

The social and economic burden of frontotemporal degeneration

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ABSTRACT

Objective: To quantify the socioeconomic burden of frontotemporal degeneration (FTD) compared to previously published data for Alzheimer disease (AD).

Methods: A 250-item internet survey was administered to primary caregivers of patients with behavioral-variant FTD (bvFTD), primary progressive aphasia, FTD with motor neuron disease, corticobasal syndrome, or progressive supranuclear palsy. The survey included validated scales for disease staging, behavior, activities of daily living, caregiver burden, and health economics, as well as investigator-designed questions to capture patient and caregiver experience with FTD.

Results: The entire survey was completed by 674 of 956 respondents (70.5%). Direct costs (2016 US dollars) equaled \$47,916 and indirect costs \$71,737, for a total annual per-patient cost of \$119,654, nearly 2 times higher than reported costs for AD. Patients ≥ 65 years of age, with later stages of disease, and with bvFTD correlated with higher direct costs, while patients < 65 years of age and men were associated with higher indirect costs. An FTD diagnosis produced a mean decrease in household income from \$75,000 to \$99,000 12 months before diagnosis to \$50,000 to \$59,999 12 months after diagnosis, resulting from lost days of work and early departure from the workforce.

Conclusions: The economic burden of FTD is substantial. Counting productivity-related costs, per-patient costs for FTD appear to be greater than per-patient costs reported for AD. There is a need for biomarkers for accurate and timely diagnosis, effective treatments, and services to reduce this socioeconomic burden. *Neurology*® 2017;89:2049-2056

GLOSSARY

AD = Alzheimer disease; **bvFTD** = behavioral-variant frontotemporal degeneration; **CPT** = Current Procedural Terminology; **FTD** = frontotemporal degeneration; **HRQoL** = health-related quality of life; **HRS** = Health and Retirement Study; **HUI3** = Health Utilities Index-3; **QALY** = quality-adjusted life-years; **RUI** = Resource Utilization Inventory.

Frontotemporal degeneration (FTD), the most common dementia in individuals < 60 years of age, affects $\approx 60,000$ individuals in the United States.¹⁻⁴ FTD presents as a diverse group of degenerative disorders with prominent features of language, personality, behavior, cognition, and motor dysfunction made up of 4 predominant clinical phenotypes: behavioral-variant FTD (bvFTD), primary progressive aphasia, FTD with motor neuron disease, and Parkinson-plus movement disorders due to progressive supranuclear palsy or corticobasal syndrome.^{1,3} Although presentations differ, all forms of FTD cause progressive loss of function and independence over 2 to 20 years.¹⁻⁶ The prevalence of FTD is 15 to 22 per 100,000 adults. Compared to Alzheimer disease (AD),^{7,8} FTD affects younger patients and progresses more rapidly, and patients' symptoms are more variable. Many patients are in their prime earning years, have dependent children, and have difficulty accessing services developed primarily for older adults with dementia. To quantify the socioeconomic burden of FTD, we conducted a web-based survey to characterize

Supplemental data
at Neurology.org

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the patient and caregiver experience with FTD-related resource use, health-related quality of life (HRQoL), and per-patient annual costs.

METHODS Standard protocol approvals, registrations, and patient consents. The Florida Atlantic University Institutional Review Board approved the study as exempt.

Survey design. Participants ($n = 956$) were recruited via announcements on the Association for Frontotemporal Degeneration website, newsletter, social media, and e-mail blasts. We designed a 250-question internet survey using Qualtrics Survey Software (Provo, UT) to characterize the socioeconomic burden of FTD from the primary caregivers' perspective. No identifiable personal information was collected. Validated scales for clinical characterization and resource use were used whenever available and are described below. We used investigator-generated questions to describe the personal burden of FTD when no validated scale existed. We used these data to estimate the economic burden of FTD. The survey was beta-tested and revised for clarity and readability before its release to the FTD community. The survey took ≈ 2 hours to complete.

