

## DISCURSIVE ARTICLE

# Tremors: A concept analysis

Jessica A. Cooley Coleman<sup>1,2</sup>  | Sara M. Sarasua<sup>1</sup> | Luigi Boccuto<sup>1</sup> |  
 Hannah W. Moore<sup>2</sup> | Steven A. Skinner<sup>2</sup> | Jane M. DeLuca<sup>1,2</sup>

<sup>1</sup>School of Nursing, Clemson University, Clemson, SC, USA

<sup>2</sup>Greenwood Genetic Center, Greenwood, SC, USA

**Correspondence**

Jessica A. Cooley Coleman, School of Nursing, 105 Sikes Hall, Clemson University, Clemson, SC, USA.

Email: cooley8@clemson.edu

**Abstract**

**Aim:** This article seeks to clarify and define the concept of *tremors*.

**Design:** The Walker & Avant (2005) concept analysis method was followed.

**Methods:** A search of PubMed, Academic Search Complete, CINAHL, ERIC, Google and Google Scholar was performed.

**Results:** Through this process, uses of the concept were assessed including definitions and categories of tremors. Defining attributes were found to include “movement disorder,” “shaking motions,” “involuntary,” “oscillatory,” “rhythmic,” “not painful or life threatening,” “always present but variable” and “can sometimes be repressed.” We identified two model cases and a borderline case, antecedents, consequences and empirical referents (including measurement tools) of tremors.

**Conclusion:** The concept analysis process has clarified and illuminated an operational definition of tremors: that tremors are a movement disorder characterized by shaking motions that are involuntary, oscillatory, rhythmic, non-painful, always present although vary in severity, and can be repressed by changing posture or going into a rest position.

**KEYWORDS**

concept analysis, Fragile X-associated tremor/ataxia, *MEF2C*, tremor management, tremor measurement, tremors

## 1 | BACKGROUND

Tremors are one of the most common types of movement disorders, with essential tremor (ET) being the most common of all adult movement disorders (Hess & Pullman, 2012). Tremors have been described equally in men and women and can affect a person at any age, although they are more common in adults middle-aged and older. Tremors can be a primary disorder, as seen in ET, a symptom of an underlying disorders such as Parkinson disease, or they can be idiopathic (Kamble & Pal, 2018).

Of interest, tremors are present in many genetic disorders. A February 2020 search of OMIM for the term “tremor” identified

594 potential genetic conditions or genes associated with tremors (Online Mendelian Inheritance in Man, OMIM®, 2019). Results at the top of the list contain the most qualities of the search term. These included hereditary ET, epilepsies, Fragile X-associated tremor/ataxia syndrome (FXTAS), Parkinson disease and neurodegenerative conditions (Table 1). Tremors can be associated with metabolic conditions, examples of which include glutaric aciduria type I, Wilson disease, Niemann-Pick disease and Krabbe disease (Online Mendelian Inheritance in Man, OMIM®, 2019).

Most disorders on this list have tremors as one of many symptoms. The essential tremor disorder is different in that the only symptom is the tremor. Studies comparing monozygotic to

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2021 The Authors. *Nursing Open* published by John Wiley & Sons Ltd.

**TABLE 1** Top Entries of Genetic Conditions Associated with Tremors Returned by OMIM from a 6 February 2020 search

Result #	MIM Number	Disorder
1	#190300, %602134, %611456, #614782, #616736	TREMOR, HEREDITARY ESSENTIAL, 1, 2, 3, 4, 5; <i>ETM1</i> , <i>ETM2</i> , <i>ETM3</i> , <i>ETM4</i> , <i>ETM5</i>
2	#618524	MYOPATHY, CONGENITAL, WITH TREMOR (MYOTREM); <i>MYBPC1</i>
3	#300623	FRAGILE X TREMOR/ATAXIA SYNDROME (FXTAS); <i>FMR1</i>
4	#601068, #607876, #613608, #615127, #615400, #618074, #618075	EPILEPSY, FAMILIAL ADULT MYOCLONIC, 1, 2, 3, 4, 5, 6, 7; <i>FAME1</i> , <i>FAME2</i> , <i>FAME3</i> , <i>FAME4</i> , <i>FAME5</i> , <i>FAME6</i> , <i>FAME7</i>
5	%190310	TREMOR, NYSTAGMUS, AND DUODENAL ULCER
6	190200	TREMOR OF INTENTION, ATAXIA, AND LIPOFUSCINOSIS
7	*603967	SODIUM CHANNEL, VOLTAGE-GATED, TYPE IV, ALPHA SUBUNIT; <i>SCN4A</i>
8	#612126	GLUT1 DEFICIENCY SYNDROME 2 (GLUT1DS2); <i>SLC2A1</i>
9	#254900	EPILEPSY, PROGRESSIVE MYOCLONIC, 4, WITH OR WITHOUT RENAL FAILURE; <i>EPH4</i>
10	#607060	PARKINSON DISEASE 8, AUTOSOMAL DOMINANT (PARK8); <i>LRRK2</i>

Note: OMIM Symbols: #: Descriptive entry that does not represent a unique locus; %: Confirmed Mendelian phenotype or phenotype locus with an unknown molecular basis; \*: Gene.

No symbol: Mendelian basis suspected but not confirmed

dizygotic twins have shown that there is high genetic heritability for ET (Lorenz et al., 2004 and Tanner et al., 2001). Several genes, including *DRD3*, *FUS*, *TENM4*, *HTRA2*, *SCN4A*, *SORT1*, *SCN11A*, *NOS3*, *KCNS2*, *HAPLN4*, *USP45* and *CACNA1G*, were found to have some minor association, risk factor or segregation in families with ET, but none are definitive. Variants found in many of these genes occur only within certain ethnic groups (e.g. variants in *TENM4* were identified in Spanish families, but not in Chinese families). It is likely that ET is genetically heterogeneous with incomplete penetrance and is influenced by environmental and epigenetic factors. The lack of definitive causative genes is likely a result of these factors along with clinical misdiagnosis of ET (Deng et al., 2019).

*MEF2C*-related disorders, also referred to as *MEF2C* haploinsufficiency syndrome, were not among the search result list in OMIM. However, an extensive review of the literature reveals cases of children with a *MEF2C*-related disorder also having tremors. One patient was reported to have a periodic tremor during infancy (Nowakowska et al., 2010), and a second patient was reported to have a hand tremor at seven years of age (Paciorkowski et al., 2013). Recently, there has been a growing interest of researching *MEF2C*-related disorders. This new connection between the disorder and tremors prompted interest in the analysis of the concept of tremors.

