

## Articles

# Enfeeblement in Elders with Essential Tremor: Characterizing the Phenomenon and Its Role in Caregiver Burden

Tess E.K. Cersonsky<sup>1</sup>, Daniel Trujillo Diaz<sup>1</sup>, Sarah Kellner<sup>1</sup>, Ruby Hickman<sup>1</sup>, Maria Anna Zdrodowska<sup>1</sup>,  
Joan K. Monin<sup>2</sup> & Elan D. Louis<sup>1,3,4\*</sup>

<sup>1</sup>Division of Movement Disorders, Department of Neurology, Yale School of Medicine, Yale University, New Haven, CT, USA, <sup>2</sup>Department of Social and Behavioral Sciences, Yale School of Public Health, Yale University, New Haven, CT, USA, <sup>3</sup>Center for Neuroepidemiology and Clinical Neurological Research, Yale School of Medicine, Yale University, New Haven, CT, USA, <sup>4</sup>Department of Chronic Disease Epidemiology, Yale School of Public Health, Yale University, New Haven, CT, USA

## Abstract

**Background:** Individuals with essential tremor (ET), a common movement disorder, experience functional impairment, which contributes to burden experienced by their loved ones and caregivers. Some burdened caregivers report their loved ones as seeming debilitated or prematurely old, a concept that we have called *enfeeblement*. Using the Essential Tremor Enfeeblement Survey (ETES), we seek to characterize enfeeblement in elders with ET and assess its contribution to caregiver burden.

**Methods:** We administered the ETES (range = 8–40, higher scores indicating more enfeeblement) and other scales to 98 caregivers of individuals with ET. Individuals with ET were also queried regarding tremors, cognitive abilities, and overall health. We then identified demographic and clinical correlates of ETES and modeled the contribution of ETES to caregiver burden (assessed using the Zarit 12-item Burden Interview [ZBI-12]).

**Results:** Mean ETES score was  $14.2 \pm 6.2$  (median = 12.0, range = 8.0–32.0); 26.5% of respondents endorsed at least one of the eight ETES items. Older age, greater tremor severity and disability, more functional and gait disability, more cognitive difficulty, and more depressive symptoms were associated with higher ETES scores. ETES was the strongest contributor to caregiver burden (ZBI-12) and substantially increased the variance explained in models of caregiver burden.

**Discussion:** Enfeeblement seems to describe a previously unexplained component of caregiver burden in elders with ET. The presence of enfeeblement may contribute to greater burden and should be factored into assessments of patient and caregiver needs.

**Keywords:** Movement disorders, essential tremor, enfeeblement, caregiver burden, embarrassment, cognition

**Citation:** Cersonsky TEK, Diaz DT, Kellner S, Hickman R, Zdrodowska MA, Monin JK, et al. Enfeeblement in elders with essential tremor: characterizing the phenomenon and its role in caregiver burden. *Tremor Other Hyperkinet Mov.* 2019; 9. doi: 10.7916/tohm.v0.687

\*To whom correspondence should be addressed. E-mail: elan.louis@yale.edu

**Editor:** Ruth Helen Walker, Mount Sinai School of Medicine, USA

**Received:** June 17, 2019; **Accepted:** September 12, 2019; **Published:** October 18, 2019

**Copyright:** © 2019 Cersonsky et al. This is an open-access article distributed under the terms of the Creative Commons Attribution–Noncommercial–No Derivatives License, which permits the user to copy, distribute, and transmit the work provided that the original authors and source are credited; that no commercial use is made of the work; and that the work is not altered or transformed.

**Funding:** None.

**Financial Disclosures:** This work was supported by the National Institutes of Health (grant no. NINDSR01NS086736), which played no role in the design of the study; the collection, analysis, and interpretation of data; or the writing of the manuscript. No authors have reported any competing financial interests.

**Conflicts of Interest:** The authors report no conflicts of interest.

**Ethics Statement:** This study was performed in accordance with the ethical standards detailed in the Declaration of Helsinki. The authors' institutional ethics committee has approved this study and all patients have provided written informed consent.

## Introduction

Essential tremor (ET), long considered a disorder characterized solely by kinetic tremor, is now known to manifest a broader array of motor and nonmotor features.<sup>1–6</sup> These may include gait and balance impairments,<sup>7–8</sup> cognitive deficits (including increased odds of mild cognitive impairment and dementia compared with normal aging adults),<sup>9–14</sup> and depression and anxiety.<sup>6,15–20</sup> These features can result in functional disability.<sup>13,21–23</sup>

Typically, ET-related impairments are not severe enough to require constant care or paid caregivers. However, they can require the assistance of relatives and friends who take on caregiving activities and act as caregivers.<sup>24</sup> Patients may rely on such individuals to assist with eating, drinking, and dressing and in performing tasks such as writing checks or completing written forms.<sup>24</sup> In patients with voice tremors, friends and relatives will act as interpreters to assist the patient in being understood.<sup>24</sup> Finally,

ET caregivers often provide both emotional and psychological support.<sup>24</sup> A recent study showed that 11% of ET caregivers provide more than 25 hours of care each week, and 13% of ET caregivers experienced high levels of caregiver burden.<sup>24,25</sup> Hence, caregiver burden is present in ET and can be substantial in some cases.