Clinical characterization. Informant-based questionnaires characterized the patient's symptoms and severity. The 10-question Quick Dementia Rating Scale⁹ staged dementia severity (range 0–30, higher scores reflect greater impairment). The 12-question Neuropsychiatric Inventory¹⁰ assessed behavioral aspects of disease (range 0–36, higher scores indicate more behavioral symptoms). The 10-question Functional Activities Questionnaire¹¹ examined instrumental activities of daily living (range 0–30, higher scores mean greater functional dependence). The 12-question Zarit Burden Inventory¹² assessed caregivers' burden (range 0–36, higher scores mean greater burden). In addition, respondents assessed patient disease stage severity at the time of the survey on the basis of their opinion and direct observation of the patient^{13,14} as mild, moderate, severe, or terminal (capturing the last 6 months of life).

Health utility and resource use. We measured patients' quality of life and health utility using the Health Utilities Index–3 (HUI3).^{15,16} The HUI3 measures health-state utility and provides a summary score for HRQoL across 8 attributes (vision, hearing, speech, ambulation, dexterity, emotion, cognition, pain), with each attribute having 5 or 6 levels of ability/disability for a total 972,000 unique health states. The HUI3 provides utility scores ranging from 1 (reflecting perfect health) to 0 (dead) with negative scores possible (minimum score -0.371) and reflecting health states deemed “worse than being dead.”¹⁵ We estimated quality-adjusted life-years (QALYs), representing quality-adjusted life expectancy, by multiplying health utility by survival time.¹⁷ As is the case with health utility, negative QALYs are possible, reflecting survival in health states being worse than death. Negative HUI3 and QALY scores reflect the respondents' belief that there is no perceived positive quality of life for the patient in this state.

The Resource Utilization Inventory (RUI)^{18,19} measures patient and caregiver dementia-associated costs, the use of formal and informal care, and the loss of paid employment. There are 4 domains: direct medical care, direct nonmedical care, informal care, and caregiver time. Actual costs are determined via Current Procedural Terminology (CPT) codes, Evaluation and Management codes, and Diagnosis Related Groups. We calculated the mean response for each resource use question. We omitted

missing values unless the patient resided in dependent care and the resource is used primarily by community-dwelling patients (i.e., home health aides). In that case, we assumed that the respondent did not use that resource in the event of nonresponse. There were no differences between completers and noncompleters for any variable after correction for multiple comparisons.

We assigned dollar values to hospital admissions on the basis of the admission-weighted average of Medicare reimbursements for Diagnosis Related Groups 56 and 57 (degenerative nervous system disorders, with and without a major complication or comorbidity). We used the Medicare reimbursement for an Evaluation and Management visit for an established patient (CPT 99214) to assign a dollar value to office visits and CPT 97110 to assign a dollar value to physical therapy visits. We used estimates from Genworth²⁰ to assign dollar values to assisted living care, nursing home care, and respite care. We adjusted nursing home and assisted living costs downward by 8% to account for the costs of food and shelter.²¹ We obtained costs for medical equipment from the Medicare fee schedule.²²

We estimated costs for paid home care using Genworth²⁰ and costs for unpaid care using wage estimates from the Bureau of Labor Statistics.^{23,24} Table e-1 at Neurology.org provides details for cost estimates. We estimated lost productivity by asking whether patients and caregivers were out of the labor force as a result of FTD. We valued lost productivity for patients using average annual earnings²⁵ multiplied by 1.25 to account for fringe benefits. We valued lost productivity for caregivers by subtracting the annual cost of hiring a home health aide from average earnings.

We calculated the annual per patient costs considering direct costs (patient medical care, patient residential care, respite care, patient medical equipment and supplies, and paid home care with formal caregivers) and indirect costs (unpaid home care for family and friends, patient lost wages, and caregiver lost wages). Average costs were determined by multiplying the average use by the price per item. For example, patients experienced an average of 0.6 hospitalizations per year. If the typical reimbursement per admission is \$36,044, then the average cost in the sample is \$21,626 ($0.6 \times \$36,044$). We calculated direct and indirect costs by summing across average costs for individual RUI items. Some respondents answered only a subset of the cost-related questions. We calculated average costs on the basis of the subsample of respondents who answered the relevant questions for each cost item.