Although the term “tremors” may seem simple, the definition of the word is often quite vague (Tremor, 2019c. In Merriam-Webster.com; Tremor, 2019a. In Cambridge Dictionary; Tremor, 2019b. In Lexico Oxford Dictionary), which may lead to a misunderstanding of the concept. Additionally, the concept is complicated by the various ways tremors are categorized and methods by which they are assessed clinically (Bhatia et al., 2018; Elias & Shah, 2014); therefore, it is important that researchers and healthcare providers understand how to distinguish between various tremor types, sometimes in

combination with other symptoms, to properly measure, diagnose and provide the most effective treatment to the patient.

To clarify the concept of tremors, the Walker and Avant (2005) concept analysis method was chosen due to its well-defined steps and prominent use in nursing science (Nuopponen, 2010). A concept analysis is a process in which the concept term is thoroughly explored to describe the essence and uses of the term and distinguish it from other closely related concepts (Walker & Avant, 2005). The research question undertaken with this process is as follows: What is the conceptual and operational definition of the term tremor as it is applied in clinical practice?

## 2 | METHOD

The Walker and Avant (2005) concept analysis method is a thorough process used to define a concept and distinguish it from other closely related concepts. This method consists of the following steps: (a) select a concept, (b) determine the aims and purpose of the analysis, (c) identify uses of the concept, (d) determine defining attributes, (e) identify a model case, (f) identify other cases (borderline, related, contrary, etc.), (g) identify antecedents and consequences and 8) define empirical referents.

With the concept and aims identified, the next step was to identify uses of the concept. For this step, a search of the literature was performed. Walker and Avant (2005) recommends “only looking for the definitions and uses of the term,” while making notes of characteristics (attributes), preceding events or incidents (antecedents), and outcomes (consequences) of the concept. The search is not for the purpose of performing a systematic literature review. The search included PubMed, Academic Search Complete, CINAHL, ERIC, Google, and Google Scholar, and used search terms “tremor”,

“tremors”, “tremor concept”, and “tremor concept analysis”. These search terms were used individually or in combination with each other. Search terms were general to entertain a broad perspective of the concept and to ensure a concept analysis did not already exist for the chosen concept. The search was limited to peer-reviewed scholarly articles published in the English language. Magazines, dissertations and continuing education units were excluded. Additionally, the search results were limited to the past 20 years, spanning 01-01-2000 to 09-23-2019, to allow for more recent and relevant findings (Figure 1).

Of note, about one-fourth of the articles from PubMed mentioned ET and about one-eighth mentioned Parkinson in the title. Individually applying “tremor concept analysis” as the only search term within titles yielded no results in any of the searched databases. The focus on results was limited to those featuring the biological and medical concept of tremors, and final analysis included articles, case studies, websites, and general and medical dictionaries. Definitions of “tremors” were obtained online from the Merriam-Webster Dictionary; the Cambridge Dictionary; the Lexico Oxford Dictionary; and the Mosby's Medical, Nursing, & Allied Health Dictionary.

Each step in the concept analysis process was an exercise in rigour via reading, rereading and making critical decisions on content while avoiding topical drift (Walker & Avant, 2005). Rigour was also achieved through reflexivity by being self-aware of the content, direction and potential biases. Additionally, this work was carefully critiqued by the co-authors who have experience in clinical genetics, qualitative research and other research methodologies. The concept analysis method consists of reviewing available literature, and therefore, research ethics committee approval was not required.

### 3 | RESULTS

#### 3.1 | Aims and purpose of analysis

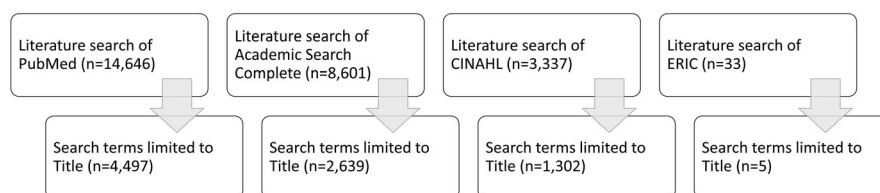
The purpose of this analysis is to clarify and develop a comprehensive operational definition of the biological and medical term and concept “tremor.” Sample cases will be presented to illustrate the concept and to facilitate developing a strong operational definition. The relationship between the antecedents, defining attributes, consequences and empirical referents of tremors can be seen in Figure 2,

as well as thoroughly described in subsequent sections. The results of this analysis will improve knowledge and communication of the concept across many disciplines, such as education, research, nursing and medicine. Additionally, this information will aid healthcare providers in diagnosing and treating patients with tremors.

