Published in final edited form as:

Epilepsia. 2019 July ; 60(7): 1462–1471. doi:10.1111/epi.16051.

High health care costs in minority groups of older US Medicare beneficiaries with epilepsy

Maria Pisu¹, Joshua Richman², Jerzy P. Szaflarski³, Ellen Funkhouser¹, Chen Dai⁴, Lucia Juarez¹, Edward Faught⁵, Roy C. Martin³

¹Division of Preventive Medicine, University of Alabama at Birmingham, Birmingham, Alabama

²Department of Surgery, University of Alabama at Birmingham, Birmingham, Alabama

³Department of Neurology, University of Alabama at Birmingham, Birmingham, Alabama

⁴Center for Health Service Research, University of Kentucky, Lexington, Kentucky

⁵Department of Neurology, Emory University, Atlanta, Georgia

Abstract

Objective: To examine health care costs in diverse older Medicare beneficiaries with epilepsy.

Methods: Using 2008–2010 claims data, we conducted a longitudinal cohort study of a random sample of Medicare beneficiaries augmented for minority representation. Epilepsy cases ($n = 36\,912$) had 1 International Classification of Diseases, Ninth Edition (ICD-9) 345.x or 2 ICD-9 780.3x claims, and 1 antiepileptic drug (AED) in 2009; new cases ($n = 3\,706$) had no seizure/epilepsy claims nor AEDs in the previous 365 days. Costs were measured by reimbursements for all care received. High cost was defined as follow-up 1-year cost 75th percentile. Logistic regressions examined association of high cost with race/ethnicity, adjusting for demographic, clinical, economic, and treatment quality factors. In cases with continuous 2-year data, we obtained costs in two 6-month periods before and two after the index event.

Results: Cohort was ~62% African Americans (AAs), 11% Hispanics, 5% Asians, and 2% American Indian/Alaska Natives. Mean costs in the follow-up were ~\$30 000 (median = \$11 547; new cases, mean = \$44 642; median = \$25 008). About 19% white compared to 27% AA cases had high cost. AA had higher odds of high cost in adjusted analyses (odds ratio [OR] = 1.20, 95% confidence interval [CI] = 1.11–1.29), although this was only marginally significant when adjusting for AED adherence (OR = 1.09, 95% CI = 1.01–1.18, $P = 0.03$). Factors associated with high cost included 1 comorbidity, neurological care, and low AED adherence. Costs were highest at ~\$17 000 in the 6 months immediately before and after the index event (>\$29 000 for new cases).

Significance: The financial sequelae of epilepsy among older Americans disproportionately affect minorities. Studies should examine contributors to high costs.

Keywords

costs; epilepsy; Medicare; older adults; quality of care; seizure

1 | INTRODUCTION

Concerns about high health care costs are central to current value-based initiatives aimed at improving population health while lowering costs,¹ and salient considering that over 60% of older adults who declare bankruptcy do so due to medical expenses.² Understanding which groups of older adults are at risk of high costs and why is warranted. Among older Americans with epilepsy, about 1.5% of older adults,³ minority groups may be at risk of high costs of care. Recent studies have found that African Americans, for example, have poor adherence to antiepileptic drugs (AEDs)⁴ and are more likely to have seizures resulting in emergency room visits.⁵ As shown in younger populations with epilepsy, these factors may lead to higher costs of care as well as poor health status.^{6–9} Non–epilepsy-related comorbidities and insurance status also contribute to high costs in younger populations.^{10,11} Among older Medicare beneficiaries with epilepsy, comorbidities were more likely in some minorities,¹² another potential contributor to high costs in these populations. Furthermore, health care costs may be affected by whether older adults receive evidence-based treatment for seizure control. Some indicators of such quality care include initial monotherapy, avoidance of enzyme-inducing AEDs as first choices, avoiding drugs prone to interactions, and making changes in drug therapy after a seizure.¹³ Among Medicare beneficiaries with epilepsy, we observed some racial/ethnic differences in quality care indicators,¹³ for example, one related to avoiding enzyme-inducing AEDs.¹⁴ Currently, there is scant information on health care costs of older Medicare beneficiaries with epilepsy, on whether minorities are more likely to have high costs compared to their white counterparts, and on what may explain this disparity.

To address these knowledge gaps, we have conducted a longitudinal cohort study of older Medicare beneficiaries with epilepsy. We examined the costs of care over a 1-year follow-up and tested our hypothesis that minorities are more likely to have high costs of care compared to their white counterparts, adjusting for factors and elements of medical care that may contribute to or moderate the risk of having high costs. In doing so, we also assessed whether receiving care concordant with quality indicators¹³ reduces the likelihood of high costs. In addition, in line with other studies that have shown higher costs after an epilepsy index event,^{8,15} we compared costs in the follow-up period to costs in the year before to determine whether the same pattern is present in the older population. We used claims data for a cohort of Medicare beneficiaries with epilepsy that overrepresents minority groups.^{4,5,12,14,16}

2 | MATERIALS AND METHODS

This study is a retrospective analysis of 2008–2010 administrative claims from the Center for Medicare and Medicaid Services. Using a longitudinal cohort study design, we examined two samples of Medicare beneficiaries 67 years and older in 2009. One was a 5% random

sample of the Medicare population, and, to increase representation of minority groups, the second was a sample of all African American, Asian/Pacific Islander, Hispanic, and American Indian/Alaskan Native (AI/AN) beneficiaries with administrative claims for seizures and/or epilepsy in 2008 to 2010. The institutional review board of the University of Alabama at Birmingham approved this study.