In studies of caregiver burden in ET, we have been able to identify several important sources of burden (such as cognitive problems, falls, and depressive symptoms), yet our models have thus far fallen far short of capturing all sources of caregiver burden. Therefore, additional sources of caregiver burden must exist. During discussions with caregivers of ET patients, a theme has emerged that caregivers experiencing higher amounts of burden viewed their loved ones as having the qualities of being prematurely old, slightly helpless, or debilitated. We have begun to conceptualize this overall quality as one of “enfeeblement.” To facilitate studies of enfeeblement in ET, we recently developed and validated a scale, the Essential Tremor Enfeeblement Survey (ETES), to measure enfeeblement in ET.<sup>26</sup>

As enfeeblement is a newly conceptualized dimension in ET, no study has explored how it manifests in patients or their families/caregivers and how it contributes to caregiver burden. We therefore identify several gaps in knowledge, which we will investigate by (1) characterizing the degree of enfeeblement in elderly ET patients (i.e., report the ETES scores in a cohort of ET patients), (2) assessing the clinical correlates of enfeeblement, and (3) investigating whether enfeeblement is indeed an independent predictor of caregiver burden in ET. Our *a priori* hypothesis regarding clinical correlates of enfeeblement was that enfeeblement might be associated with age, tremor severity, and functional abilities. We tentatively hypothesized that enfeeblement might be a significant independent contributor to caregiver burden in ET. We believe that by characterizing enfeeblement in elders with ET and examining its correlates, new insights can be gained regarding how ET impacts patient quality of life.

## Methods

### Sample and survey collection

Our study subjects were dyads, with each dyad comprising an elderly ET patient and his/her caregiver; there were 100 dyads (i.e., 200 individuals). ET patients were recruited from the Clinical Pathological Study of Cognitive Impairment in Essential Tremor (COGNET), a 230-participant, longitudinal study of cognitive function in elders with ET (NINDS R01NS086736). They were contacted during a 3-month time window (November 2017–January 2018) via telephone by trained study personnel (MAZ) and asked to participate in an online survey related to quality of life of ET individuals and people with whom they have close relationships. Caregivers were identified when applicable by patients as individuals who (1) help with daily tasks, (2) provide emotional support, and/or (3) know him/her well and can provide insight into his/her well-being. Participants were contacted and the survey was administered until 100 dyads had completed study measures. Surveys were distributed and completed via the Yale Qualtrics Survey Tool, unless the patient or caregiver was unable to use email (due to tremor, cognitive status, or other constraints), in which case the survey was

administered over the telephone ( $n = 23$  for patients,  $n = 12$  for caregivers). Upon enrollment, signed informed consent (patients) or verbal informed consent (caregivers) was obtained; Yale University and Columbia University Internal Review Boards approved study procedures. For those individuals without decision-making capacity, legal next of kin signed the necessary informed consent.

### Caregiver information

For caregivers, we collected demographic information such as age, gender, race, education, relationship to patient, and living arrangement. Caregivers also completed the following three scales: (1) the ETES, (2) a modified version of the Essential Tremor Perceived Embarrassment Assessment (pETEA), and (3) the Zarit 12-item Burden Interview (ZBI-12). The ETES measures enfeeblement (i.e., having the qualities of being prematurely old, helpless, or debilitated) and is composed of eight questions (see Table 1) to which caregivers reply on a scale of 1–5 (strongly disagree, disagree, neither agree nor disagree, agree, strongly agree), with higher scores indicating more enfeeblement (range 8–40).<sup>26</sup> The ETES has demonstrated good reliability (intraclass correlation coefficient = 0.73) and good convergent validity to a variety of other measures.<sup>26</sup> The modified pETEA is composed of 14 items querying caregivers to rate on a scale of 1 (strongly disagree) to 5 (strongly agree) their loved ones’ embarrassment related to their tremor (e.g., “My relative is embarrassed by the tremor because other people might think that he/she is nervous”), with higher scores indicating higher levels of perceived embarrassment (range 14–70).<sup>25,27</sup> The pETEA has been shown to be reliable and valid.<sup>25</sup> The ZBI-12, which has been shown to be reliable and valid,<sup>28</sup> is composed of 12 items (e.g., “Do you feel that your health has suffered because of your involvement with your relative?,” “Do you feel strained when you are around your relative?”) that are scored on a scale of 0 (strongly disagree) to 4 (strongly agree; range 0–48). Scores greater than 19 indicate high burden.<sup>29</sup>