#### 3.2 | Definitions of tremors from dictionaries

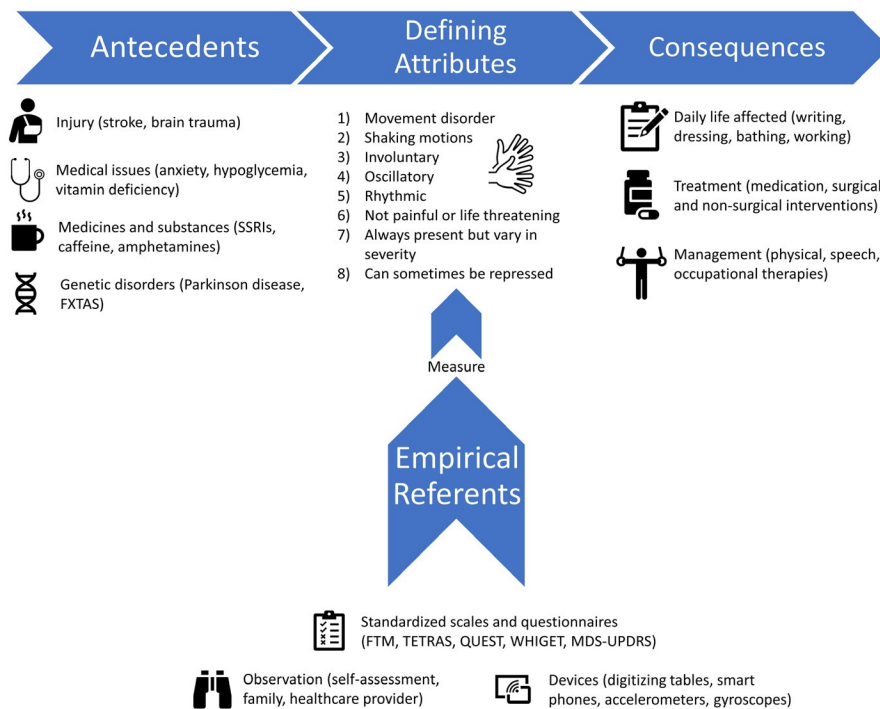
The earliest use of the word tremor meant a feeling of terror, in line with its Latin roots, originating from the verb “*tremere*” (to tremble). In the 1600s and onward, tremor was used to mean a shaking motion (Louis & Palmer, 2017). The Merriam-Webster Dictionary defines tremor as “1a) a trembling or shaking usually from physical weakness, emotional stress or disease, 1b) nervous excitement; 2) a quivering or vibratory motion, especially: a discrete small movement following or preceding a major seismic event; 3a) a feeling of uncertainty or insecurity, 3b) a cause of such a feeling” (Tremor, 2019c. In Merriam-Webster.com). The Cambridge Dictionary defines tremor as “1) a shaking movement in a person's body, usually because of fright, excitement or illness; 2) a slight earthquake (sudden, violent movement of the earth's surface)” (Tremor, 2019a. In Cambridge Dictionary). The Lexico Oxford Dictionary defines tremor as “1) an involuntary quivering movement, 1.1) a tremble or quiver in a person's voice, 1.2) a sudden feeling of fear or excitement; 2) a slight earthquake” (Tremor, 2019b. In Lexico Oxford Dictionary). As seen in definitions from various dictionaries, the word “tremor” is associated with a geological concept and as a feeling; however, these two versions of the concept will not be a focus in this analysis. Instead, we will focus on the biological and medical concept of tremors. Both the Merriam-Webster and Cambridge dictionaries include “shaking” but they differ in why a tremor takes place, except for each mentioning disease/illness. The Lexico Oxford dictionary goes a step further by clarifying these movements are “involuntary.”

Lastly, the Mosby's Medical, Nursing, & Allied Health Dictionary was consulted for a medical definition. In this dictionary, tremors are defined as “rhythmic, purposeless, quivering movements resulting from the involuntary alternating contraction and relaxation of opposing groups of skeletal muscles occurring in some elderly individuals, certain families, and patients with various neurodegenerative disorders” (Tremors, 2001. In Mosby's Medical, Nursing, & Allied Health Dictionary).



**FIGURE 1** A literature search via PubMed, Academic Search Complete, CINAHL and ERIC was performed. Search terms used were “tremor”, “tremors”, “tremor concept”, and “tremor concept analysis”. The search was limited to peer-reviewed scholarly articles published in the English language. To allow for more recent and relevant findings, search terms were limited to the past 20 years. Next, search terms were applied specifically for the Title to narrow down results

## Concept Analysis of Tremors



**FIGURE 2** Schematic of the relationship between the antecedents, defining attributes, consequences and empirical referents of tremors

**TABLE 2** Common Classification Scheme for Tremors (Elias & Shah, 2014)

Tremor Type	Description
Resting	Occur in a body part that is supported against gravity with no voluntary movements taking place
Action	Takes place with voluntary movements
Postural	Occur when a person holds a position against gravity
Kinetic	Occur during any voluntary movement
Intention	Tend to increase in severity as the person completes the movement
Task-specific	Occur during specific tasks
Isometric	Occur after voluntary muscle contraction in an otherwise stationary body part

### 3.3 | Categories of tremors in literature and practice

One common classification method is resting tremors versus action tremors (Table 2). Resting tremors occur in a body part that is supported against gravity with no voluntary movements taking place. Action tremors are those that take place with voluntary movements. There are further subcategories of action tremors including postural, kinetic, intention, task-specific and isometric. Postural tremors are those that occur when a person holds a position against gravity, such as outstretching one's arms. Kinetic tremors occur during any voluntary movement. Intention tremors increase in severity as the person completes the movement. Task-specific tremors are ones that occur during specific tasks, such as writing. Lastly, isometric tremors

appear after voluntary muscle contraction in an otherwise stationary body part, such as when one makes a fist (Elias & Shah, 2014).

Another classification method distinguishes among physiological, exaggerated physiological or pathological tremors (Table 3). Physiological tremors are present in everyone and are generally small scale and not readily detectable. These tremors are normal and occur with the transition of rest and movements of the muscles. Exaggerated, or enhanced, physiological tremors are normal tremors that worsen due to certain factors (such as age, hyperthyroidism, caffeine, stress or anxiety) to the point of being visible. Pathological tremors are ones that impair and hinder a person's everyday life and are often a part of a disorder. The most common pathological tremors are ET and Parkinsonian tremor (Elias & Shah, 2014).

On other occasions, tremors are classified solely on their aetiology, such as Parkinsonian tremor, or based on the anatomical origin of the tremors, such as cerebellar tremor. Others may be based on the situational occurrence of the tremor, such as primary writing tremor. It can often be difficult to distinguish between tremor conditions, and the matter can be complicated even more given the various ways to categorize tremors. The Task Force on "Tremor of the International Parkinson and Movement Disorder Society" had published consensus criteria for tremors in 1988. They reconvened in 2018 to resolve inconsistencies and release their updated classification system. The task force proposed classification along two axes. Axis 1 included clinical characteristics and features, such as family history, age of onset and location of the tremors in the body. Axis 2 consisted of the aetiology of the tremors, such as being either acquired, genetic or idiopathic (Bhatia et al., 2018).

