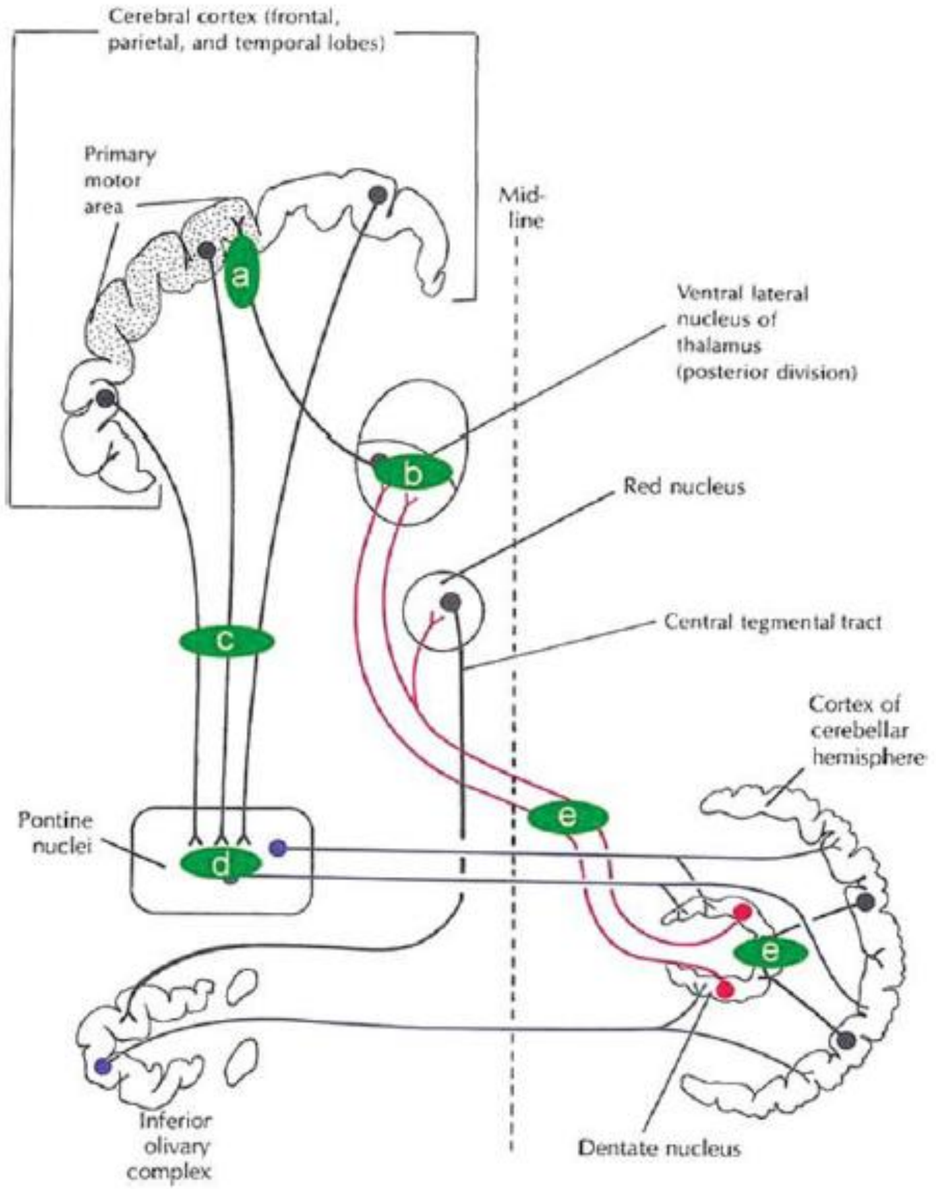
- Oscillatory Network Dysfunction
- Neurodegenerative signs
- GABA dysfunction
- Cerebellar dysfunction

# Localization in ET is multiverse




Dupuis et al. Disappearance of essential tremor after stroke. Mov Disord 2010

# Cerebellar dysfunction in ET




*Dupuis et al. 2010*

# Imbalance and Speech impairment in ET

- Speech ataxia is frequent in every stage in ET
- Signs of imbalance and truncal ataxia are common in ET
- Therefore, conclusion is that **ET is associated with an impairment of the cerebellum and its pathways**

Kronenbuerger M, Konczak J, Ziegler W, Buderath P, Frank B, Coenen VA, Kiening K, Reinacher P, Noth J, Timmann D. Balance and motor speech impairment in essential tremor. Cerebellum. 2009 Sep;8(3):389-98. doi: 10.1007/s12311-009-0111-y. Epub 2009 May 19. PMID: 19452239.