2.1 | Study population

Methods to identify epilepsy cases have been described elsewhere.^{12,14} Briefly, we identified Medicare beneficiaries who in 2009 had (1) at least one claim with International Classification of Diseases, Ninth Edition (ICD-9) code 345. xx or at least two claims with ICD-9 780.3x that were 30 days apart, and (2) at least one AED prescription of 60 days or more. This algorithm was based on ones with positive predictive values of 70%–94% in different populations.^{17–19} The first claim with ICD-9 345.xx or 780.3x was designated as the “index” event. Cases were restricted to those with continuous coverage for Medicare Parts A, B, and D, and no managed care plans, in the follow-up period, that is, the 1 year after index event or until death (whichever came first). Among these cases, we defined potential *new cases* as those with a period of 365 days before the index event with (1) continuous Part A, B, and D coverage and no managed care plans; (2) no claims with ICD-9 codes for epilepsy or seizures; and (3) no prescription for any AEDs. For comparison purposes, from the 5% Medicare random sample we obtained a cohort of beneficiaries (with or without epilepsy) with continuous coverage and no managed care similar to the epilepsy cases, using a random claim in 2009 as a pseudo index event.

2.2 | Study outcomes

The main outcome was having “high costs” in the follow-up period, defined as costs above the 75th percentile of the cost distribution. In sensitivity analyses, we also considered high costs above the 80th and 90th percentile. The secondary outcome was 6-month costs over a 2-year period around the index date. This outcome was obtained for a subset of beneficiaries with at least one claim in each 6-month interval before and after the index event.

Costs were obtained by summing all payment amounts to providers by Medicare, beneficiaries, and other payers (if beneficiaries had any other coverage). These payments were for all care received (epilepsy-related and non-epilepsy-related) and included hospitalizations, outpatient visits and procedures, and physician visits. Beneficiaries’ payments were those due through deductibles, coinsurance, and copayments.

2.3 | Analysis

We first obtained the proportion of beneficiaries with high costs among epilepsy cases and in the random beneficiary sample. We conducted bivariate analyses using chi-square tests to assess differences between beneficiaries with and without high costs. Using logistic regression, we tested the hypothesis that minority groups would have higher odds of high costs than white beneficiaries. We adjusted for several factors identified a priori as potential confounders of the association between race/ethnicity and high costs. According to a behavioral model of access to care,²⁰ these included pre-disposing, enabling, and need

factors that affect health care utilization and, ultimately, outcomes of care such as costs. Thus, the analysis adjusted for:

1. *Predisposing factors*: age, gender;
2. *Need factors*: neurological care (having claims for a neurologist or neurosurgeon visit in the 30 days before to the 60 days after the epilepsy index date), and number of co-morbid conditions (identified in the year before the index event using methods to obtain the Charlson Comorbidity index^{21,22}). In addition, because cerebrovascular disease is the most common risk factor for epilepsy²³ and occurs disproportionately among minorities, in particular African Americans,²⁴ we also included an indicator for this condition; and
3. *Socioeconomic enabling factors*: being eligible for Part D Low Income Subsidy (LIS), ZIP code level poverty indicators. With 2010 Census data, we created an indicator for high poverty corresponding to ZIP codes where >20% of households lived below 100% of the Federal Poverty Line.

Our models also adjusted for beneficiaries' US region of residence (Northeast vs Other) to account for geographic variation in care and costs. In addition, we adjusted for the following health care-related behaviors or factors:

1. Low adherence to AED treatment, that is, proportion of days covered (PDC) with a prescription < 80%. The PDC is the ratio of the number of days with at least one AED prescription over the total number of days from the first AED prescription to the end of the last refilled prescription or to the end of follow-up (whichever comes first). About 32% of cases had a PDC < 80%⁴;
2. Care concordant with Quality Indicators for Epilepsy Treatment (QUIET) 15, that is, whether adjustments to AEDs were made following a seizure. Among beneficiaries with a seizure for which an emergency room (ER) visit occurred (n = 4132), 50% had AED changes and care concordant with QUIET 15⁵;
3. Care concordant with QUIET 6 for new cases, that is, starting AED treatment with monotherapy (>90%)¹²;
4. Care concordant with QUIET 9 for new cases, that is, at least two non-enzyme-inducing AEDs tried before starting enzyme-inducing drugs (about 60%)¹⁴; and,
5. Presence of drug interaction risk (care not concordant with QUIET 11) for new cases (about 25%).¹⁶

Furthermore, we compared characteristics of all epilepsy cases with those of the subset selected for the analysis of the 6-month cost outcomes. We then obtained mean 6-month costs by payer (Medicare, beneficiary, other payer), and median, 25th percentile, and 75th percentile for total costs of all payers combined. All analyses were conducted in SAS 9.4 (SAS Institute).

3 | RESULTS

By design, epilepsy cases overrepresented minorities: about 62% were African Americans, 11% Hispanics, 5% Asians, and 2% AI/ANs (Table 1). Similar to the random sample, about two-thirds were women, and about 40% were younger than 75 years. About half of the cases had four or more comorbidities (vs 19% of the random sample), 82% were eligible for the Part D LIS (vs 33.5% of the random sample), and >40% resided in low-poverty ZIP code areas (vs 21.5% of the random sample).