**TABLE 3** Additional Classification Method for Tremors (Elias & Shah, 2014)

Tremor Type	Description
Physiological	Generally small-scale tremors present in most everyone but are not readily detectable
Exaggerated physiological	Physiological tremors that are worsened due to certain factors to the point of being visible
Pathological	Tremors that impair and hinder a person's everyday life and are often a part of a disorder

### 3.4 | Distinguishing tremors from other related disorders

Many movement disorders appear similar to tremors, but they too have their own defining attributes to differentiate them from tremors. Seizures, myoclonus, shivering, tics and akathisia all have some overlapping features to tremors; most noticeable would be the shaking movement, but there are also clues that help distinguish them. Mostly, tremors are constant but may be so slight that one does not notice it happening. However, there are a few tremor disorders that appear intermittently, such as tremors caused by some metabolic disorders, Leigh syndrome, migraines and dominant episodic ataxias (Torres-Russotto, 2019). Seizures may come in spells and then the shaking disappears. During a seizure, the person may be cognitively impaired and also cannot control the seizure by simply changing their position or posture. Myoclonus movements are characterized by a "jerk-release" movement, therefore are not oscillatory. Shivering often occurs only as a single spell and can involve trunk muscles, which is not typically a feature of tremors. Tics are episodic and fast but can be voluntarily withheld by the person at times. Akathisia consists of oscillatory movements, but they are irregular, episodic and like tics, can be voluntarily withheld (Torres-Russotto, 2019).

### 3.5 | Defining attributes of tremors

Defining attributes are the characteristics of the concept that define it and distinguish it from other concepts. Through this analysis, several defining attributes of tremors emerged. Tremors are (a) a movement disorder, characterized by (b) shaking motions that are (c) involuntary, (d) oscillatory, which is to repeat back and forth around a central point, (e) rhythmic, or having a regular pattern or motion, (f) are not painful or life threatening, and (g) the majority are always present but can vary in severity, including to the point where they do not seem noticeable by the person experiencing them; (h) lastly, tremors can sometimes be repressed by changing the body's posture, or by putting the affected body part into a rest position.

### 3.6 | Model case, borderline case and contrary case

A model case is one that displays all the defining attributes and is considered a definitive example of the concept (Walker & Avant, 2005). A borderline case exhibits some but not all the defining attributes

of the concept, and therefore is similar but not exactly the same. The contrary case does not exhibit any of the defining attributes, showing clearly what the concept is not. The following case reports were found in the literature and are used here to demonstrate and differentiate the concept.

#### 3.6.1 | Model case 1: Essential tremor

Hawkins-Walsh (2003) reported a 21-year-old male who saw his physician for a routine check-up. He stated he was well with no illnesses but has noticed his arms and hands were shaking quite often recently. He was unsure of exactly when the shaking started, but it has been a few years and has gotten worse lately to the point that his friends have expressed concern. He reported taking 10 mg Ritalin (methylphenidate) twice daily for attention-deficit/hyperactivity disorder, but no other medications, illegal drugs or tobacco. He noted that alcohol consumption contributed to decreasing the shaking and reported having three to four beers a night on the weekends. He also reported drinking one to two caffeinated sodas daily. Upon physical examination, his speech was clear, there were no gait abnormalities, no clonus present, and his posture was normal, but there was shaking present upon finger-to-nose test, handwriting test and when extending his arms against gravity. His cranial nerves and tendon reflexes were also normal. He reported no family history of Parkinson, multiple sclerosis or seizures, but it was revealed that his father also had shaking in his hands. His father said he always thought the shaking ran in the family, indicating a larger family history (Hawkins-Walsh, 2003).

Parkinson disease was ruled out since the patient did not have any other neurological issues. The clinician tested the patient's thyrotropin levels (also known as thyroid-stimulating hormone), which came back normal. Based on the physical examination and family history, the clinician diagnosed the patient with ET. ET is the most common form of tremor and movement disorder. The upper limbs are most affected, followed by the head, lower limbs, voice, face and trunk. ET can run in families, indicating an autosomal dominant genetic pattern. There have been some genes linked to ET in certain populations, such as *DRD3* and *TENM4*; however, ET is very heterogeneous and many of the genes are still unknown (Online Mendelian Inheritance in Man, OMIM®, 2019). ET often improves with consumption of alcohol, but it is important to note the risk of abuse if a person relies on alcohol to control the tremor, as greater amounts of alcohol will eventually be needed to achieve the same result. The

patient was advised to decrease his caffeine intake and was told of potential medications that could help with ET. He was informed that Ritalin could also be aggravating the tremor. He was advised on the risks of relying on alcohol to improve his symptoms (Hawkins-Walsh, 2003). The patient was going to be able to continue his college career and said he would be sure to limit factors that would aggravate his tremors.

In conclusion, the physician was able to see the involuntary shaking in the patient's hands and arms upon physical examination. The physician would have seen that the movements were rhythmic and oscillatory. The tremors were not painful or life threatening to the patient but were always present at some level to the point that his friends had noticed. The shaking could be repressed enough to manage his academic career, but the tremors still happened quite often. It is clear to see that the patient exhibited all the defining attributes of tremors.

### 3.6.2 | Model Case 2: Fragile X-associated tremor/ataxia

Another clear model case was described by Cerquera's group in their 2016 case report. A patient came to the clinic due to his disabling tremors. Upon examination, the clinicians noted a resting tremor in his right hand, as well as rigidity, bradykinesia, or slowness of movement, and hypomimia, or reduced facial expressions. A dopamine transporter single-photon emission computerized tomography (SPECT) analysis was abnormal, showing less uptake of the injected tracer in the dopamine receptors in the brain, indicative of Parkinson disease. The patient was diagnosed with Parkinson disease. However, it was also revealed that his daughter was a premutation carrier for Fragile X syndrome, and his grandson had a full mutation and was affected with Fragile X syndrome. A person in the normal range would have up to 54 CGG repeats in the 5' untranslated region of the *FMR1* gene. A premutation would contain 55–200 repeats, and a full mutation is over 200 repeats (Willemsen et al., 2011). Upon testing, it was shown that the patient had a premutation of 90 CGG repeats, which lead to the diagnosis of Fragile X-associated tremor/ataxia (FXTAS). The authors mentioned that it is possible this patient presented with parkinsonism only because of the FXTAS; however, the authors noted two other cases in the literature of patients with both Parkinson disease and FXTAS (Cerquera et al., 2016).

Upon being diagnosed with Parkinson disease, the patient was prescribed levodopa, which improved the patient's rigidity but did not have a large impact on the tremors. Over the following four years, the patient developed bilateral postural and action tremor of his hands. Additionally, his gait was affected, and he became confined to a wheelchair. The clinicians prescribed several other drugs, which he also responded to poorly (Cerquera et al., 2016). The patient opted for another form of treatment, which will be discussed in a subsequent section.

The patient has a movement disorder characterized involuntary, rhythmic and oscillatory shaking motions. Although the tremors have affected his daily life, they were not reported to be painful or life threatening. It was not stated if the patient's tremors could be suppressed, but the tremors had increased in severity over the years. The patient's condition meets all the defining attributes of tremors.