# Neurodegenerative Hypothesis in ET

Progressive illness

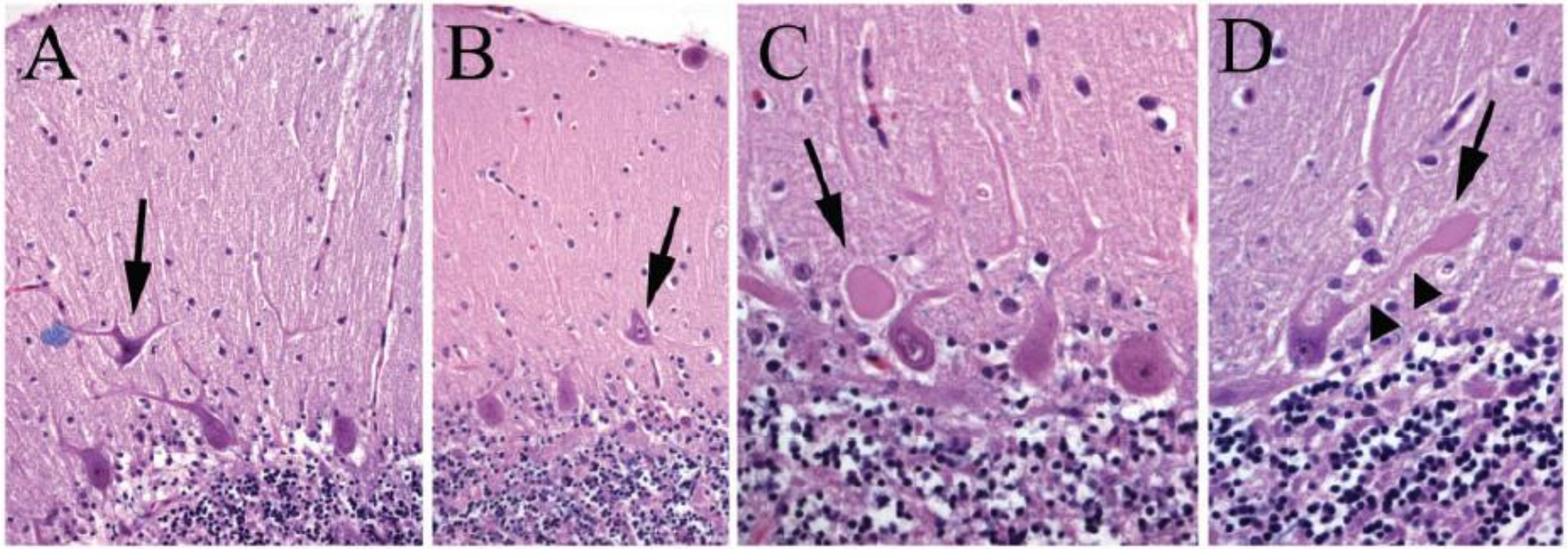
Age dependent

Other associated abnormalities also worsen over time

Association with other degenerative diseases of the brain like PD and Alzheimer’s dementia