Total costs in the follow-up period were on average \$30 253 (median = \$11 547, 25th percentile = \$3309, 75th percentile = \$39 800) for all cases and \$44 642 (median = \$25 008, 25th percentile = \$7573, 75th percentile = \$61 473) for new cases. The proportion with high costs ranged from 18.8% of white to 27.3% of African American cases (Table 1). A higher proportion of new cases (37.4%) had high costs, ranging from 29.2% of white to 40.6% of African Americans (Table 1). In the random sample, total costs in the follow-up were \$12 612 (median = \$3751, 25th percentile = \$1425, 75th percentile = \$12 222), and the proportion with high costs ranged from 18.4% of Asians to 29.9% of African Americans (Table 1).

After adjusting for covariates, African Americans with epilepsy had higher odds of high costs than white cases (odds ratio [OR] = 1.20, 95% confidence interval [CI] = 1.11–1.29 for all cases, and OR = 1.66, 95% CI = 1.29–2.14 for new cases). Hispanic, Asian, and AI/AN cases did not differ from white cases, except for Hispanic new cases having higher odds of high costs than white new cases (OR = 1.39, 95% CI = 1.01–1.93; Table 2). In the random sample, there were no differences across racial/ethnic groups except for Asians having lower odds of high costs compared to whites (Table 2). In sensitivity analyses, we found that results were similar when the threshold for high costs was the 80th instead of the 75th percentile, and that all race/ethnic groups, except for AI/ANs, had higher odds of high costs compared to whites when the threshold was the 90th percentile (results not shown). Other factors positively associated with high costs among cases included having one or more comorbid conditions versus none, having a stroke, having neurological care, and being LIS eligible (Table 2). In the random sample, older age, a high number of comorbidities, and neurological care were positively associated with high costs (Table 2).

Low AED adherence was associated with a greater likelihood of high costs (OR = 2.66, 95% CI = 2.52–2.80) among cases, whereas care concordant with QUIET 15 was not associated with high costs among beneficiaries with seizures in ER settings (Table 3). Among new cases, the association of high cost and treatment concordant with QUIET 6 was marginally significant (OR = 0.72, 95% CI = 0.53–0.98), whereas the association with QUIET 9 concordant treatment was not significant. Being at risk for drug interactions was associated with lower odds of high costs (OR = 0.80, 95% CI = 0.68–0.95; Table 3). Adjusting for these care factors did not explain the significant association of high costs with African American race/ethnicity. However, when controlling for non-adherence, this association was only marginally significant (OR = 1.09, 95% CI = 1.01–1.18, $P = 0.03$) (not shown).

The subset of beneficiaries with at least one claim in each 6-month interval before and after the index event included 26 800 cases, of which 2525 were new cases, and 525 403 were random sample beneficiaries. These beneficiaries did not differ significantly from the overall cohorts presented in Table 1 except for a higher proportion of cases with at least four comorbid conditions (51%) and a slightly higher proportion with high costs (27%; results not shown). Costs of care showed a similar pattern across all groups of epilepsy cases. The highest costs were in the 6 months before and in the 6 months after the epilepsy index event with mean total costs of about \$17 000 in each of those 6-month periods, and median costs of \$6271 and \$5024 in the 6 months before and after the index event, respectively (Figure 1). For new cases, mean costs were >\$29 000 in the time around the index event, and median costs were \$14 911 and \$15 328 in the 6 months before and after the index event, respectively (Figure 1). Cost patterns in the random sample were relatively stable in each of the 6-month periods and ranged on average from \$4718 to \$6627 (median = \$1046-\$1687; Figure 1).

Beneficiaries were responsible for an average of \$2367 in the 6 months before, and \$2638 in the 6 months after the index event (median = \$954-\$1323), about 12%–15% of total costs (Figure 1). The beneficiary cost for new cases was \$3558 in the 6 months before, and \$4236 in the 6 months after the index date (median = \$2063-\$2045). In the random sample, the beneficiary's share of costs was 15%–17%, and mean costs ranged from \$718 to \$1110 per 6 months over the 2-year period (median = \$196-\$423).

4 | DISCUSSION

In this cohort of mainly racial/ethnic minority groups of older Americans with epilepsy, minorities were more likely to have high costs of care. This disparity was not explained by the individual, economic, and health care factors considered. Costs of care were higher in epilepsy cases than in a random sample of Medicare beneficiaries, and especially high for those who may have developed epilepsy at this later age. More than 10% of these costs could be a direct burden to beneficiaries in out of pocket costs, and a considerable financial consequence of epilepsy especially for minority populations like African Americans. However, costs of care increased before an epilepsy event occurred, especially in potential new epilepsy cases. This suggests that comorbid conditions present before the epilepsy event may be leading to high costs. On the other hand, some indicators of quality care and better drug adherence were associated with a lower likelihood of high costs, indicating some potential avenues to reduce them.