### 3.6.3 | Borderline case: Seizures

A case report was published by Hayashi et al., (2018) in which they describe a 34-year-old male with reduced vision and night blindness. The patient was being seen for a complete ophthalmic examination, including several ophthalmologic examinations and full-field electroretinograms recordings (ERGs). During the ERG process, pupils are dilated and then electrical signals from the retina are recorded during dark and light exposure. Both dark-adapted and light-adapted ERGs were performed, followed by 30 Hz light flicker light-adapted ERG (Hayashi et al., 2018).

Before transitioning to long-duration flashing ERG recordings, the patient alerted the clinician that he was developing paralysis in his upper limbs. Directly after, he started having lower limb convulsions and then lost consciousness. The patient was given an injection of diazepam, and the convulsions ceased. Later, he had magnetic resonance imaging (MRI), computed tomography of the head and electroencephalogram examination, all of which were normal. After the ordeal, the patient mentioned that he had lost consciousness with seizures in the past. These seizures were caused by the flashing light of the ERG examination. Flickering of artificial and even natural light has been known to induce seizures, and therefore, the patient was diagnosed with photosensitive epileptic seizures. The authors stress that providers should obtain a detailed seizure history about a patient before conducting ERG recordings to avoid an ordeal like this patient experienced (Hayashi et al., 2018).

The convulsions were an involuntary shaking movement disorder; however, they were not rhythmic or oscillatory and instead were very jerky movements. The flashing lights of the ERG examination led to abnormal neuronal discharges in the patient's brain, resulting in seizures and loss of consciousness. Light as a trigger and loss of consciousness are not traits that are associated with tremors. The patient's seizures only come about with certain stimuli (light), whereas tremors are usually a constant presence. The patient's condition meets the defining attributes of movement disorder, shaking motions and involuntariness. However, oscillatory, rhythmic, not life threatening, constant presence and ability to repress were defining attributes that were not met.

### 3.6.4 | Contrary case

Cinotti et al., (2018) published a case report about a 58-year-old patient with a previous diagnosis and 20-year history of systemic lupus erythematosus. The patient came to the emergency department



with multiple cutaneous hematomas that arose without any traumatic event occurring. Clinicians tested her platelet count, and the results were normal. Additionally, her lupus anticoagulant and antiphospholipid antibodies were negative. No haemorrhage was seen on abdominal ultrasound or skull computed tomography. Her partial thromboplastin time was elongated at greater than 54 s (normally between 20–34 s). All intrinsic factors of coagulation (FXII, FXI, FX, FVII, FVIII) were tested. The patient's FVIII activity level was less than 1%, and a level below 50% can be indicative of haemophilia A. A Bethesda assay was performed and yielded a result of 15.2 Bethesda units (BU), whereas the normal value should be less than 0.5 BU (Cinotti et al., 2018).

The patient was diagnosed with acquired haemophilia A (AHA). Her immune system created antibodies against her own FVIII proteins, thus depleting her FVIII levels and causing the severe presentation that prompted her to go to the emergency room. The clinicians prescribed prednisolone at a dose of  $1 \text{ mg kg}^{-1} \text{ d}^{-1}$  with decreasing dosage over a three-month period, and her FVIII levels returned to normal and symptoms vastly improved. The authors advise that providers consider AHA if patients with systemic lupus erythematosus also present with hematomas and prolonged partial thromboplastin time (Cinotti et al., 2018).

The patient's condition has its own set of attributes, but none match the attributes of tremors. She was not exhibiting a movement disorder and was not shaking involuntarily in a rhythmic and oscillatory fashion. It is not mentioned if the patient was having pain, but likely she was sore at the sites of the hematomas. As tremors are not painful, this is another attribute that does not match. Tremors are also not life threatening, but the patient's condition could have been if she had a traumatic event and could not stop the bleeding. Lastly, the patient's condition would not be improved simply by changing her posture or trying to prevent it. With none of the defining attributes of tremors, this is just one of the many potential examples of a contrary case to tremors.

### 3.7 | Antecedents of tremors

Antecedents are conditions or events that happen before the concept occurs (Walker & Avant, 2005). Antecedents of tremors include injury, genetic disorders, non-genetic medical issues, and medications or substances. Injury to the brain, such as stroke or trauma from a blow or accident, can cause a person to have tremors (Tremor Fact Sheet & NINDS, 2017). Tremors are common in patients with certain genetic disorders (Table 1). Some have been previously mentioned, but can include Parkinson disease, familial ET, Fragile X-associated tremor/ataxia syndrome (FXTAS), spinal muscular atrophy, spinocerebellar ataxia, as well as other perhaps less known genetic disorders such as Wilson disease, Perry syndrome, Wiedemann-Rautenstrauch syndrome and Partington syndrome (Tremors. (n.d.). In National Library of Medicine (US)). Tremors can also be caused by other non-genetic medical conditions, including anxiety, hyperthyroidism, hypoglycaemia, fever, liver or kidney failure, multiple sclerosis, and

vitamin E, vitamin B12, zinc or magnesium deficiency. Lastly, tremors can be the result of certain medications or substances. Medications such as selective serotonin reuptake inhibitors (SSRIs), beta agonists and amphetamines may have side effects of tremors (Warren, 2017). Substances such as an excess of caffeine or mercury poisoning can also cause tremors (Tremor Fact Sheet & NINDS, 2017).

### 3.8 | Consequences of tremors

Consequences are the events that happen after the concept has occurred (Walker & Avant, 2005). Although tremors are not life threatening, they could become so debilitating that the person's daily life is severely affected. Tremors may affect a person's ability to feed, bathe and dress themselves. Tremors could also affect a person's ability to write and type, which could lead to decreased job performance or termination. The tremor may be so debilitating that a caretaker is required, which would be quite an expense for the person. Tremors could also affect the person's social life as they may limit their exposure to others due to embarrassment.

Management or treatment could be a consequence of tremors. Physical, speech and occupational therapies can help with managing tremors. Reducing external substances that cause or exaggerate tremors, such as caffeine, should be considered. Medications, including beta blockers, anti-seizure drugs or tranquilizers, can be prescribed to help with tremors. However, tranquilizers are to be used with care due to their side effects of sleepiness, poor concentration and coordination, and developing dependence. There are medications available specifically for treating tremors due to Parkinson disease. Botulinum toxin injections can also help control tremors; however, the toxin can cause muscle weakness (Tremor Fact Sheet & NINDS, 2017).