### Patient information

Patient demographic information was collected at the most recent COGNET study visit (January 2016–February 2018) and included age, gender, race, education, and number of medications. The following functional, cognitive, and psychiatric surveys were also collected from patients at this time: Tremor Disability Scale (range 0–100, higher score indicates more disability),<sup>30</sup> Cumulative Illness Rating Scale (CIRS, which comprehensively assesses illness in 14 categories [e.g., cardiac, hepatic, renal, endocrine], range 0–42, higher score indicates more illness),<sup>31,32</sup> Montreal Cognitive Assessment (MoCA, range 0–30, lower score indicates more cognitive difficulty),<sup>33</sup> Geriatric Depression Scale (GDS, range 0–30, higher scores indicate more depressive symptoms),<sup>34</sup> and Generalized Anxiety Disorder 7-item scale (GAD-7, range 0–21, higher scores indicate more anxious symptoms).<sup>35</sup> A modified Essential Tremor Embarrassment Assessment (ETEA) was also administered to patients; this is the patient equivalent of the pETEA (higher scores indicate higher levels of embarrassment, range 14–70).

**Table 1. Essential Tremor Enfeeblement Survey Questions**

ETES Question	Positive Endorsement among All Participants (n = 98)	Positive Endorsement among High Scorers (ETES Score >20.4; n = 19)
1. The tremor makes your loved one suddenly seems prematurely old	16 (16.3)	10 (52.6)
2. Because of the tremor, your loved one seems totally unable to effectively use their hands	12 (12.2)	9 (47.4)
3. Because of their tremor, they seem too disabled to undergo usual living processes	8 (8.2)	7 (36.8)
4. They seem to be rendered helpless by their affliction	4 (4.1)	4 (21.1)
5. Because of their tremor, they seem broken down	8 (8.2)	8 (42.1)
6. Your loved one now seems to be fading away	6 (6.1)	6 (31.6)
7. The tremor makes your loved one seem enfeebled	7 (7.1)	7 (36.8)
8. Watching your loved ones struggle with their tremor sometimes makes you feel exhausted	13 (13.2)	10 (52.6)

ETES, Essential Tremor Enfeeblement Survey.  
Positive endorsement = answering “agree” or “strongly agree.”

Patients completed a videotaped neurological examination, which was evaluated by a senior movement disorders neurologist (EDL). A total tremor score (range 0–36) was calculated based on 12 postural and kinetic tremor items rated from 0 to 3, and ET diagnoses were confirmed using Washington Heights-Inwood Genetic Study of ET (WHIGET) diagnostic criteria,<sup>36</sup> which have been shown to be reliable<sup>37</sup> and valid.<sup>38</sup> The number of steps off a straight line during tandem-gait assessment was also recorded. Finally, semi-structured interviews with informants designated by patients were used to calculate Lawton Instrumental Activities of Daily Living (IADL, range 0–8) scores<sup>39</sup> and Clinical Dementia Rating (CDR, range 0–3) for the patient.<sup>40</sup> Lower IADL indicates less independent function, and higher CDR indicates more cognitive impairment.

### Statistical analysis

All analyses were completed using SPSS 24; p-values < 0.05 were considered significant. All continuous measures were assessed for normality using Kolmogorov–Smirnov tests. We reported descriptive data on ETES scores, and then correlated all continuous measures (e.g., age, tremor score, pETEA) to ETES score using Spearman’s correlations. We then used regression models to assess the association between ETES score and ZBI-12 score. Because the ZBI-12 score was not normally distributed, we stratified the score into high values (i.e., upper quartile [score ≥7]) vs. lower values (i.e., remaining three quartiles). We then examined two adjusted models: in the first model, we assessed the association between ZBI-12 and all of the covariates associated with ETES in our previous analyses. In the second model, we added the ETES score as a covariate to that model to establish how much additional variance in ZBI-12 was explained by the addition of the ETES score.

We conducted several sensitivity analyses to understand how different groups contributed to our final results. We assessed individuals in our sample who were relatively younger with relatively shorter tremor

duration and less severe tremor, as it is valuable to study enfeeblement and its correlates in a younger patient group with moderate disease duration and severity, thereby not limiting one’s view to old patients with long durations and severe disease. To do so, we stratified the sample into age tertiles, total tremor score tertiles, and tremor duration tertiles, and selected the 15 participants with the youngest–least severe tremor–most short-lived tremor profile. We then repeated our primary analyses in this sample. Hereafter, we refer to this subgroup as the “less severe” subset. We also repeated our main analyses using a subset of patients without diagnosed dementia (CDR <1) to ascertain the contribution those with dementia (CDR ≥1, n = 5) may have made to our final results.

## Results

### Demographic and clinical data on final sample

Of the 100 dyads assessed, two were excluded because the caregiver was also a paid healthcare worker, or the patient filled out the caregiver survey themselves. Demographic information for dyads is shown in Table 2.

### Characterize the degree of enfeeblement in ET patients

Mean ETES was  $14.2 \pm 6.2$  (median = 12.0, range = 8.0–32.0). Positive endorsement (i.e., answering “agree” or “strongly agree”) of individual enfeeblement questions is shown in Table 1. We found that 26.5% of respondents positively endorsed at least one statement, and 17.3% positively endorsed at least two statements; question 1 was the most highly individually endorsed item (16.3%) and question 4 was the least endorsed (4.1%). Among those with a total ETES score greater than 20.4 (mean score + 1 SD, n = 19), 52.6% positively endorsed statement 1 (“The tremor makes your loved one suddenly seem prematurely old”), and 52.6% positively endorsed statement 8 (“Watching your loved one struggle with their tremor sometimes makes you feel exhausted”).