Statistical analyses. Analyses were conducted with SPSS version 23 (IBM Corp, Armonk, NY). Descriptive statistics characterized the caregiver respondents and the patients. We compared groups using analysis of variance for continuous variables and χ^2 tests for categorical variables. We compared median incomes using Kruskal-Wallis tests. We used a generalized linear model with a gamma distribution and log link to estimate the relationship between patient-level costs and patient characteristics and summed costs by item at the individual level. We restricted the sample to respondents who had nonmissing responses for at least 15 of the 18 RUI items ($n = 595$ respondents) and recoded any remaining missing values to zero. We selected the cutoff of 15 to balance the benefit of including as many respondents in the analysis as possible against the disadvantage of including respondents with incomplete cost data. Respondents who answered 15 items were similar in terms of sex, age, disease type, and disease duration to respondents who answered <15 .

RESULTS Sample characteristics. Nine hundred fifty-six individuals started the survey, and 674 (70.5%) completed it. There were no significant demographic

differences between completers and noncompleters. The patients were divided into 4 groups (table 1) based on the caregiver's assessment: mild, moderate, severe, or terminal. The majority of caregiver respondents were female spouses, while the majority of patients were men. The diagnostic groups were 52.9% bvFTD, 21.1% primary progressive aphasia, 7.3% FTD with motor neuron disease, and 5.4% progressive supranuclear palsy or corticobasal syndrome, while 13.3% were undefined FTD (i.e., the respondent did not know the subtype). As demonstrated in table 1, the caregiver global ratings matched well with duration of disease and standardized rating scales of global staging (Quick Dementia Rating Scale),⁹ behavior (Neuropsychiatric Inventory),¹⁰ and function (Functional Activities Questionnaire).¹¹ Caregiver burden (Zarit Burden Inventory)¹² was not different across stages of disease.

Changes in household income and lost days of work. At the time of survey, 45% of caregivers still worked, while 37% were no longer employed after the patient's FTD diagnosis. Seventy-four percent of caregivers worked full-time. Only 3.3% of patients were still working. Caregivers reported lost days of work due to patient health issues (25.6%) or caregiver health issues (21.6%). Caregivers and patients who

were still working full-time reported a median loss of 7.0 days over the previous 4 weeks due to FTD-related matters.

Respondents provided the total household income for the patient and family 12 months before and 12 months after the FTD diagnosis (table 2). The overall household income before diagnosis ranged from \$75,000 to \$99,000 but declined after diagnosis to \$50,000 to \$59,999 ($p < 0.001$). There were no differences in the extent of loss of household income by FTD subtype, caregiver type, or patient sex (table 2).

Patient and caregiver health costs associated with FTD.

We found that 67% of caregivers of patients with FTD reported a notable decline in their health and that 53% reported increased personal health care costs calculated from the RUI. On average, caregivers had 7 clinician visits and slightly less than 1 inpatient admission per year. On average, patients had 6 overnight respite stays, 16 daytime respite stays, 35 clinician visits, and 2 hospital or emergency room visits. In addition, 31.6% of respondents needed to hire a paid caregiver several times per week.

Estimates of annual per patient costs. Total direct costs (i.e., the value of goods and services for which there are explicit monetary payments) were \$47,916. Total