Surgical interventions may be necessary or chosen to help treat tremors. Two surgical methods include deep brain stimulation (DBS) and thalamotomy. During DBS, electrodes are surgically implanted in the brain and electrical signals are sent to the thalamus, the region of the brain responsible for involuntary body movement. A thalamotomy involves surgically destroying a small portion of the thalamus. This procedure is a last resort when medications and other treatments are not working. Thalamotomies are rarely performed today due to alternate non-surgical treatments that are available. Non-surgical interventions include radiofrequency ablation and focused ultrasound. Radiofrequency ablation is often used to treat pain but can also treat tremors. It uses an electrical signal to heat nerve tissue, which blocks the tremor signal to the body. This method is not permanent and would have to be repeated. Focused ultrasound uses ultrasound waves guided by MRI to create a lesion in the thalamus (Tremor Fact Sheet & NINDS, 2017).

Recall the model case patient with FXTAS and Parkinson disease who developed worsening tremors over the years. The patient was not a candidate for deep brain stimulation (DBS) due to his age, cognitive impairment and brain atrophy. Due to these issues, it was predicted that DBS would have a poor outcome and higher

risk of complications. Therefore, he opted for MRI-guided focused ultrasound. The patient had remarkable improvement: 83% relief of tremor severity according to two rating scales (right limb score and Fahn-Tolosa-Marin tremor rating scale), 50% increase in motor tasks and 40% improvement in his disability. The patient's tremor was vastly improved, and he was again able to feed himself and use utensils after having previously lost that ability (Cerquera et al., 2016).

### 3.9 | Empirical referents

Empirical referents are events that prove the concept occurred (Walker & Avant, 2005). The empirical referents do not measure the concept itself but identify and measure the defining attributes. A person would know the difference between normal movement and a tremor just by observation (self-assessment or observation by another person, like a family member). A healthcare provider could also be seen to confirm tremors in the patient. Assessment may also include drawing tests, computerized tremor analysis using special devices, questionnaires and standardized scales (Table 4).

Digital tablets can be used to access writing and drawing tests instead of using the naked eye to score these tests (Elble & McNames, 2016). The frequency and amplitude of the tremors can be measured, which will also help classify what type of tremor is occurring. For example, action and dystonic tremors often have a low frequency (4–8 Hz), physiological and other types of action tremors may have a medium frequency (7–11 Hz), and orthostatic tremor will have a high frequency (>12 Hz) (Torres-Russotto, 2019). Transducer devices are used to measure the tremor in units of hertz (Hz). These devices are often portable and can include accelerometers, gyroscopes, digitizing tablets, and, most recently, smartphones. An accelerometer measures linear acceleration, whereas a gyroscope can sense rotation by measuring angular momentum. The use of smartphones could lead to a more rapid evaluation of the patient's tremor. TREMOR12 app was developed by Pieter L. Kubben to measure acceleration, degree of rotation, rotation speed of the tremors and gravity to standardize. Raw data can be exported from the app for analysis (Kubben et al., 2016).

Standardized scales, such as the Fahn-Tolosa-Marin Tremor Rating Scale (FTM) or The Essential Tremor Rating Assessment Scale (TETRAS), can be used to measure tremors. The FTM scale is a 5-point scale used to rate tremors on severity, body part and assesses handwriting, drawing, pouring water, speaking, feeding solids and liquids, hygiene, dressing and working (Fahn et al., 1988). TETRAS assesses ET, especially focusing on the upper limbs which play a larger role in ET. This scale examines head, face, voice and lower limb tremors, as well as handwriting, and standing performance, and rates each section from 0–4 (Elble, 2016). Differences between these two scales are that TETRAS includes a wing-beating upper limb assessment that the FTM does not include. Conversely, the FTM has a measure for rest tremor, which is omitted by the TETRAS since rest tremor is typically not a main hindrance in ET. TETRAS may be better suited for measuring ET and severe tremors, while FTM may

**TABLE 4** Empirical Referents: events that measure the tremors' defining attributes

Empirical referents	Types
Transducer Devices	Accelerometers: measures tremors by linear acceleration (Elble & McNames, 2016)
	Gyroscopes: measures tremors by angular momentum to sense rotation (Elble & McNames, 2016)
	Digitizing tablets: assesses writing and drawing to measure effects of tremor (Elble & McNames, 2016)
Assessment	Smartphones: apps can measure acceleration, degree and speed of rotation (Kubben et al., 2016)
	Self or clinical. Includes observation, writing and drawing tests.
Standardized Scales	Fahn-Tolosa-Marin Tremor Rating Scale (FTM): 5-point scale to rate tremors on severity and body part (Fahn et al., 1988)
	The Essential Tremor Rating Assessment Scale (TETRAS): scale that assesses ET (Elble, 2016)
Questionnaires	Quality of Life in Essential Tremor Questionnaire (QUEST): questions on tremor severity, impact, perceived health and quality of life (Tröster et al., 2005)
	Hand Tremor Questionnaire: questions to differentiate between ET and Parkinson Disease (Kwon et al., 2018)
PhenX Toolkit	Washington Heights-Inwood Genetic Study of Essential Tremor (WHIGET) Tremor Rating Scale: 23-item exam for the rating of tremors (Hamilton et al., 2011)
	Movement Disorder Society United Parkinson's Disease Rating Scale (MDS-UPDRS): measures the symptom severity for Parkinson Disease (Hamilton et al., 2011)

be better for tremor disorders that have a rest tremor component (Ondo et al., 2017).

There are also questionnaires available, such as the Quality of Life in Essential Tremor Questionnaire (QUEST) and the Hand Tremor Questionnaire. The QUEST Questionnaire has questions about tremor severity, tremor impact, and perceived health and quality of life (Tröster et al., 2005). The Hand Tremor Questionnaire includes five questions in which a person with Parkinson disease would answer "yes," and seven questions in which a person with ET would answer "yes"; therefore, this scale is used to differentiate between Parkinson disease and ET (Kwon et al., 2018). The PhenX toolkit, which is a catalog of recommended measurement protocols, includes the Signs of Essential Tremors Washington Heights-Inwood Genetic Study of Essential Tremor (WHIGET) Tremor Rating Scale and Parkinsons Disease Symptoms Movement Disorder



Society United Parkinson's Disease Rating Scale (MDS-UPDRS). The WHIGET tremor rating scale is a 23-item examination with items performed while seated and standing. The examination is meant to be videotaped and scored as recommended in the protocol. The MDS-UPDRS is specifically to measure severity of Parkinson disease by examining motor and non-motor exercises (Hamilton et al., 2011).