**Table 2. Demographic and Clinical Data on 98 Patients and 98 Caregivers**

Measure			Value	
Patient (n = 98)	Demographics	Age (years)	80.5 ± 9.0*	
		Education (years)	16.2 ± 2.6 (16.0)	
		Gender	Male	44 (44.9)
			Female	54 (55.1)
		Race	White	97 (99.0)
			Black	0 (0.0)
			Other	1 (1.0)
		Tremor	Total tremor score (range 0–36)	20.7 ± 5.6*
			Tremor duration (years)	41.6 ± 22.8 (38.4)
	Tremor Disability Scale (range 0–100)		65.1 ± 24.8 (70.0)	
	Functional and Medical	Cumulative Illness Rating Scale (CIRS, range 0–39)	2.3 ± 2.2 (4.0)	
		Lawton Instrumental Activities of Daily Living (IADL, range 0–8)	7.3 ± 1.6 (8.0)	
		Steps off line in tandem gait	4.9 ± 3.9 (4.0)	
		Number of medications	5.3 ± 3.4 (5.0)	
	Cognitive	Montreal Cognitive Assessment (MoCA, range 0–30)	21.3 ± 8.5 (25.0)	
		Clinical Dementia Rating (CDR, range 0–3)	Normal (CDR = 0)	78 (79.6)
			Questionable dementia (CDR = 0.5)	15 (15.3)
			Dementia (CDR ≥1)	5 (5.1)
	Psychological and psychosocial	Geriatric Depression Scale (GDS, range 0–30)	5.9 ± 4.7 (5.0)	
		Clinical depression (GDS ≥10)	18 (18.6)	
Generalized Anxiety Disorder 7-item scale (GAD-7, range 0–21)		2.3 ± 3.1 (1.0)		
Essential Tremor Embarrassment Assessment (ETEA, range 14–70)		38.0 ± 12.3*		
Caregiver (n = 98)	Demographics	Age (years, n = 97)	71.0 ± 11.8 (73.0)	
		Gender	Male	35 (35.7)
	Female		63 (64.3)	
	Race	White	95 (96.9)	
		Black	0 (0.0)	
		Other	3 (3.1)	
		Education	High School or General Equivalency Diploma (GED)	16 (16.3)
	Trade School		7 (7.1)	
	Associate’s degree		14 (14.3)	
	Bachelor’s degree		34 (34.7)	
	Master’s degree		21 (21.4)	
	Doctorate or equivalent		6 (6.1)	
	Relationship to patient	Spouse	61 (62.2)	
		Child	22 (22.4)	
Sibling		2 (2.0)		

Table 1 continued

**Table 2.** (Continued) **Demographic and Clinical Data on 98 Patients and 98 Caregivers**

Measure			Value
Psychosocial	Living arrangement	Other family member	3 (3.1)
		Friend	10 (10.2)
		Living with patient	57 (58.2)
		Not living with patient	40 (40.8)
	No data	1 (1.0)	
	Essential Tremor Perceived Embarrassment Assessment (pETEA, range 14–70)	33.2 ± 10.9*	
	Essential Tremor Enfeeblement Survey (ETES, range 8–40)	14.2 ± 6.2 (12.0)	
Zarit 12-Item Burden Interview (ZBI-12, range 0–48)	5.3 ± 6.5 (2.0)		
Dyad ( <i>n</i> = 98)	Age Difference	Patient age–caregiver age	9.5 ± 13.3 (4.2)
		Caregiver same age as patient (±3 years)	35 (35.7)
		Caregiver older than patient	8 (8.2)
		Caregiver younger than patient	54 (55.1)
		No data	1 (1.0)
	Gender Difference	Male–Male	2 (2.0)
		Female–Female	22 (22.5)
		Male–Female	74 (75.5)

All continuous measures are reported as mean ± SD; all categorical measures are reported as n (%).

\*Variable follows Gaussian distribution (Kolmogorov–Smirnov Normality Test  $p \geq 0.05$ ); for all non-normally distributed variables, median is indicated in parentheses.