Epilepsy-related costs have been reported mainly for the younger population.²⁵ Annual costs for all care received ranged from \$12 000 to \$18 000 in studies conducted in the early to late 2000s in private insurance populations.^{7,26–28} These costs were similar for older adults in Medicare Advantage plans in 2000–2006, for whom costs were about \$10 000 higher after compared to before the index epilepsy date.¹⁵ In older Arizona beneficiaries in fee for service Medicare plans around our study period, the mean annual cost was about \$22 000, with a median of about \$13 000.²⁹ These average estimates are lower than our estimate of > \$30 000 in the follow-up period, whereas the median costs were similar. As in our study, costs were also considerably higher for incident cases. Reasons for cost differences across

studies of older Medicare beneficiaries may be due to how cases and follow-up periods are defined, and to our study overrepresenting African Americans, who had higher costs than other groups. The costs of the overall Medicare older population with epilepsy may be lower and closer to the cost of white beneficiaries. Moreover, it is important to consider that any claims data analyses can only include patients who received medical care. Thus, by not including patients who did not need medical care, we and others may overestimate epilepsy costs. It is unclear, however, what proportion of older adults with epilepsy do not seek medical attention over a 1-year period.

This and other studies show that older adults with epilepsy have health care costs considerably higher than their counterparts without epilepsy or seizures. In our sample, costs during the 1-year follow-up were about \$17 000 higher than those of counterparts (with a difference in medians of about \$7000). These amounts are not very different from costs of other serious chronic diseases like breast or prostate cancer in the year postdiagnosis.³⁰ Of these costs, 12%–15% may be paid by Medicare beneficiaries through deductibles, copayments, and coinsurance, especially if beneficiaries do not have supplemental insurance. One 2009 study found that older Medicare beneficiaries had actual out of pocket costs of >\$400 on average for outpatient visits and >\$250 for hospitalizations, in addition to about \$1450 for drug prescriptions, including \$400 for AEDs.¹¹ This is a substantial burden for an older population that is more likely to have low socioeconomic status than the general Medicare older population; beneficiaries with epilepsy are more likely to be eligible for Medicare Part D LIS and dually eligible for Medicare and Medicaid.¹² Given this financial sequela of epilepsy, it is important to understand what contributes to high costs in older adults and what can be done to reduce them.

Some contributors to costs have been identified for younger populations, and include non–epilepsy-related comorbidities and uncontrolled epilepsy.²⁵ In older adults, we also found that multiple comorbidities were associated with high costs. These are burdensome for Medicare beneficiaries overall regardless of the presence or absence of epilepsy; beneficiaries with multiple chronic conditions are more likely to spend 20% of their income on health care costs.³¹ Moreover, given that cost spikes may occur before epilepsy events, especially in new cases, it will be important to investigate whether these high costs are due to uncontrolled epilepsy or to other diagnoses, procedures, and types of health care encounters around an epilepsy event. In a private insurance younger population with epilepsy, health care utilization was mainly for non–epilepsy-specific care, and epilepsy-specific costs were only a fraction of the total.^{10,25} The same may hold for older adults, especially given important risk factors for epilepsy and seizures like stroke.

Similar to other studies,^{9,15,29,32} our indicator of low treatment adherence was associated with high costs. Other indicators of epilepsy care quality may be inversely associated with high costs, including starting treatment on monotherapy, as well as, counterintuitively, having drug interaction risk. These results may mask some important confounding. Older adults on monotherapy may be the ones with controlled epilepsy; one study defined uncontrolled epilepsy as the use of multiple AEDs.⁷ Beneficiaries with interaction risk may be those receiving care for comorbid conditions; benefits from that care may outweigh the risk associated with the drug combinations they are prescribed. Moreover, the proportion of

beneficiaries with an interaction risk considered severe or fatal was quite low; most beneficiaries were prescribed drug combinations with lower risk.¹⁶ More research is needed to understand how the quality of care for comorbid conditions benefits older adults with epilepsy. Other quality of epilepsy care indicators we considered were not associated with high costs. There was only a tenuous association indicating lower odds of high costs for beneficiaries with QUIET 9 concordant care, in line with a study in a younger UK population in which use of enzyme-inducing drugs was associated with higher costs than use of non-enzyme-inducing AEDs.³³

Factors included in our analysis were not enough to explain the higher odds of high costs for African Americans with epilepsy, except potentially for AED adherence. Because race/ethnicity differences were not observed in the random sample of Medicare beneficiaries, closer scrutiny of the health care utilization of African Americans and other demographic groups with epilepsy is warranted. Given that African Americans may have lower adherence to AED treatment⁴ and be more likely to have ER-related claims for seizures,⁵ it is plausible to hypothesize that their higher costs were driven by ER visits and hospitalizations. In other studies, cost differences for adherent and nonadherent patients were due mainly to these events.^{9,15} If this is true, then investigating which diagnoses are associated with those events will shed light on interventions to reduce costs and improve outcomes in minority populations.

In conjunction with the available literature, there are potential interventions that might be developed to address the escalating costs of medical care in the older population with epilepsy, for example, programs that focus on improving compliance (eg, through home-health nurse visits) and that may improve AED adherence. Although neurological care appeared to bear higher costs, this may be due to more complicated and higher-cost patients being referred to neurologists while “simpler” and less costly cases are managed by primary care providers. Alternatively, neurological care may lead to higher costs only in the short term, due to imaging, hospital admissions, and/or more frequent specialty/subspecialty visits. Investigations should test this hypothesis. A few studies comparing care and outcomes across treatment settings may support it.^{34,35} In our population, neurological care was associated with what may be considered better care, that is, QUIET 9 concordant AEDs,¹⁴ starting AED within 30 days of index event,¹² and lower risk of drug interactions in new cases.¹⁶ Provider-level interventions, for example to stress the importance of monotherapy and minimizing medication burden(s), may be necessary to reduce costs. In addition, we must consider how health care costs may be driven by the social and economic conditions of older adults with epilepsy, and consider interventions addressing social determinants of health.^{15,36,37} There is increasing evidence that providing social and support services to address the realities of where patients live leads to better outcomes and reduced health care utilization and costs.³⁸ Therefore, a focus on patient-level, provider-level, and potentially community-level interventions is needed to develop models of care that can reduce epilepsy costs.