# Neurodegenerative Hypothesis in ET

A and B: Purkinje cell heterotopic dislocation into molecular layer

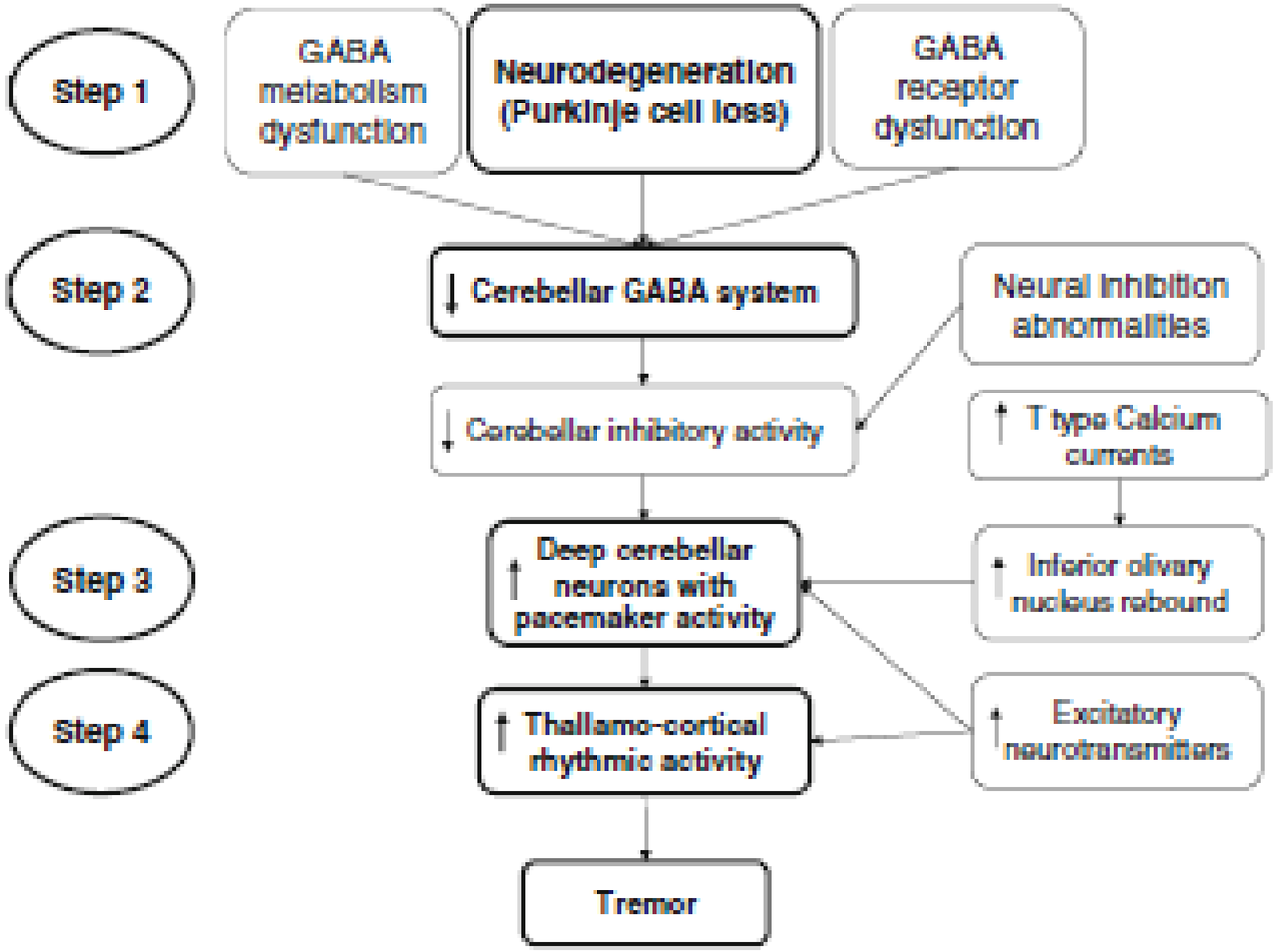



C and D: Purkinje cells dendrite swelling

**Fig. 3** Purkinje cell heterotopias and dendrite swellings in cerebellum from an ET case. LH&E-stained cerebellar cortical sections. In **A** and **B**, the cell body of an occasional Purkinje cell is displaced upward into the molecular layer (arrows) (200× magnification). In **C** and **D**, there are glassy, eosinophilic swellings in the molecular layer adjacent to Purkinje cell bodies (arrows). Connection to a Purkinje cell dendrite (arrowheads in **D**) clearly identifies this as a dendrite swelling (400× magnification).