### Assess the clinical correlates of enfeeblement

A number of patient variables were associated with greater enfeeblement (Table 3), including older age, greater tremor severity, greater tremor-related disability, more functional difficulty, more tandem gait difficulty, more cognitive difficulty, more depressive symptoms, and, marginally, more medications. Caregivers who endorsed higher levels of perceived embarrassment (pETEA) and higher levels of caregiver burden (ZBI-12) also endorsed higher ETES scores. Greater age difference between the caregiver and patient was associated with greater ETES score (Table 3). In addition to the analyses shown in this table, we compared ETES responses between caregivers with high school or equivalent education ( $n = 16$ , mean ETES =  $13.9 \pm 5.6$ ) and all higher levels of education ( $n = 82$ , mean ETES =  $14.2 \pm 6.3$ ); these were not significantly different (Mann–Whitney  $U$ -test,  $p = 0.889$ ). We also compared ETES scores between patients with GDS consistent with clinical depression (GDS  $\geq 10$ ;  $n = 18$ , mean ETES =  $18.3 \pm 6.2$ ) versus those with no clinical depression (GDS  $< 10$ ;  $n = 81$ , mean ETES =  $13.2 \pm 5.8$ ); those with GDS  $\geq 10$  were characterized as significantly more enfeebled than their less depressed counterparts (Mann–Whitney  $U$ -test,  $p = 0.002$ ).

### Investigate whether enfeeblement is an independent predictor of caregiver burden in ET

Using two regression models, we assessed the association between ETES score and ZBI-12 scores. In the first model, we assessed the

association between ZBI-12 and its significant covariates from our previous analysis assessing clinical correlates of enfeeblement (patient age, total tremor score, IADL, steps off line in tandem gait, number of medications, CDR, GDS, pETEA, and dyadic age differences);  $r^2$  was 0.499. In the second model, we added the ETES score as a covariate; the ETES coefficient was 0.230,  $p = 0.008$ , and  $r^2$  for the entire model increased to 0.597. Indeed, in that model, the ETES was the most robust predictor of ZBI-12.

### Sensitivity analyses

The selected “less severe” subsample ( $n = 15$ , age =  $70.4 \pm 6.4$  years, tremor score =  $14.6 \pm 4.3$ , tremor duration =  $18.8 \pm 12.6$  years) had mean ETES =  $10.9 \pm 2.8$  and ZBI =  $2.5 \pm 3.4$ , which, though numerically somewhat lower, were not different to a significant degree from these values in the entire sample (both  $p \geq 0.10$ ), and which still indicated the presence of both enfeeblement and caregiver burden in this sample. Furthermore, in regression models in which ETES alone was assessed as a predictor of ZBI, the coefficient of ETES actually increased from 0.255 in the entire sample to 0.459 in the less severe subsample, indicating that enfeeblement was a robust correlate of caregiver burden in both samples.

Those without dementia (CDR  $> 1$ ,  $n = 93$ ) had mean ETES =  $13.8 \pm 6.0$  and mean ZBI =  $4.9 \pm 6.1$ ; values that were similar to those in the entire sample. All measures that had correlated to ETES in the larger

Table 3. Clinical Correlates of ETES Score

Measure			Correlation Coefficient ( $r_s$ )	Correlation p
Patient	Demographics	Age (years)	0.30	<b>0.003</b>
		Education (years)	-0.06	0.54
	Tremor	Total tremor score	0.40	<b>&lt;0.001</b>
		Tremor duration (years)	0.12	0.24
		Tremor Disability Scale	0.28	<b>0.006</b>
	Functional	Cumulative Illness Rating Scale (CIRS)	0.09	0.69
		Lawton Instrumental Activities of Daily Living (IADL)	-0.31	<b>0.004</b>
		Steps off line in tandem gait	0.23	<b>0.03</b>
		Number of medications	0.20	0.05
	Cognitive	Montreal Cognitive Assessment (MoCA)	-0.21	<b>0.04</b>
		Clinical Dementia Rating (CDR)	0.23	<b>0.02</b>
	Psychological and psychosocial	Geriatric Depression Scale (GDS)	0.45	<b>&lt;0.001</b>
		Generalized Anxiety Disorder 7-item scale (GAD-7)	-0.08	0.48
Essential Tremor Embarrassment Assessment (ETEA)		0.12	0.26	
Caregiver	Demographics	Age (years)	-0.12	0.23
		Psychosocial	Perceived Essential Tremor Embarrassment Assessment (pETEA)	0.60
		Zarit 12-item Burden Interview (ZBI-12)	0.63	<b>&lt;0.001</b>
Dyad		Age difference (patient age-caregiver age)	0.31	<b>0.002</b>

ETES, Essential Tremor Enfeeblement Survey.

Correlations are Spearman's correlation between the indicated measure and ETES.

Bolded values are significant ( $p < 0.05$ ).

patient group were also significantly correlated in the nondemented subset, except IADL and steps off the line in tandem gait (both now marginally significant,  $p < 0.10$ ); in addition, total medications were correlated to ETES in this subgroup. CDR was no longer correlated to ETES, as would be expected when reduced to only nondemented values (i.e., only 0 [normal] and 0.5 [questionable dementia]). When model analyses were repeated (see above), the first model (without ETES) yielded  $r^2 = 0.463$ , and the second model (with ETES) had  $r^2 = 0.582$  with ETES coefficient = 0.253,  $p = 0.009$ ). Hence, these data were very similar to those for the entire sample.