This study has limitations to consider. As stated above, we were not able to identify epilepsy cases who did not need medical care in the study period. Moreover, the claim-based epilepsy identification algorithm may have missed cases, although it was more conservative than

published algorithms that have high positive predictive values. We only considered a 1-year clean period to identify new cases; some may have epilepsy events before that period. It is unclear, however, how including these prevalent cases among new cases affects results; they may be the less severe cases and, thus, bias results toward lower costs for new cases. Moreover, some new cases may have been excluded if using AEDs, such as gabapentin, for reasons other than epilepsy. We did not adjust for inflation, and thus, we may have overestimated the cost difference from the period before to the period after the index event. However, this is a relatively short time span in which inflation did not increase significantly.³⁹ Our assessment of guideline-concordant AEDs may have been affected by incomplete Part D data; however, only about 6% of Part D prescriptions are not adjudicated,⁴⁰ and data are considered valid.⁴¹ Low AED adherence could be underestimated because our determination is based on gaps in prescription refills and it does not reflect whether patients take their AEDs once the prescription is refilled. Moreover, it could be overestimated as gaps may be, for instance, due to physician-prescribed interruptions. Results may not generalize to the larger Medicare population but only to beneficiaries with fee for service Medicare and on Part D. Lastly, our cohort overrepresented minority groups by design compared to a random sample of Medicare beneficiaries meeting similar inclusion criteria.⁴

In conclusion, costs for older adults with epilepsy are a considerable financial burden for health care payers and patients, especially for African Americans. Costs spike in the 6 months before and 6 months after medical encounters related to epilepsy or seizures. This burden is higher for those with health compromised by other comorbidities or recurring seizure events. However, some factors such as better AED adherence and perhaps better care for co-morbid conditions could help reduce these costs. Further research should investigate the reasons for health care utilization as well as the quality of medical care for epilepsy and other comorbid conditions that may contribute or prevent high costs in different groups of older adults. Findings would inform the necessary interventions and programs to ensure a life free of seizures and side effects, including financial side effects, for all groups of older adults with epilepsy.

ACKNOWLEDGMENTS

The authors thank Aquila Brown-Galvan, Nancy Cohen, and Kay Clements for administrative support, medical coding, and clinical input.

CONFLICT OF INTEREST

J.P.S. has received research funding from the National Institutes of Health, National Science Foundation, Shor Foundation for Epilepsy Research, Department of Defense, UCB Biosciences, NeuroPace, SAGE Therapeutics, Serina Therapeutics, Greenwich Biosciences (supply of Epidiolex), State of Alabama, Biogen, and Eisai; is a consultant or an advisory board member for SAGE Therapeutics, GW Pharmaceuticals, NeuroPace, Upsher-Smith Laboratories, Medical Association of the State of Alabama, SK LifeSciences, Serina Therapeutics, LivaNova, Lundbeck, and Elite Medical Experts; and is an editorial board member for *Epilepsy & Behavior*, *Journal of Epileptology* (associate editor), *Journal of Medical Science*, *Epilepsy Currents* (contributing editor), and *Folia Medica Copernicana*. E.Fa. has served as a consultant for Biogen, Eisai, and UCB Pharma, and as a data-safety monitoring board member for Eisai, SAGE, and SK Life Science; has received research funding from Brain Sentinel, NeuroPace, the University of Alabama at Birmingham, and UCB Pharma; is on the editorial board of *Epilepsy Currents*; was on the Medicare Evidence Development and Coverage Advisory Committee of the Center for Medicare and Medicaid Services 2011–2014; was Chair of the Treatments Committee of the American Epilepsy Society 2012–2015; and is Chair of the International League Against Epilepsy Task Force on Epilepsy in the Elderly. R.C.M. has received research funding from the National Institutes of Health, the National Science Foundation, the State of Alabama, and the University of Alabama at Birmingham; and serves on the editorial board

for *Epilepsy Currents*. None of the other authors has any conflict of interest to disclose. The authors confirm that they have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with these guidelines.

Funding information

The study was funded by the National Institute of Neurological Disease and Stroke (1RO1NS080898-01, Maria Pisu, Principal Investigator).