*Louis et al. Brain 2007*

# GABA hypothesis in ET




*Martin-Lahoz et al. Cerebellum 2016*

# ESSENTIAL TREMOR MANAGEMENT

**DID YOU KNOW?**

ONLY 7-8% OF PATIENTS WITH ET RECEIVE TREATMENT

# Challenges of Drug Development Programs in Essential Tremor

- There is no single ET disease
  - heterogeneous group of ET subjects studied
- Lack of biological marker for ET
  - Allows for misdiagnosis
- Pathophysiology not well understood
  - Therefore, treatment pathways are underrecognized

**Many trials in ET have negative findings**

*Louis et al. Frontiers in Neuro 2012*

# Pharmacological treatment Evidence

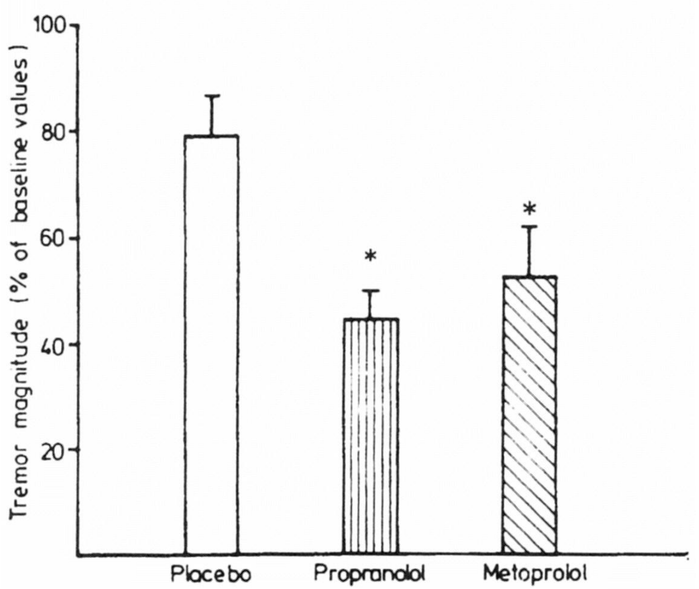
| Agent | Evidence | Target dose | Key limitations |
|---|---|---|---|
| Propranolol (only FDA-approved drug for ET) | AAN Level A; reduces limb tremor in 50–70% | 120–240 mg/day, titrated | Avoid with symptomatic bradycardia, hypotension, asthma; fatigue |
| Primidone | AAN Level A | 250–750 mg/day; start low and titrate slowly | Sedation, dizziness, acute nausea or ataxia at the start |
| Propranolol + primidone | May beat either alone | — | Use when monotherapy is inadequate |
| Topiramate | AAN Level B; MDS clinically useful at >200 mg/day | Effective doses about 215–333 mg/day | Trouble concentrating, paresthesias, nausea |
| Gabapentin, atenolol, sotalol, alprazolam | AAN Level B | — | Alprazolam: dependence and CNS effects |
| Nadolol, nimodipine, clonazepam | AAN Level C | — | Weak evidence |
| Levetiracetam, 3,4-diaminopyridine, flunarizine | Don't use (Level B/C negative) | — | Ineffective |

# Drug treatment: **Propranolol**

Table 2 *Changes in objective tremor score during treatment with placebo, propranolol, sotalol, and atenolol*