## 4 | Conclusion

Tremors have been reported as a primary disorder as well as secondary symptoms of other underlying disorders, including many genetic disorders. Due to the ongoing and upcoming research on *MEF2C*-related disorders, where tremors have been occasionally reported as a symptom, the concept of tremors was chosen for this concept analysis. In addition to clarifying the concept, an operational definition, antecedents, defining attributes, consequences and empirical referents of the concept of tremors have emerged. The operational definition developed by this concept analysis is that tremors are a movement disorder characterized by shaking motions that are involuntary, oscillatory, rhythmic, non-painful, always present although vary in severity, and can be repressed by changing posture or going into a rest position. Additionally, two model cases, a borderline case and a contrary case have been discussed to further illuminate and delineate the concept, and assessment tools were reviewed.

The rigorous Walker and Avant method was used to distinguish the concept of tremors, but this method has some limitations. Given the focus was on the Walker and Avant steps, information that did not fall into those specific categories could be missing. Another limitation was the number of sources returned by the literature search. Although titles were sorted and reviewed, and select sources were fully read to conduct the concept analysis steps, there is the possibility that other sources not fully read could have included helpful information for the concept analysis. Although English is considered the universal language of science, limiting the sources to English alone could be another limitation. Lastly, the concept analysis focused on the medical term of tremors, and therefore, this narrower focus could be a potential limitation.

This is the first concept analysis applied to tremors. Future research could include reviewing diagnostic criteria of the empirical referents (such as the FTM or TETRAS) or performing an assessment of the knowledge and understanding of tremors in current practicing providers in order to verify the definition developed by this concept analysis. This clarification of the concept will assist healthcare providers, researchers and nurses in categorizing and recognizing the various types of tremors, as well as distinguishing between other closely related concepts, such as tics and seizures. This is especially important when tremors interfere with the patients' quality of life. Lastly, this information will help these professionals provide a comprehensive assessment of the type and severity of tremor, gauge the level of patient concern and provide the best treatment and care to the patient.

## DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available and cited within the article. The authors will not share the data from this study.

## ORCID

Jessica A. Cooley Coleman  <https://orcid.org/0000-0002-7050-8796>

## REFERENCES

- Bhatia, K. P., Bain, P., Bajaj, N., Elble, R. J., Hallett, M., Louis, E. D., Raethjen, J., Stamelou, M., Testa, C. M., & Deuschl, G. (2018). Consensus Statement on the classification of tremors from the task force on tremor of the International Parkinson and Movement Disorder Society. *Movement Disorders*, 33(1), 75–87. <https://doi.org/10.1002/mds.27121>
- Cerquera, C., Rumia, J., Herrera, J. M., Moreno, V., Bargallo, N., & Valldeoriola, F. (2016). A single case report of MR-guided focused ultrasound thalamotomy for tremor in fragile X-associated tremor/ataxia. *Parkinsonism & Related Disorders*, 28, 159–160. <https://doi.org/10.1016/j.parkreldis.2016.04.002>
- Cinotti, E., Trovato, E., Fimiani, M., & Rubegni, P. (2018). Acquired a haemophilia: A case report. *Journal of the European Academy of Dermatology and Venereology*, 32(3), e106–e107. <https://doi.org/10.1111/jdv.14592>
- Deng, H., Wu, S., & Jankovic, J. (2019). Essential tremor: Genetic update. *Expert Reviews in Molecular Medicine*, 21(e8), 1–14. <https://doi.org/10.1017/erm.2019.7>
- Elble, R. J. (2016). The essential tremor rating assessment scale. *Journal of Neurology & Neuromedicine*, 1(4), 34–38. <https://doi.org/10.29245/2572.942X/2016/4.1038>
- Elble, R. J., & McNames, J. (2016). Using portable transducers to measure tremor severity. *Tremor and Other Hyperkinetic Movements*, 6, 375. <https://doi.org/10.7916/D8DR2VCC>
- Elias, W. J., & Shah, B. B. (2014). Tremor. *Journal of the American Medical Association*, 311(9), 948–954. <https://doi.org/10.1001/jama.2014.1397>
- Fahn, S., Tolosa, E., & Marin, C. (1988). Clinical rating scale for tremor. In J. Jankovic, & E. Tolosa (Eds.), *Parkinson's disease and movement disorders* (pp. 225–234). Urban & Schwarzenberg.
- Hamilton, C. M., Strader, L. C., Pratt, J. G., Maiese, D., Hendershot, T., Kwok, R. K., Hammond, J. A., Huggins, W., Jackman, D., Pan, H., Nettles, D. S., Beaty, T. H., Farrer, L. A., Kraft, P., Marazita, M. L., Ordovas, J. M., Pato, C. N., Spitz, M. R., Wagener, D., ... Haines, J. (2011). The Phenx toolkit: Get the most from your measures. *American Journal of Epidemiology*, 174(3), 253–260. <https://doi.org/10.1093/aje/kwr193>
- Hawkins-Walsh, E. (2003). Case study of a young man with tremor. *Journal of the American Academy of Nurse Practitioners*, 15(5), 220–223. <https://doi.org/10.1111/j.1745-7599.2003.tb00362.x>
- Hayashi, Y., Miura, G., Uzawa, A., Baba, T., & Yamamoto, S. (2018). Case of convulsive seizure developing during electroretinographic recordings: A case report. *BMC Neurology*, 18(1), 52. <https://doi.org/10.1186/s12883-018-1051-2>
- Hess, C. W., & Pullman, S. L. (2012). Tremor: Clinical phenomenology and assessment techniques. *Tremor and Other Hyperkinetic Movements*, 2, tre-02-65-365-1. <https://doi.org/10.7916/D8WM1C41>
- Kamble, N., & Pal, P. K. (2018). Tremor syndromes: A review. *Neurology India*, 66, S36–S47. <https://doi.org/10.4103/0028-3886.226>
- Kubben, P. L., Kuijff, M. L., Ackermans, L. P., Leentjes, A. F., & Temel, Y. (2016). TREMOR12: An open-source mobile app for tremor quantification. *Stereotactic and Functional Neurosurgery*, 94(3), 182–186. <https://doi.org/10.1159/000446610>