REFERENCES

1. Irshaid YM, Hamdi AA, Al Homrany M. Evaluation of therapeutic drug monitoring of antiepileptic drugs. *Int J Clin Pharmacol Ther*. 2003;41:126–31. [PubMed: 12665161]
2. Thorne D, Foohey P, Lawless R, Porter K. Graying of U.S. bankruptcy: fallout from life in a risk society. 2018 Available at: <https://ssrn.com/abstract=3226574>. Accessed January 5, 2019.
3. Faught E, Richman J, Martin R, et al. Incidence and prevalence of epilepsy among older U.S. Medicare beneficiaries. *Neurology*. 2012;78:448–53. [PubMed: 22262750]
4. Piper K, Richman J, Faught E, et al. Adherence to antiepileptic drugs among diverse older Americans on Part D Medicare. *Epilepsy Behav*. 2017;66:68–73. [PubMed: 28038389]
5. Szaflarski JP, Martin RC, Faught E, et al. Quality Indicator for Epilepsy Treatment 15 (QUIET-15): intervening after recurrent seizures in the elderly. *Epilepsy Behav*. 2017;70:253–8. [PubMed: 28412154]
6. Manjunath R, Davis KL, Candrilli SD, et al. Association of antiepileptic drug nonadherence with risk of seizures in adults with epilepsy. *Epilepsy Behav*. 2009;14:372–8. [PubMed: 19126436]
7. Cramer JA, Wang ZJ, Chang E, et al. Healthcare utilization and costs in adults with stable and uncontrolled epilepsy. *Epilepsy Behav*. 2014;31:356–62. [PubMed: 24239435]
8. Zachry WM III, Doan QD, Smith BJ, Clewell JD, Griffith JM. Direct medical costs for patients seeking emergency care for losses of epilepsy control in a U.S. managed care setting. *Epilepsy Behav*. 2009;16:268–73. [PubMed: 19747882]
9. Faught RE, Weiner JR, Guerin A, Cunnington MC, Duh MS. Impact of nonadherence to antiepileptic drugs on health care utilization and costs: findings from the RANSOM study. *Epilepsia*. 2009;50:501–9. [PubMed: 19183224]
10. Kurth T, Lewis BE, Walker AM. Health care resource utilization in patients with active epilepsy. *Epilepsia*. 2010;51:874–82. [PubMed: 20002149]
11. Halpern MT, Renaud JM, Vickrey BG. Impact of insurance status on access to care and out-of-pocket costs for U.S. individuals with epilepsy. *Epilepsy Behav*. 2011;22:483–9. [PubMed: 21890417]
12. Martin RC, Faught E, Szaflarski JP, et al. What does the U.S. Medicare administrative claims database tell us about initial antiepileptic drug treatment for older adults with new-onset epilepsy? *Epilepsia*. 2017;58:548–57. [PubMed: 28176298]
13. Pugh MJ, Berlowitz DR, Montouris G, et al. What constitutes high quality of care for adults with epilepsy? *Neurology*. 2007;69:2020–7. [PubMed: 17928576]
14. Pisu M, Richman J, Piper K, et al. Quality of antiepileptic treatment among older Medicare beneficiaries with epilepsy: a retrospective claims data analysis. *Med Care*. 2017;55:677–83. [PubMed: 28437319]
15. Ettinger A, Manjunath R, Candrilli SD, Davis KL. Prevalence and cost of nonadherence to antiepileptic drugs in elderly patients with epilepsy. *Epilepsy Behav*. 2009;14:324–9. [PubMed: 19028602]
16. Faught E, Szaflarski JP, Richman J, et al. Risk of pharmacokinetic interactions between antiepileptic and other drugs in older persons and factors associated with risk. *Epilepsia*. 2018;59:715–23. [PubMed: 29411348]
17. Thurman DJ, Beghi E, Begley CE, et al. Standards for epidemiologic studies and surveillance of epilepsy. *Epilepsia*. 2011;52(suppl 7):2–26. [PubMed: 21899536]