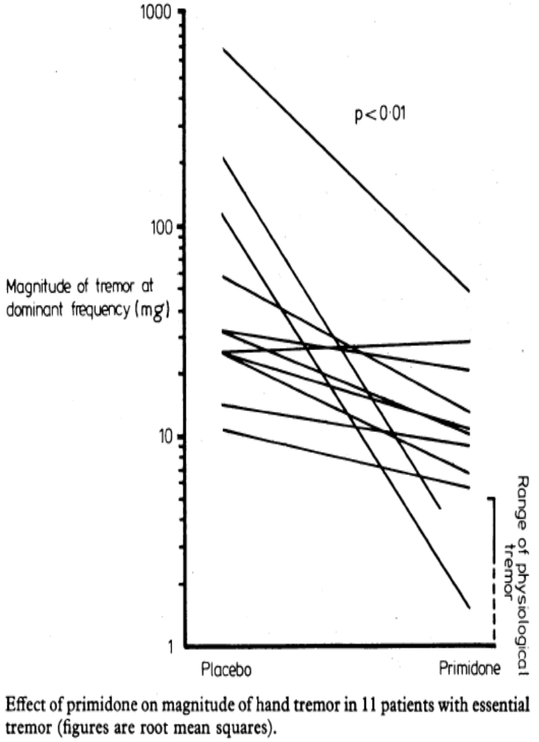
| *Patient* | *Placebo* | *Propranolol* | *Sotalol* | *Atenolol* |
|---|---|---|---|---|
| 1 | 17 | 11 | 11 | 14 |
| 2 | 17 | 10 | 12 | 12 |
| 3 | 1 | 0 | 2 | 1 |
| 4 | 9 | 7 | 6 | 4 |
| 5 | 8 | 4 | 3 | 8 |
| 6 | 13 | 8 | 6 | 12 |
| 7 | 18 | 14 | 16 | 15 |
| 8 | 5 | 3 | 1 | 1 |
| 9 | 8 | 2 | 4 | 6 |
| Mean score | 10.7 | 6.6 | 6.8 | 8.1 |
| ±1 SEM | 1.98 | 1.55 | 1.71 | 1.81 |

(Maximum tremor score=25)

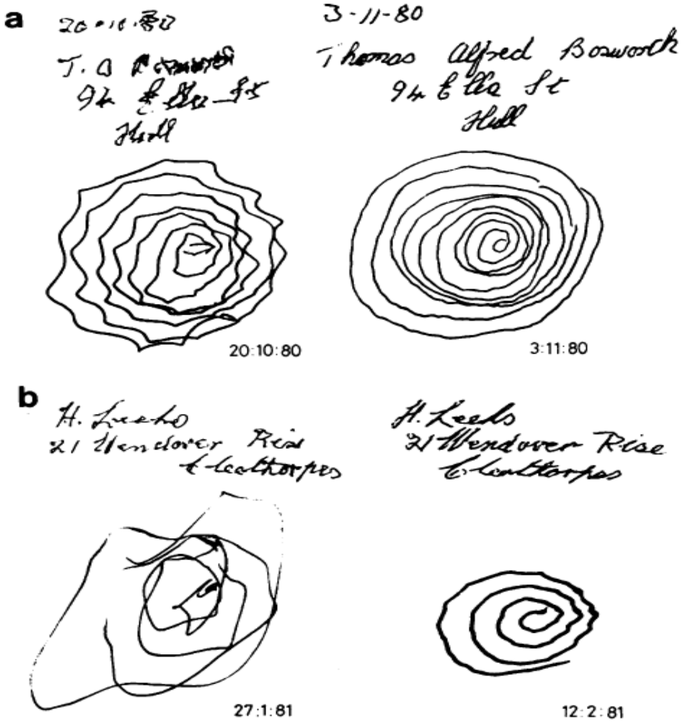



- Can also help with anxiety-sensitive tremor
- Contraindication: asthma/COPD, and possibly DM
- SE: fatigue, headache, hypotension, ED, depression.

## Drug treatment: **Primidone**




Effect of primidone on magnitude of hand tremor in 11 patients with essential tremor (figures are root mean squares).




- Fewer contraindications than propranolol but more initial side effects (fatigue, dizziness, balance impairment, somnolence, cognitive impairment).
- In 50% of the patient a 50% improvement.

*Findely et al. Br Med Jr 1982* *Chakrabarti et al. JNNP 1982*

Courtesy Dr *Kronenbuerger*

# Do you start **Propranolol or Primidone first?**

| | **Propranolol** | **Primidone** |
|---|---|---|
| **Acute** adverse reactions: | 8% | 30% |
| **Chronic** side effects: | 17% | 0% |
| Drug tolerance: | 12.5% | 13% |

*Koller et al. Neurology 1989*

Courtesy Dr *Kronenbuerger*

# Other drug options?

Gabapentine (monotherapy):

30% tremor improvement (Gironell et al. Arch Neuro 1999)

Topiramate:

29% tremor improvement (Onto et al. Neurology 2006)

Alprazolam / clonazepam

use with caution due to abuse potential (Zesiewicz et al. 2016)