- Kwon, K.-Y., Ryu, H.-S., Lee, H. M., Kim, M.-J., Shin, H.-W., Park, H. K., You, S., Sung, Y.-H., Chung, S. J., & Koh, S.-B. (2018). Hand tremor questionnaire: A useful screening tool for differentiating patients with hand tremor between Parkinson's disease and essential tremor. *Journal of Clinical Neurology (Seoul, Korea)*, *14*(3), 381–386. <https://doi.org/10.3988/jcn.2018.14.3.381>
- Lorenz, D., Frederiksen, H., Moises, H., Kopper, F., Deuschl, G., & Christensen, K. (2004). High concordance for essential tremor in monozygotic twins of old age. *Neurology*, *62*(2), 208–211. <https://doi.org/10.1212/01.wnl.0000103236.26934.41>
- Louis, E. D., & Palmer, C. C. (2017). Tremble and tremor: Etymology, usage patterns, and sound symbolism in the history of English. *Neurology*, *88*(7), 706–710. <https://doi.org/10.1212/WNL.0000000000003576>
- Nowakowska, B. A., Obersztyń, E., Symanska, K., Bekieska-Figatowska, M., Xia, Z., Ricks, C. B., Bocian, E., Stockton, D. W., Szczubka, K., Nawara, M., Patel, A., Scott, D. A., Cheung, S. W., Bohan, T. P., & Stankiewicz, P. (2010). Severe Mental Retardation, Seizures, and Hypotonia Due to Deletions of *MEF2C*. *American Journal of Medical Genetics*, *153B*(5), 1042–1051.
- Nuopponen, A. (2010). Methods of concept analysis—A comparative study. *LSP Journal – Language for Special Purposes, Professional Communication, Knowledge Management and Cognition*, *1*(1), Article 1. <https://rauli.cbs.dk/index.php/lspcog/article/view/2970>
- Ondo, W., Hashem, V., LeWitt, P. A., Pahwa, R., Shih, L., Tarsy, D., Zesiewicz, T., & Elble, R. (2017). Comparison of the Fahn-Tolosa-Marin clinical rating scale and the essential tremor rating assessment scale. *Movement Disorders Clinical Practice*, *5*(1), 60–65. <https://doi.org/10.1002/mdc3.12560>
- Online Mendelian Inheritance in Man, OMIM®. *McKusick-Nathans Institute of Genetic Medicine*. : Johns Hopkins University. Retrieved November 19, 2019 from <https://omim.org/>
- Paciorkowski, A. R., Traylor, R. N., Rosenfeld, J. A., Hoover, J. M., Harris, C. J., Winter, S., Lacassie, Y., Bialer, M., Lamb, A. N., Schultz, R. A., & Berry-Kravis, E. (2013). *MEF2C* Haploinsufficiency features consistent hyperkinesia, variable epilepsy, and has a role in dorsal and ventral neuronal developmental pathways. *Neurogenetics*, *14*(2), 99–111. <https://doi.org/10.1007/s10048-013-0356-y>
- Tanner, C. M., Goldman, S. M., Lyons, K. E., Aston, D. A., Tetrud, J. W., Welsh, M. D., Langston, J. W., & Koller, W. C. (2001). Essential tremor in twins: An assessment of genetic vs environmental determinants of etiology. *Neurology*, *57*(8), 1389–1391. <https://doi.org/10.1212/wnl.57.8.1389>
- Torres-Russotto, D. (2019). Clinical approach to tremor in children. *Parkinsonism and Related Disorders*, *59*, 111–116. <https://doi.org/10.1016/j.parkreldis.2019.03.015>
- Tremor (2001). *Mosby's Medical, Nursing, & Allied Health Dictionary*. Elsevier Inc. (Mosby). Retrieved from [https://link-gale-com.libproxy.clemson.edu/apps/doc/A173873314/HRCA?u=clemsonu\\_main&sid=HRCA&xid=b87471fe](https://link-gale-com.libproxy.clemson.edu/apps/doc/A173873314/HRCA?u=clemsonu_main&sid=HRCA&xid=b87471fe)
- Tremor (2019). In *Merriam-Webster.com*. Retrieved September 29, 2019, from <https://www.merriam-webster.com/dictionary/tremor>
- Tremor (2019). In *Lexico powered by Oxford*. Retrieved September 29, 2019, from <https://www.lexico.com/en/definition/tremor>
- Tremor (2019). In *Cambridge Dictionary*. Retrieved September 29, 2019, from <https://dictionary.cambridge.org/dictionary/english/tremor>
- Tremor Fact Sheet (2017). In *National Institute of Neurological Disorders and Stroke*. Retrieved September 29, 2019, from <https://www.ninds.nih.gov/disorders/patient-caregiver-education/fact-sheets/tremor-fact-sheet>
- Tremors (n.d.). In National Library of Medicine (US). Genetics Home Reference. Retrieved October 23, 2019, from <https://ghr.nlm.nih.gov/search?query=tremors&tab=all>
- Tröster, A. I., Pahwa, R., Fields, J. A., Tanner, C. M., & Lyons, K. E. (2005). Quality of life in essential tremor questionnaire (QUEST): Development and initial validation. *Parkinsonism & Related Disorders*, *11*(6), 367–373. <https://doi.org/10.1016/j.parkreldis.2005.05.009>
- Walker, L., & Avant, K. (2005). *Strategies for theory construction in nursing*, 4th ed. Pearson/Prentice Hall.
- Warren, E. (2017). Neurological symptoms in primary care Part 4: Tremor. *Practice Nurse*, *47*(6), 28–30.
- Willemsen, R., Levenga, J., & Oostra, B. A. (2011). CGG repeat in the *FMR1* gene: Size matters. *Clinical Genetics*, *80*(3), 214–225. <https://doi.org/10.1111/j.1399-0004.2011.01723.x>

**How to cite this article:** Cooley Coleman JA, Sarasua SM, Boccuto L, Moore HW, Skinner SA, DeLuca JM. Tremors: A concept analysis. *Nurs Open*. 2021;8:2419–2428. <https://doi.org/10.1002/nop2.840>