### Discussion

We explored enfeeblement, a newly conceptualized dimension of ET, by (1) characterizing the extent to which elderly ET patients are enfeebled, (2) assessing clinical correlates of enfeeblement, and (3) investigating whether enfeeblement is an independent predictor of caregiver burden in ET. These analyses address a gap in knowledge, as, to date, there are no published data on any of these questions. We hope our results will better inform the ET community regarding the level of care necessary to comprehensively support both elderly ET patient and caregiver needs.

Mean ETES score was  $14.2 \pm 6.2$ . Among the highest scoring participants (ETES score  $>20.4$ ,  $n = 19$ ), the most commonly endorsed

questions were “The tremor makes your loved one seem prematurely old” and “Watching your loved one struggle with their tremor sometimes makes you feel exhausted.” These statements indicate that those who perceive their loved ones as being enfeebled base this judgment largely on seeming prematurely old and personal exhaustion. Therefore, we can surmise that perceived enfeeblement in ET is not merely based on one's actual perception of their loved ones' tremor but rather a combination of patient's tremor disability and caregiver's emotional strain.

Our data indicate that a wide variety of clinical factors feed into the view of caregivers that their loved ones are prematurely old, slightly helpless, or debilitated. While we accurately predicted that some factors, such as older age, greater tremor severity, and greater tremor-related disability, would be associated with enfeeblement, the correlation between patient depressive symptoms and caregiver enfeeblement was surprising to us given the lack of obvious connection between the constructs. This may indicate that caregivers perceive their loved ones' feelings of apathy, hopelessness, or general discontent as them being prematurely old or disabled. Indeed, it is interesting that psychological features of ET relate to caregiver impressions of being disabled, indicating that both motor and nonmotor symptoms seem to contribute to enfeeblement.

Several of our hypothesized measures were not significantly correlated with enfeeblement, such as tremor duration and medical

comorbidity. Even in the “less severe” group, with a tremor duration significantly lower than the “more severe” group, enfeeblement was a robust predictor of caregiver burden and was not significantly different between the groups. Further unexpected was a lack of correlation between medical comorbidity (CIRS) and enfeeblement, as well as a marginal correlation between medication use and enfeeblement. We previously assumed that enfeeblement would strongly relate to medical burden, but it seems to be related to a host of other factors aside from medical comorbidity score.

Furthermore, as we observed that enfeeblement was correlated with CDR, we hypothesized that our sensitivity analyses using a subgroup of patients without dementia (CDR <1) may yield different results. Such a correlation between having dementia and being perceived as being prematurely debilitated may have skewed our overall sample. This was not the case; results showed that, besides a marked change in correlation between CDR and ETES, the nondemented subsample was largely indistinguishable from the larger sample. This indicates that, contrary to our hypotheses, enfeeblement is not merely a construct of decreased cognitive ability and rather explains a significant portion of caregiver burden in all individuals with ET.

Enfeeblement may indeed help fill the gap of understanding of contributions to caregiver burden in ET. In a logistic regression model, we found that inclusion of ETES increased the variance explained in ZBI-12 by 19.62% (i.e.,  $r^2 = 0.499$  vs.  $r^2 = 0.597$ ) as compared with other measures, including pTEEA, which has been implicated previously.<sup>25</sup> This indicates not only that enfeeblement is a significant contributor to caregiver burden but also that it contributes more to caregiver burden than previous measures. Furthermore, ETES is a robust predictor of ZBI-12 in a group of relatively younger subjects with less severe tremor and shorter tremor duration, which confirms that, although age is related to perceptions of enfeeblement, enfeeblement is present and contributes significantly to caregiver burden even in those with less advanced age and disease. It is evident that enfeeblement contributes to caregiver burden in patients and caregivers across the spectrum of ET manifestations.

In addition to the limitations in utilizing a highly motivated, self-selecting cohort (i.e., individuals who volunteered for the study may have more tremor- or cognition-related or psychological complaints) for these analyses, questionnaires were completed online or by telephone; thus, it is conceivable that individuals with hearing loss or voice tremor may have self-selected not to participate. It would be valuable to administer the ETES to the caregivers of those with these impairments, as dyads were excluded if the patient was unable to complete their questionnaire. This might capture a group with higher ETES scores. We also would have benefited from enrolling more caregivers who were siblings or other family members of patients, as analyses of caregiver relationship to patient were limited in statistical power due to the small sizes of these subsamples. In addition, it is possible, as many of the caregivers were of a population with higher likelihood of cognitive illness, that some caregivers may have had small cognitive deficits that would have made it more difficult to understand the surveys, though this is unlikely as the caregivers' qualitative responses were largely without issues

indicative of significant cognitive dysfunction. We also did not assess caregiver depression, employment, or financial status, which could all contribute to caregiver burden. Furthermore, our focus was on elders with ET. Nevertheless, we performed a sensitivity analysis to study enfeeblement and its correlates in a younger patient group with moderate disease duration and severity. The size of this sample was small and a larger study, conducted in an even younger age group, would be of value. Our patient population was also fairly uniformly of white race and highly educated; it would be beneficial to the generalizability of this outcome measure to assess enfeeblement in more diverse patient populations. Further studies may also address the effects of possible enfeeblement-related interventions in ET patient-caregiver dyads on caregiver burden and enfeeblement.