Table 1 Sample characteristics

| Variable | Stage of FTD | | | | p Value |
|-------------------------------------|--------------|------------|-------------|-------------|---------|
| | Mild | Moderate | Severe | Terminal | |
| CG age, y | 58.7 (9.2) | 60.9 (9.8) | 61.5 (10.0) | 61.0 (11.1) | 0.28 |
| CG, % female | 88.9 | 82.4 | 73.2 | 74.2 | 0.006 |
| CG relationship, % | | | | | 0.03 |
| Spouse | 79.6 | 84.1 | 80.0 | 74.2 | |
| Child | 9.3 | 8.0 | 13.1 | 17.7 | |
| Patient age, y | 64.5 (10.5) | 65.6 (8.1) | 66.2 (8.8) | 67.9 (8.1) | 0.14 |
| Patients, % female | 22.6 | 27.0 | 37.3 | 40.3 | 0.007 |
| FTD diagnosis, % | | | | | 0.32 |
| bvFTD | 63.0 | 55.7 | 47.9 | 54.1 | |
| Progressive aphasia | 13.0 | 19.1 | 24.9 | 21.3 | |
| MND spectrum | 7.4 | 7.7 | 7.3 | 4.9 | |
| PSP or CBS | 7.5 | 4.1 | 5.8 | 6.6 | |
| Other or nonspecified | 9.3 | 13.4 | 14.1 | 13.1 | |
| Duration of disease, y | 2.4 (2.1) | 3.8 (3.1) | 5.7 (3.4) | 6.3 (4.1) | <0.001 |
| Quick Dementia Rating System | 6.9 (3.1) | 14.5 (5.3) | 23.9 (5.3) | 25.5 (4.5) | <0.001 |
| Functional Activities Questionnaire | 10.6 (6.7) | 20.4 (7.3) | 26.9 (5.5) | 27.2 (5.5) | <0.001 |
| Neuropsychiatric Inventory | 7.9 (4.9) | 12.3 (6.3) | 13.5 (7.2) | 16.6 (9.8) | <0.001 |
| Zarit Burden Inventory | 25.4 (10.9) | 27.7 (7.6) | 28.3 (7.9) | 28.1 (7.6) | 0.16 |

Abbreviations: bvFTD = behavioral variant of frontotemporal degeneration; CBS = corticobasal syndrome; CG = caregiver; FTD = frontotemporal degeneration; MND = motor neuron disease; PSP = progressive supranuclear palsy. Values are mean (SD).

Table 2 Change in median household income

| | Total | FTD subtype | | | |
|---------------------|-------------------|---------------|---------------|---------------|---------------|
| | | bvFTD | PPA | FTD-MND | PSP/CBS |
| 12 mo before DX, \$ | 75,000-99,999 | 75,000-99,999 | 75,000-99,999 | 60,000-74,999 | 50,000-59,999 |
| 12 mo after DX, \$ | 50,000-59,999 | 50,000-59,999 | 50,000-59,999 | 35,000-49,999 | 40,000-49,999 |
| p Value | <0.001 | <0.001 | <0.001 | 0.001 | 0.003 |
| | Type of caregiver | | | Patient sex | |
| | Spouse CG | Child CG | Other CG | Male | Female |
| 12 mo before DX, \$ | 75,000-99,999 | 40,000-49,999 | 75,000-99,999 | 75,000-99,999 | 75,000-99,999 |
| 12 mo after DX, \$ | 50,000-59,999 | 30,000-34,999 | 35,000-39,999 | 50,000-59,999 | 40,000-49,999 |
| p Value | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 |

Abbreviations: bvFTD = behavioral variant of frontotemporal degeneration; CG = caregiver; DX = diagnosis; FTD-MND = frontotemporal degeneration with motor neuron disease; PPA = primary progressive aphasia; PSP/CBS = progressive supranuclear palsy/corticobasal syndrome. Median ranges.

indirect costs (the value of the changes in the provision of goods and services that are attributable to FTD but for which there are no explicit monetary payments) were \$71,737. The sum of estimated direct and indirect costs is \$119,654.

Table 3 reports the relationship between patient characteristics and costs. The sample used in the regression analysis had a higher proportion of men (69% vs 61%) but was otherwise similar in terms of age, stage, underlying diagnosis, and disease duration. Patients ≥ 65 years of age incurred higher direct costs (\$17,900) but lower indirect costs (\$25,000). Men had higher indirect costs because they were more likely to use unpaid care and to have stopped working because of the disease. Women had higher direct costs, mainly because they were more likely to live in nursing homes or assisted living facilities. Patients with severe or terminal stages of disease incurred higher direct costs (\$54,000). Across the FTD subtypes, bvFTD had higher direct costs (\$13,030) than other subtypes.

Other costs associated with FTD. Caregivers also reported patient-related crises during the prior year: 19% required an emergency department visit, 11%

required emergency medical services, 8% required urgent psychiatric care, 6% required police intervention, and 6% required contacting a lawyer. Poor financial decisions by patients with FTD were reported by 58% of respondents. Legal costs were reported by 9.6% of respondents, attributed largely to court appearances and attorney fees. The leading reasons for court appearances included legal guardianship (9.0%), bankruptcy (4.4%), loss of home (3.9%), loss of business (3.8%), criminal cases (3.2%), and civil lawsuits (2.7%). The leading reasons for attorney fees included initiating a power of attorney (25.9%), revising wills (22.9%), guardianships (7.6%), and court appearances (5.8%).