Courtesy Dr *Kronenbuerger*

# Chemodenervation for tremor

- **Limb (hand/wrist) tremor:** 3 RCTs (n=168, patients refractory to oral drugs) used 50–100 U in forearm muscles.
  - **Clinical tremor ratings improved, but function did not**.
  - Benefit lasted up to about **16 weeks**.
  - **Hand weakness** occurred in **30% at 50 U and 69% at 100 U**.
  - The 2026 MDS update (4 RCTs, n=221, mean doses 50–116 U) found inconsistent benefit, high risk of bias, and hand weakness in **30–50% at higher doses**.
- **Limiting weakness:** Injections are usually placed in wrist flexors (flexor carpi radialis and ulnaris).
  - A meta-analysis found significant benefit with **EMG-guided** injection but not with anatomic landmark guidance.
  - In a 96-week open-label study, **kinematic sensor-guided** muscle selection and dosing cut tremor amplitude by about 76% in ET, with only mild weakness.


MDS evidence-based review of treatments for essential tremor.
Movement Disorders : Official Journal of the Movement Disorder Society. 2019. Ferreira JJ, Mestre TA, Lyons KE, et al.
Update on Medical Treatments for Essential Tremor: An International Parkinson and Movement Disorder Society Evidence-Based Medicine Review.
Movement Disorders : Official Journal of the Movement Disorder Society. 2026. Dash D, Bruno V, Schwingenschuh P, et al
Botulinum Toxin for Essential Tremor and Hands Tremor in the Neurological Diseases: A Meta-Analysis of Randomized Controlled Trials.
Toxins. 2022. Liao YH, Hong CT, Huang TW

# Chemodenervation for tremor (cont)

- **Head tremor:** This is the strongest indication, since beta-blockers work poorly for axial tremor.
  - In the NEJM RCT by Marques et al. (n=117), **31% vs 9%** improved by ≥2 points on the CGI at week 18 (RR 3.37). Benefit peaked at week 6 (44% vs 7%) and faded by week 24. [11]
  - Older small trials of sternocleidomastoid/splenius injection showed no benefit for horizontal head tremor without dystonia. [2]
- **Voice, chin and jaw tremor:** BoNT-A may help (laryngeal injection for voice).
- **Regulatory status:** No BoNT product is FDA-labeled for ET.
- **Practical points:** Reinject about every 3–4 months. Titrate the dose per muscle based on weakness and response. It works best with an experienced injector using EMG or kinematic guidance.