18. Pugh MJ, Rosen AK, Montez-Rath M, et al. Potentially inappropriate prescribing for the elderly: effects of geriatric care at the patient and health care system level. *Med Care*. 2008;46:167–73. [PubMed: 18219245]
19. Holden EW, Grossman E, Nguyen HT, et al. Developing a computer algorithm to identify epilepsy cases in managed care organizations. *Dis Manag*. 2005;8:1–14. [PubMed: 15722699]
20. Andersen RM, Davidson PL. Improving access to care in America: individual and contextual indicators In: Andersen RM, Rice TH, Kominski GF, eds. *Changing the U.S. Health Care System: Key Issues in Health Services, Policy, and Management*. San Francisco, CA: Jossey-Bass Health Series, 2001; p. 3–31.
21. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol*. 1992;45:613–9. [PubMed: 1607900]
22. Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. *J Clin Epidemiol*. 1993;46:1075–9; discussion 1081–90. [PubMed: 8410092]
23. Martin RC, Faught E, Richman J, et al. Psychiatric and neurologic risk factors for incident cases of new-onset epilepsy in older adults: data from U.S. Medicare beneficiaries. *Epilepsia*. 2014;55:1120–7. [PubMed: 24902475]
24. Howard G, Moy CS, Howard VJ, et al. Where to focus efforts to reduce the black-white disparity in stroke mortality: incidence versus case fatality? *Stroke*. 2016;47:1893–8. [PubMed: 27256672]
25. Begley CE, Durgin TL. The direct cost of epilepsy in the United States: a systematic review of estimates. *Epilepsia*. 2015;56:1376–87. [PubMed: 26216617]
26. Ivanova JI, Birnbaum HG, Kidolezi Y, Qiu Y, Mallett D, Caleo S. Economic burden of epilepsy among the privately insured in the US. *Pharmacoeconomics*. 2010;28:675–85. [PubMed: 20623993]
27. Wilner AN, Sharma BK, Soucy A, Krueger A. Health plan paid cost of epilepsy in 2009 in the U.S. *Epilepsy Behav*. 2012;25:412–6. [PubMed: 23123280]
28. Wilner AN, Sharma BK, Thompson A, Soucy A, Krueger A. Diagnoses, procedures, drug utilization, comorbidities, and cost of health care for people with epilepsy in 2012. *Epilepsy Behav*. 2014;41:83–90. [PubMed: 25461195]
29. Ip Q, Malone DC, Chong J, Harris RB, Labiner DM. Economic impact of epilepsy and the cost of nonadherence to antiepileptic drugs in older Medicare beneficiaries. *Epilepsy Behav*. 2018;80:208–14. [PubMed: 29414554]
30. Pisu M, Henrikson N, Banegas M, Yabroff KR. Costs of cancer along the care continuum: what we can expect based on recent literature. *Cancer*. 2018;124(21):4181–91. [PubMed: 30475400]
31. Cohen S, Davis K, Willink A. Medicare beneficiaries' high out of pocket costs: cost burdens by income and health status. *Issue Brief (Commonw Fund)*. 2017;11:1–14. [PubMed: 28498650]
32. Davis KL, Candrilli SD, Edin HM. Prevalence and cost of nonadherence with antiepileptic drugs in an adult managed care population. *Epilepsia*. 2008;49:446–54. [PubMed: 18031549]
33. Borghs S, Thieffry S, Noack-Rink M, et al. Health care cost associated with the use of enzyme-inducing and non-enzyme-active antiepileptic drugs in the UK: a long-term retrospective matched cohort study. *BMC Neurol*. 2017;17:59. [PubMed: 28335764]
34. Hope OA, Zeber J, Kressin NR, et al. New-onset geriatric epilepsy care: race, setting of diagnosis, and choice of antiepileptic drug. *Epilepsia*. 2009;50:1085–93. [PubMed: 19054416]
35. Szaflarski JP, Rackley AY, Lindsell CJ, Szaflarski M, Yates SL. Seizure control in patients with epilepsy: the physician vs. medication factors. *BMC Health Serv Res*. 2008;8:264. [PubMed: 19094222]
36. Adler NE, Glymour MM, Fielding J. Addressing social determinants of health and health inequalities. *JAMA*. 2016;316:1641–2. [PubMed: 27669456]
37. Artiga S, Hinton E. Beyond health care: the role of social determinants in promoting health and health equity. 2018 Available at: <https://www.kff.org/disparities-policy/issue-brief/beyond-health-care-the-role-of-social-determinants-in-promoting-health-and-health-equity/>. Accessed January 5, 2019.
38. Taylor LA, Tan AX, Coyle CE, et al. Leveraging the social determinants of health: what works? *PLoS One*. 2016;11:e0160217. [PubMed: 27532336]

39. Dunn A, Grosse SD, Zuvekas SH. Adjusting health expenditures for inflation: a review of measures for health services research in the United States. *Health Serv Res.* 2018;53:175–96. [PubMed: 27873305]
40. Roberto PN, Stuart B. Out-of-plan medication in Medicare Part D. *Am J Manag Care.* 2014;20:743–8. [PubMed: 25365749]
41. Zhou L, Stearns SC, Thudium EM, Alburikan KA, Rodgers JE. Assessing Medicare Part D claim completeness using medication self-reports: the role of veteran status and generic drug discount programs. *Med Care.* 2015;53:463–70. [PubMed: 25793271]

Key Points

- Costs of care for older adults with epilepsy are considerably higher than for the general population of older Americans and highest before and after an epilepsy or seizure event
- African Americans were more likely to have high costs after the epilepsy event than other racial/ethnic groups
- Poor adherence to antiepileptic drug treatment, a higher number of comorbidities, and receiving neurological care were associated with high costs
- Quality care indicators examined here were not associated with high costs or may be protective

FIGURE 1.

Costs of care for 12–0 months before the index event, and for 0–12 months after the index event, for all and new epilepsy cases, and for a random sample of Medicare beneficiaries. Mean costs by payer (Medicare, beneficiary, and other payer), and median, 25th percentile, and 75th percentile of total costs for all payers combined are shown

TABLE 1
 Characteristics of Medicare beneficiaries with epilepsy and in a random sample, 2009. Medicare claims data 2008–2010

All epilepsy cases, n = 36 912		New epilepsy cases, n = 3706		Medicare beneficiaries' random sample, n = 633 710		
	All	With high costs	All	With high costs	All	With high costs
All	100	25.0	100	37.4	100	25.0
Race/ethnicity						
White	19.2	18.8 ^a	17.9	29.2 ^a	87.0	24.6 ^a
African American	62.5	27.3 ^a	61.2	40.6 ^a	7.7	29.9 ^a
Hispanic	11.3	24.2 ^a	12.3	36.0 ^a	2.4	28.9 ^a
Asian	5.0	22.7 ^a	6.6	35.1 ^a	2.4	18.4 ^a
AI/AN	2.0	20.8 ^a	2.0	31.5 ^a	0.4	28.1 ^a
Female	61.6	24.5 ^b	64.9	36.8	69.1	24.7 ^a
Male	38.4	25.8 ^b	35.1	38.7	30.9	25.7 ^a
Age in 2009						
67–74	41.5	24.8 ^b	34.9	39.3	38.4	20.0 ^a
75–84	36.1	25.8 ^b	37.3	37.5	35.6	25.9 ^a
85+	22.4	24.0 ^b	27.8	35.1	26.0	31.1 ^a
Comorbid conditions						
0	8.3	5.9 ^a	3.7	15.2 ^a	41.4	15.0 ^a
1–3	45.7	15.9 ^a	41.0	24.6 ^a	39.5	25.1 ^a
4 or more	46.0	37.5 ^a	55.3	48.5 ^a	19.1	46.6 ^a
Neurologist close to diagnosis	36.3	31.1 ^a	72.8	40.3 ^a	5.5	47.0 ^a
No neurologist	63.7	21.5 ^a	27.2	29.8 ^a	94.5	23.7 ^a
LIS eligible	82.0	26.6 ^a	77.2	39.9 ^a	33.5	31.3 ^a
Not LIS eligible	18.0	17.6 ^a	22.8	29.2 ^a	66.5	21.8 ^a
Region of residence						