Changes in HRQoL. Table 4 reports HUI3^{15,16} scores and QALYs¹⁷ by severity of disease, FTD subtype, and caregiver-patient dyadic relationships. HUI3 scores and QALYs were lower for patients in the severe and terminal stages, with scores indicating that patients' quality of life is worse than dead ($p < 0.001$). Across all stages of disease, caregivers reported declines in HRQoL regardless of relationship; however, QALYs were highest in female caregiver-male

Table 3 Estimates from generalized linear models

| Variable | n (%) | Effects, \$1,000 (95% CI) | | | | | |
|-----------------|------------|---------------------------|---------|---------------------------|---------|--------------------------|---------|
| | | Direct costs | p Value | Indirect costs | p Value | Total costs | p Value |
| Age ≥ 65 y | 349 (58.7) | 17.94 (7.81 to 28.07) | 0.001 | -24.98 (-33.13 to -16.83) | <0.001 | -11.95 (-21.57 to -2.33) | 0.01 |
| Male | 415 (69.7) | -6.89 (-17.33 to 3.55) | 0.19 | 17.18 (8.69 to 25.67) | <0.001 | 13.03 (2.68 to 23.38) | 0.01 |
| Severe stage | 281 (47.2) | 54.43 (40.83, 68.03) | <0.001 | -3.18 (-11.03 to 4.67) | 0.43 | 46.38 (36.14 to 56.62) | <0.001 |
| bvFTD | 314 (52.8) | 13.03 (3.10 to 22.96) | 0.01 | 0.72 (-6.93 to 8.37) | 0.85 | 12 (2.47 to 21.53) | 0.01 |
| Duration 2-6 y | 346 (58.2) | -2.06 (-12.30 to 8.18) | 0.69 | 9.29 (1.34 to 17.24) | 0.02 | 5.99 (-3.92 to 15.90) | 0.24 |
| Duration >6 y | 141 (23.7) | 1.57 (-10.43 to 13.57) | 0.79 | 5.95 (-3.58 to 15.48) | 0.22 | 3.37 (-8.43 to 15.17) | 0.58 |

Abbreviations: bvFTD = behavioral variant of frontotemporal degeneration; CI = confidence interval. Estimates (95% CIs).

Table 4 Health-related quality of life

| Stage of FTD | | | | | |
|-------------------------|-------------|-------------|--------------|---------------|---------|
| Variable | Mild | Moderate | Severe | Terminal | p Value |
| HUI3 | 0.55 (0.27) | 0.24 (0.27) | -0.09 (0.20) | -0.17 (0.15) | <0.001 |
| QALYs | 1.2 (1.5) | 0.8 (1.5) | -0.64 (1.4) | -1.03 (0.9) | <0.001 |
| Caregiver-patient dyads | | | | | |
| Variable | Male-male | Male-female | Female-male | Female-female | p Value |
| HUI3 | 0.09 (0.29) | 0.09 (0.32) | 0.13 (0.32) | 0.02 (0.28) | 0.08 |
| QALYs | 0.21 (0.9) | 0.25 (1.9) | 0.27 (1.6) | -0.50 (1.2) | 0.006 |
| FTD subtype | | | | | |
| Variable | bvFTD | PPA | FTD-MND | PSP/CBS | p Value |
| HUI3 | 0.14 (0.33) | 0.09 (0.31) | 0.10 (0.33) | 0.04 (0.31) | 0.34 |
| QALYs | 0.31 (1.7) | 0.15 (1.6) | 0.04 (1.1) | 0.07 (1.6) | 0.59 |

Abbreviations: bvFTD = behavioral variant of frontotemporal degeneration; FTD = frontotemporal degeneration; FTD-MND = frontotemporal degeneration with motor neuron disease; HUI3 = Health Utilities Index-3; PPA = primary progressive aphasia; PSP/CBS = progressive supranuclear palsy and corticobasal syndrome; QALY = quality-adjusted life-year. Values are mean (SD).

patient dyads and lowest in female caregiver–female patient dyads. There were no significant differences in HRQoL or QALYs by FTD subtypes.