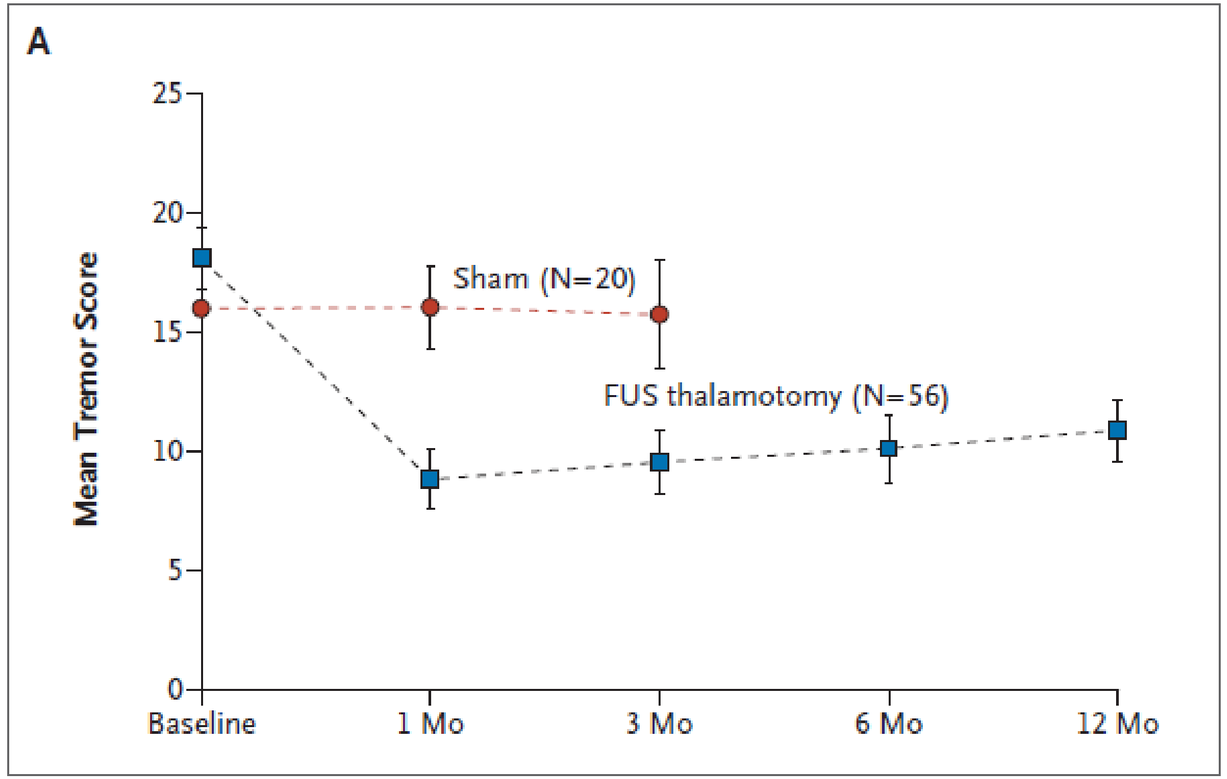
MDS evidence-based review of treatments for essential tremor.
Movement Disorders : Official Journal of the Movement Disorder Society. 2019. Ferreira JJ, Mestre TA, Lyons KE, et al.

# Botulinum neurotoxin injections

- The two therapeutic types of Botulinum toxin are type A (Botox®, Dysport®, Xeomin®, Daxxify®) and type B (Myobloc®)
- After the injections into the affected muscles, the benefit usually lasts from 2-6 months

| DRUG | FDA APPROVAL AS OF Oct 2023 |
|---|---|
| **OnabotulinumtoxinA (BOTOX)** | CM, CD, Blepharospasm >12yo, spasticity in >2yo, Severe axillary hyperhidrosis, strabismus in patients ≥12 yo, overactive bladder. |
| **IncobotulinumtoxinA (XEOMIN)** | CD, Blepharospasm, UE spasticity (peds and adults), sialorrhea (peds and adults) |
| **AbobotulinumtoxinA (DYSPORT)** | CD, Spasticity in >2yo. |
| **DaxibotulinumtoxinA (DAXXIFY)** | CD |
| **RimabotulinumtoxinB (Myobloc)** | CD, sialorrhea |