	All epilepsy cases, n = 36 912				New epilepsy cases, n = 3706				Medicare beneficiaries' random sample, n = 633 710			
	All	With high costs	All	With high costs	All	With high costs	All	With high costs	All	With high costs	All	With high costs
Northeast ^c	18.7	28.9 ^a	18.8	41.7	19.3	26.7 ^a						
Other region	81.3	24.1 ^a	81.2	36.5	80.6	24.6 ^a						
High poverty ZIP	44.1	26.1 ^a	43.6	38.3	21.5	26.6 ^a						
Not high poverty	55.9	24.2 ^a	56.4	36.9	78.5	24.6 ^a						

Abbreviations: AI/AN, American Indian/Alaskan Native; LIS, Part D Low Income Subsidy.

^a $P < 0.001$.

^b $P < 0.01$.

^c Northeast = Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania.

TABLE 2

Adjusted logistic regressions to examine the association of high costs^a and race/ethnicity

	Epilepsy cases		
	Prevalent n = 36 912 OR (95% CI)	New n = 3706 OR (95% CI)	Random sample n = 633 710 OR (95% CI)
White	1.00	1.00	1.00
African American	1.20 (1.11–1.29)	1.66 (1.29–2.14)	1.01 (0.99–1.04)
Hispanic	0.99 (0.89–1.09)	1.39 (1.01–1.93)	0.92 (0.89–0.96)
Asian	0.99 (0.87–1.14)	1.43 (0.97–2.10)	0.60 (0.58–0.63)
AI/AN	1.08 (0.88–1.33)	1.04 (0.52–2.07)	1.09 (0.99–1.19)
Female	0.93 (0.89–0.98)	0.84 (0.71–0.99)	0.91 (0.90–0.92)
Age in 2009			
67–74	1.00	1.00	1.00
75–84	0.98 (0.93–1.04)	0.75 (0.62–0.90)	1.24 (1.22–1.26)
85+	0.90 (0.84–0.97)	0.62 (0.51–0.77)	1.46 (1.44–1.48)
Comorbid conditions			
0	1.00	1.00	1.00
1–3	2.63 (2.24–3.10)	1.12 (0.61–2.03)	1.71 (1.68–1.73)
4 or more	7.55 (6.40–8.91)	2.80 (1.53–5.11)	3.99 (3.93–4.06)
Cerebrovascular disease vs other	1.13 (1.07–1.20)	1.31 (1.05–1.64)	1.11 (1.10–1.13)
Neurologist close to the epilepsy index date	1.65 (1.57–1.74)	1.49 (1.23–1.81)	2.49 (2.43–2.55)
LIS eligible	1.44 (1.33–1.56)	1.43 (1.15–1.79)	1.35 (1.33–1.37)
High poverty	1.02 (0.97–1.08)	0.87 (0.74–1.03)	1.00 (0.98–1.01)
Region of residence ^b			
Other vs Northeast	0.84 (0.78–0.89)	0.76 (0.63–0.93)	1.02 (1.00–1.03)
Used, n	35 378	3561	622 917

Note: Analyses were adjusted for all variables listed here.

Abbreviations: AI/AN, American Indian/Alaskan Native; CI, confidence interval; LIS, Part D Low Income Subsidy; OR, odds ratio.

^aHigh costs = annual cost 75% in the follow-up period.

^bNortheast = Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania.

TABLE 3
Summary of analyses on association of high costs^a with health care behavior and quality care indicators

Indicators	n	n used	Odds ratio	95% confidence interval
Prevalent cases				
Low adherence, PDC < 80%	36 912	35 732	2.66	2.52 2.80
Care concordant with QUIET 15 among cases with seizure in the ER	4132	4009	1.07	0.93 1.24
New cases				
Care concordant with QUIET 6	3706	3601	0.72	0.53 0.98
Care concordant with QUIET 9	3706	3601	0.88	0.76 1.02
Drug interaction risk present	3706	3601	0.80	0.68 0.95

Note: Analyses were adjusted for race, gender, age, number of comorbid conditions, cerebrovascular disease, having a neurologist visit 30–60 days around index event, eligible for Part D Low Income Subsidy, in Northeast, and high-poverty ZIP code.

Abbreviations: ER, emergency room; PDC, proportion of days covered; QUIET, Quality Indicators of Epilepsy Treatment.

^aHigh costs = total cost in 1 year after the index event > 75% percentile.