Comparison to economic costs of AD. Lastly, we examined the cost analyses for annual direct, indirect, and total costs reported for patients with dementia in previous studies (table 5). Most of the cited studies examined patients with AD, mild cognitive impairment due to AD, or nonspecified dementia. These studies used a variety of data collection strategies, including record reviews, structured interviews, and validated scales. Studies from non-US sources were converted to 2016 US dollars for comparison. Reported costs were higher in more advanced stages of dementia²⁶ and in younger-onset and non-AD dementias.^{19,27} Costs were greater in the United States than in studies originating in other countries. Most studies did not account for lost wages in the calculation of indirect costs and used HRQoL or QALYs to assess influence on quality of life. Across studies, inability to complete activities of daily living, worsening behavior, caregiver burden, the number of comorbid medical conditions, and increasing severity of disease were associated with higher costs.

One of the largest studies in the United States examining dementia costs²¹ used a subsample of 856 patients from the Health and Retirement Study (HRS). This study reported a number of different cost estimates, which varied based on how unpaid care was valued and whether costs were adjusted for coexisting conditions, to report annual direct costs of \$33,329 and annual indirect costs of \$30,839 (total annual costs: \$64,168). Their estimate of costs

unadjusted for coexisting conditions with unpaid care valued at the replacement cost (i.e., the cost of hiring a paid home health worker) is comparable to our findings. However, overall costs of dementia care estimated from the HRS data were 53% lower than our reported total costs for FTD, or a total of \$119,653.

DISCUSSION FTD is associated with substantial direct and indirect costs, diminished quality of life, and increased caregiver burden. Most patients with FTD are working age, and most patients have to leave the labor force during their peak earning years. Caregivers of patients with FTD may also need to alter their careers to provide care. Combined, these factors contribute to a substantial decrease in household income. Previous studies have documented the heavy burden imposed by FTD on caregivers and families,^{28,29} but there has not been a study to date that captured the economic burden of FTD in the US.

A clinic-based study from Singapore²⁷ that examined differences in median annual costs between young- and late-onset dementia reported young-onset dementia costs almost twice those of late-onset dementia in the clinic patient group (\$15,815 vs \$8,396). This same study found that FTD and vascular dementia had higher costs than young-onset AD. Another study in Argentina³⁰ found annual direct costs for FTD to be higher than for AD, with at least part of that cost accounted for by psychotropic medications. Most studies have reported that resource use (institutional care, community care, home services) was highly correlated with dependency for activities of daily living and behavior. This is

Table 5 Comparison of direct, indirect, and total costs associated with dementia care

| Year of study | Source of data | Study population | Country of origin | Annual costs, 2016 US \$ |
|-----------------------|---------------------------|--------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------------|
| 2011 ³² | RUD Lite | 1,222 Patients with AD | Spain, Sweden, UK, US | Annual direct: \$37,647 |
| 2011 ²⁶ | Questionnaire | 176 Patients with dementia | Germany | Annual direct: \$21,450 (mild) \$45,760 (moderate) \$60,060 (severe) |
| 2011 ³⁰ | Structured interview | 104 Patients with dementia | Argentina | Annual direct for AD: \$4,625 Annual direct for FTD: \$4,924 Annual direct costs VaD: \$5,112 |
| 2013 ¹⁹ | RUI | 259 Patients with MCI | US | Annual direct: \$40,448 Annual indirect: \$2,452 Annual per patient: \$42,900 |
| 2015 ³³ | Medical records | 41,740 Patients with dementia | Ireland | Annual per patient: \$45,852 |
| 2013 ²¹ | Estimated costs | 856 Patients with dementia | US | Annual direct: \$28,501 Annual indirect: \$27,789 Annual per patient: \$56,290 |
| 2014 ³⁴ | RUD | 57 Patients with AD | France | Annual direct: \$13,104 Annual indirect: \$22,716 Annual per patient: \$35,820 |
| 2014 ³⁵ | Medical claims | 1,861 Caregivers of patients with AD | US | Annual health care: \$7,168 |
| 2015 ^{36,37} | Electronic health records | 147 Caregivers of patients with AD | US | Annual health care: \$2,585 |
| 2015 ³⁸ | Insurance claims | 27,948 Patients with AD | Finland | Annual direct: \$26,099 |
| 2015 ³⁹ | RUD Lite | 1,497 Patients with AD | Germany, France, UK | Annual direct: \$15,315 Annual indirect: \$12,029 Annual per patient: \$27,344 |
| 2016 ⁴⁰ | RUD | 175 Patients with dementia | Spain | Annual direct: \$10,145 Annual indirect: \$16,500 Annual per patient: \$26,645 |
| 2016 ²⁷ | Financial questionnaire | 255 Patients with dementia | Singapore | Annual per patient late onset: \$8,396 Annual per patient young onset: \$15,815 |
| 2016 ⁴¹ | RUD | 296 Patients with AD | Sweden | Annual direct: \$7,226 Annual indirect: \$41,737 Annual per patient: \$48,963 |