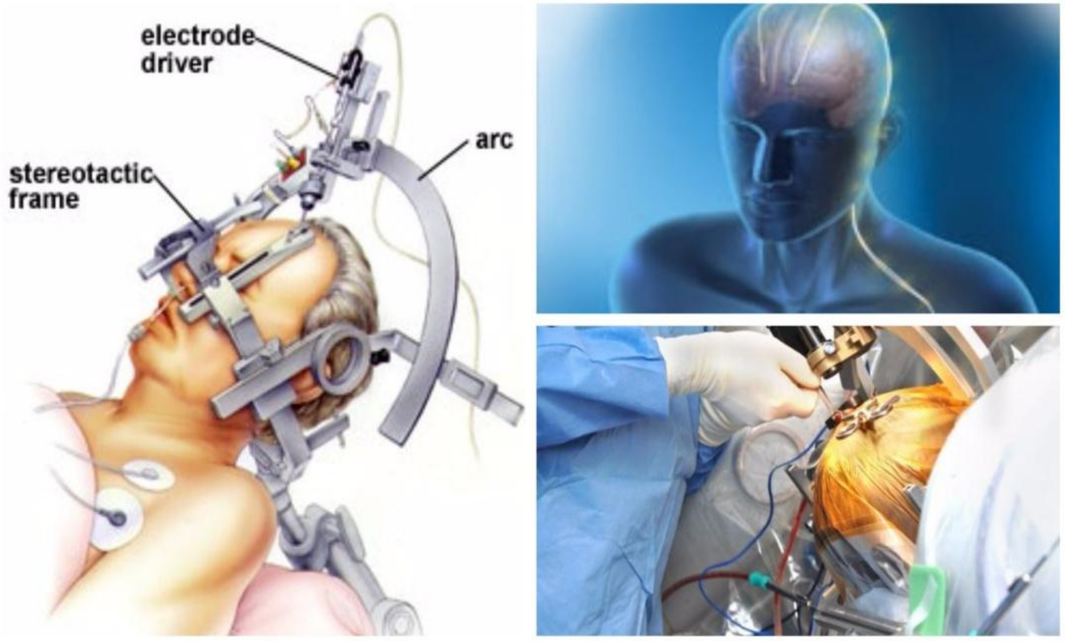
# Focused Ultrasound Thalamotomy for ET

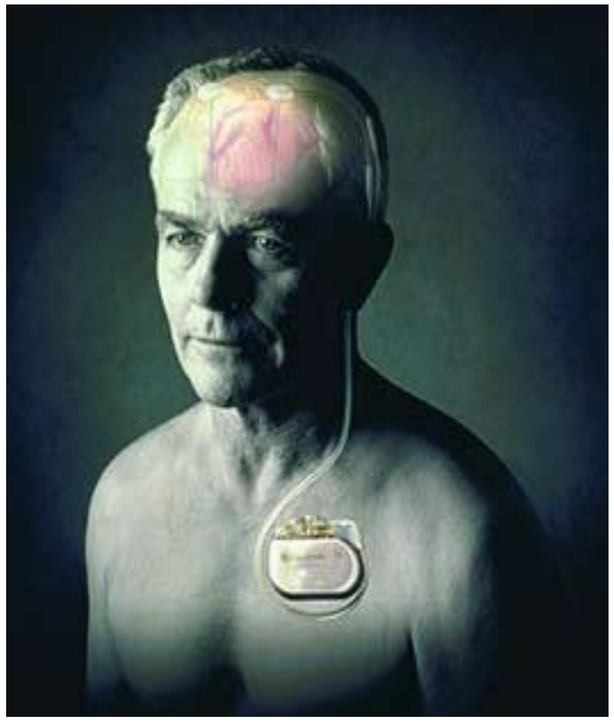



| | |
|---|---|
| **Side effects** | 14% paraesthesia |
| | 2% dysarthria |
| | 9% balance impairment |

*(Elias et al. NEJM 2016 )*

# Deep Brain Stimulation for ET



# Deep Brain Stimulation for ET

Benefit: 47-65% improvement of tremor

Side effects 19% paresthesia
9% dysarthria
6% balance impairment

Battery replacement: every 4 years
*(Flora et al. Mov Disord 2010 [review])*

Wound infection: 1.7%
Component malfunction: 0.5%
Loss of desired effect: 4%

*Fenoy et al. J Neurosurg 2014*

# Long-term efficacy of deep brain stimulation for essential tremor: An observer-blinded study

Steffen Paschen, Julia Forstenpointner, Jos Becktepe, Sebastian Heinzel, Helge Hellriegel, Karsten Witt, Ann-Kristin Helmers, Günther Deuschl. *Neurology Mar 2019, 92 (12) e1378-e1386*

- Twenty patients with ET with DBS had standardized video-documented examinations at baseline, in the stimulation-on condition at short term (13.1 ± 1.9 months since surgery, mean ± SEM), and in the stimulator switched on and off (stim-ON/OFF) at long term; all assessments were done between 32 and 120 months (71.9 ± 6.9 months) after implantation.
- The primary outcome was the Tremor Rating Scale (TRS) blindly assessed by 2 trained movement disorder neurologists. Secondary outcomes were TRS subscores A, B, and C; Archimedes spiral score; and activities of daily living score.
- **Disease continues to progress / Efficacy declines over time.**






**From Guidelines to Action: Movement Disorders Care Through Regional & Multidisciplinary Collaboration**

**Miami, Florida, USA** | November 7-8, 2026

International Parkinson and Movement Disorder Society Pan American Section

In collaboration with:

Baptist Health