In our study, we characterized enfeeblement in elders with ET and analyzed its contribution to caregiver burden in ET. Enfeeblement was associated with numerous clinical factors and contributed more significantly to caregiver burden than any other variable, including perceived embarrassment. Although subtle, our study is of potential clinical utility as it may help clinicians and families to focus on those factors that contribute most to caregiver burden in this chronic and sometimes-debilitating disease. Possible interventions could include caregiver training or therapy in coping with their loved ones' disease and associated enfeeblement or providing more resources for managing their loved ones' needs. Providing patients with more resources for being more self-efficient could also reduce the burden on caregivers. One of these factors seems to be enfeeblement, a novel clinical construct that is just now being formalized in ET. Knowledge that is centered around the factors that contribute to patient difficulty is empowering for patients and physicians.

## References

1. Chandran V, Pal PK, Reddy JYC, Thennarasu K, Yadav R, Shivashankar N. Non-motor features in essential tremor. *Acta Neurol Scand* 2012;125(5):332–337. doi: 10.1111/j.1600-0404.2011.01573.x
2. Bareš M, Husárová I, Lungu OV. Essential tremor, the cerebellum, and motor timing: towards integrating them into one complex entity. *Tremor Other Hyperkinet Mov* 2012;2. pii: tre-02-93-653-1.
3. Sengul Y, Sengul HS, Sural MK, Bakim B, Forta H. A comparison between rate of nonmotor symptom development in essential tremor and Parkinson's disease. *Acta Neurol Belg* 2015;115(3):289–294. doi: 10.1007/s13760-014-0408-6
4. Sengul Y, Sengul HS, Yucekaya SK, Yucel S, Bakim B, Pazarci NK, et al. Cognitive functions, fatigue, depression, anxiety, and sleep disturbances: assessment of nonmotor features in young patients with essential tremor. *Acta Neurol Belg* 2015;115(3):281–287. doi: 10.1007/s13760-014-0396-6
5. Louis ED. Non-motor symptoms in essential tremor: a review of the current data and state of the field. *Parkinsonism Relat Disord* 2016;22:S115–S118. doi: 10.1016/j.parkreldis.2015.08.034
6. Musacchio T, Purrer V, Papagianni A, Fleischer A, Mackenrodt D, Malsch C, et al. Non-motor symptoms of essential tremor are independent of tremor severity and have an impact on quality of life. *Tremor Other Hyperkinet Mov* 2016;6:361. doi: 10.7916/D8542NCH