Abbreviations: AD = Alzheimer disease; FTD = frontotemporal degeneration; MCI = mild cognitive impairment; RUD = Resource Utilization in Dementia; RUI = Resource Utilization Inventory; VaD = vascular dementia.

consistent with our finding that direct costs were significantly higher in bvFTD compared with other FTD subtypes.

Our study found that the economic burden for FTD in the United States is approximately twice that reported for AD.²¹ Given the age of the population affected by AD, the authors did not estimate productivity-related costs. When productivity-related costs are excluded and just direct costs and informal care costs are considered, our estimate of \$69,000 per patient cost for FTD is similar to their estimate of the \$64,000 per patient cost of AD dementia in the United States. However, because

many patients with FTD and their caregivers would otherwise be in the labor force, the true per-patient economic burden of FTD may be substantially higher than for AD. It is worth noting that the reported AD per-patient care costs vary widely (table 5) and may reflect the impact that different methodologies have on generating cost estimates.

Our study has limitations. Individuals with an inherently positive view of research were more likely to respond to an invitation to participate. Not all individuals who initiated the survey completed the survey, but we found no sociodemographic differences between completers and noncompleters. We relied

on self-reported resource use data, which may be subject to inaccurate recall. To counter this, we used well-accepted, validated instruments in dementia research (e.g., RUI and HUI3). Our sample population was caregivers rather than the patients themselves, and all diagnoses are self-reported. To overcome this, we used well-validated informant rating scales to assess presence and stage of dementia, activities of daily living, behavior, and HRQoL to characterize the patients. It is worth noting that in a disease with no formal clinical staging, caregivers' assessment of stage of disease strongly correlated across all validated staging, functional, and behavioral instruments. Finally, this study was cross-sectional and is unable to estimate longitudinal costs associated with disease progression.

Our finding of an increased economic burden for FTD compared to what is reported for AD may still underestimate true costs. Our cost estimates were based on items for which we could assign a unit cost to the item without making speculative assumptions and reasonably attribute the cost to FTD vs other illnesses. Therefore, while we measured caregiver's use of medical services, we did not assign a monetary value and could not determine what share of care is attributable to the unique burden of FTD caregiving without undertaking additional analyses.²⁹

Although the absolute number of patients with FTD is lower than the number with AD, the economic burden of FTD is substantial. One of the key factors to this burden may be the earlier age at onset, typically occurring during patients' or caregivers' peak earning years. A better understanding of the substantial socioeconomic burden of FTD will provide the needed evidence base to help inform healthcare policy,³¹ to drive research agendas, and to enhance targeted allocation of resources that will lead to timely and accurate diagnosis and effective treatments where none now exists.

AUTHOR CONTRIBUTIONS

Dr Galvin: study and questionnaire design, statistical analyses and interpretation, drafting, revising, and submitting the manuscript. Dr Howard: questionnaire design, statistical analyses, reviewing and editing the manuscript. Ms. Denny, Ms. Dickinson, and Dr Tatton: questionnaire design, reviewing and editing the manuscript.

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