7. Rao AK, Gilman A, Louis ED. Balance confidence and falls in nondemented essential tremor patients: the role of cognition. *Arch Phys Med Rehabil* 2014;95(10):1832–1837. doi: 10.1016/j.apmr.2014.04.001
8. Hoskocová M, Ulmanová O, Šprdlík O, Sieger T, Nováková J, Jech R, et al. Disorders of balance and gait in essential tremor are associated with midline tremor and age. *Cerebellum* 2013;12(1):27–34. doi: 10.1007/s12311-012-0384-4
9. Louis ED. Functional correlates of lower cognitive test scores in essential tremor. *Mov Disord* 2010;25(4):481–485. doi: 10.1002/mds.22920
10. Benito-León J, Louis ED, Mitchell AJ, Bermejo-Pareja F. Elderly-onset essential tremor and mild cognitive impairment: a population-based study. *J Alzheimer's Dis* 2011;23(4):727–735. doi: 10.3233/JAD-2011-101572
11. Thawani SP, Schupf N, Louis ED. Essential tremor is associated with dementia: prospective population-based study in New York. *Neurology* 2009;73(8):621–625. doi: 10.1212/WNL.0b013e3181b389f1
12. Lombardi WJ, Woolston DJ, Roberts JW, Gross RE. Cognitive deficits in patients with essential tremor. *Neurology* 2001;57(5):785–790. doi: 10.1212/wnl.57.5.785
13. Frisina PG, Tse W, Hälbig TD, Libow LS. The pattern of cognitive-functional decline in elderly essential tremor patients: an exploratory-comparative study with Parkinson's and Alzheimer's disease patients. *J Am Med Dir Assoc* 2009;10(4):238–242. doi: 10.1016/j.jamda.2008.10.013
14. Kim J-S, Song I-U, Shim Y-S, Park J-W, Yoo J-Y, Kim Y-I, et al. Cognitive impairment in essential tremor without dementia. *J Clin Neurol* 2009;5(2):81. doi: 10.3988/jcn.2009.5.2.81
15. Lenka A, Benito-León J, Louis ED. Is there a premotor phase of essential tremor? *Tremor Other Hyperkinet Mov* 2017;7:498. doi: 10.7916/D80S01VK
16. Smeltere L, Kuzņecovs V, Ertz R. Depression and social phobia in essential tremor and Parkinson's disease. *Brain Behav* 2017;7(9):e00781. doi: 10.1002/brb3.781
17. Louis ED. Essential tremor as a neuropsychiatric disorder. *J Neurol Sci* 2010;289(1–2):144–148. doi: 10.1016/j.jns.2009.08.029
18. Louis ED, Cosentino S, Huey ED. Depressive symptoms can amplify embarrassment in essential tremor. *J Clin Mov Disord* 2016;3(1):11. doi: 10.1186/s40734-016-0039-6
19. Sinoff G, Badarny S. Mild cognitive impairment, dementia, and affective disorders in essential tremor: a prospective study. *Tremor Other Hyperkinet Mov* 2014;4:227. doi: 10.7916/D85B00KN
20. Li Z-W, Xie M-J, Tian D-S, Li J-J, Zhang J-P, Jiao L, et al. Characteristics of depressive symptoms in essential tremor. *J Clin Neurosci* 2011;18(1):52–56. doi: 10.1016/j.jocn.2010.05.021
21. Héroux ME, Parisi SL, Larocerie-Salgado J, Norman KE. Upper-extremity disability in essential tremor. *Arch Phys Med Rehabil* 2006;87(5):661–670.
22. Bain PG, Mally J, Gresty M, Findley IJ. Assessing the impact of essential tremor on upper limb function. *J Neurol* 1993;241(1):54–61.
23. Louis ED, Barnes L, Albert SM, Cote L, Schneier FR, Pullman SL, et al. Correlates of functional disability in essential tremor. *Mov Disord* 2001;16(5):914–920.
24. Morgan S, Kellner S, Gutierrez J, Collins K, Rohl B, Migliore F, et al. The experience of essential tremor caregivers: burden and its correlates. *Front Neurol* 2017;8:396. doi: 10.3389/fneur.2017.00396
25. Kellner S, Morgan S, Gutierrez J, Collins K, Rohl B, Migliore F, et al. Perceived embarrassment and caregiver burden in essential tremor caregivers. *J Neurol Sci* 2017;383:205–210. doi: 10.1016/j.jns.2017.11.020
26. Trujillo Diaz D, Cersonsky TEK, Kellner S, Zdrodowska MA, Hickman R, Cosentino S, et al. Enfeeblement in essential tremor: development and validation of a new psychometric measure. *J Geriatr Psychiatry Neurol* 2019;32(3):145–151. doi: 10.1177/0891988719834345
27. Traub RE, Gerbin M, Mullaney MM, Louis ED. Development of an essential tremor embarrassment assessment. *Parkinsonism Relat Disord* 2010;16(10):661–665. doi: 10.1016/j.parkreldis.2010.08.017
28. Bédard M, Molloy DW, Squire L, Dubois S, Lever JA, O'Donnell M. The Zarit burden interview. *Gerontologist* 2001;41(5):652–657.
29. Yu J, Yap P, Liew TM. The optimal short version of the Zarit Burden Interview for dementia caregivers: diagnostic utility and externally validated cut-offs. *Aging Ment Health* 2019;23(6):706–710. doi: 10.1080/13607863.2018.1450841
30. Louis ED, Barnes LF, Wendt KJ, Albert SM, Pullman SL, Yu Q, et al. Validity and test-retest reliability of a disability questionnaire for essential tremor. *Mov Disord* 2000;15(3):516–523.
31. Miller MD, Paradis CF, Houck PR, Mazumdar S, Stack JA, Rifai AH, et al. Rating chronic medical illness burden in geropsychiatric practice and research: application of the Cumulative Illness Rating Scale. *Psychiatry Res* 1992;41(3):237–248.
32. Linn BS, Linn MW, Gurel L. Cumulative Illness Rating Scale. *J Am Geriatr Soc* 1968;16(5):622–626.
33. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. *J Am Geriatr Soc* 2005;53(4):695–699.
34. Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, et al. Development and validation of a geriatric depression screening scale: a preliminary report. *J Psychiatr Res* 1982;17(1):37–49.
35. Spitzer RL, Kroenke K, Williams JBW, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med* 2006;166(10):1092–1097.
36. Louis ED, Ottman R, Ford B, Pullman S, Martinez M, Fahn S, et al. The Washington Heights-Inwood Genetic Study of Essential Tremor: methodologic issues in essential-tremor research. *Neuroepidemiology* 1997;16(3):124–133.
37. Louis ED, Ford B, Bismuth B. Reliability between two observers using a protocol for diagnosing essential tremor. *Mov Disord* 1998;13(2):287–293. doi: 10.1002/mds.870130215
38. Louis ED, Wendt KJ, Albert SM, Pullman SL, Yu Q, Andrews H. Validity of a performance-based test of function in essential tremor. *Arch Neurol* 1999;56(7):841–846.
39. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969;9(3):179–186.
40. Morris JC. Clinical dementia rating: a reliable and valid diagnostic and staging measure for dementia of the Alzheimer type. *Int Psychogeriatr* 1997;9 Suppl 1:173–176; discussion 177–178.