Prevalence of epilepsy/seizures as a comorbidity of neurologic disorders in nursing homes

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ABSTRACT

Objective: To determine the prevalence of epilepsy/seizure (epi/sz) comorbid with other neurologic disorders in elderly nursing home residents and to examine demographic and regional variability and associations with clinical characteristics.

Methods: We studied 5 cross-sectional cohorts of all residents in any Medicare/Medicaid-certified nursing home in the United States on July 15 of each year from 2003 to 2007. Epi/sz was identified by ICD-9 codes (345.xx or 780.39) or check box (Minimum Data Set). Epi/sz prevalence was stable across all years, so only 2007 data were examined further. Logistic regression with generalized estimating equations was used to model cross-sectional prevalence of epi/sz as a function of demographics and neurologic comorbidities of interest, with adjustment for clinical characteristics, including cognitive status, comorbidity burden, medication burden, and activities of daily living.

Results: Point prevalence of epi/sz in 2007 was 7.7% (n = 91,372 of N = 1,186,579) differing by geographical region, race/ethnicity, age group, and sex. Neurologic conditions having the highest association with epi/sz were brain tumor (epi/sz prevalence 23.4%–35.2%), head injury (17.9%), hemiplegia (17.7%), and stroke (13.7%). Epi/sz comorbid with stroke or dementia had a strong decreasing association with age (65–74 years had ≈3.8-times higher odds of epi/sz than 85+ years). Activities of daily living, comorbidity burden, and cognition scores were worse in persons with than without epi/sz.

Conclusions: The prevalence of epi/sz in the elderly nursing home population is >7-fold higher compared to community-dwelling elderly and is 7 to 30 times higher among those with certain comorbid neurologic conditions. Demographics and clinical characteristics had weaker associations with epi/sz prevalence. *Neurology*® 2017;88:750–757

GLOSSARY

ASD = antiseizure drug; **epi/sz** = epilepsy/seizure; **ICD-9** = *International Classification of Diseases, ninth revision*; **MDS** = Minimum Data Set; **MS** = multiple sclerosis; **NH** = nursing home; **OR** = odds ratio.

Because of their general health, elderly individuals are much more likely to have severe consequences from a seizure than younger persons.¹ With increasing concern regarding the ability to provide adequate and appropriate care to the nursing home (NH) population, it is important to define the epidemiology of epilepsy in this cohort. In community-dwelling elderly, the prevalence of epilepsy is ≈1.1%.^{2,3} A majority of these cases are located in the geographic Stroke Belt.^{4–6} Neurologic conditions comorbid with epilepsy are also common in NH elderly. Although the number of elderly will more than double in the United States, approaching 71.5 million by 2030,⁷ and the lifetime probability of a person entering an NH before death is 43% to 46%,⁸ there has not been a systematic evaluation of the prevalence of epilepsy with other neurologic disorders or the activity or cognitive status of these individuals.

We obtained the Minimum Data Set (MDS) assessments completed on all residents of Medicare- and/or Medicaid-certified NHs throughout the United States over a 5-year period (2003–2007). Non-Medicare patients were included, and because very few NHs are non-Medicare, this data set provides information regarding almost all persons in US NHs.

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Figure 1 Flowchart describing cohort of nursing home residents selected

A total of 2,761,650 Minimum Data Sets (MDS) were available for 2007, with 1,186,579 individuals being ≥ 65 years of age and having a full assessment.

The aim of this study was to assess the prevalence of epilepsy and seizures (epi/sz) in US NHs, to characterize regional and demographic variability, and to examine whether epi/sz prevalence differed by clinical characteristics. Our hypotheses were that NH residents with certain neurologic disorders would be highly affected by epi/sz and that those with epi/sz would have worse activities of daily living and cognitive status.

METHODS Study design and study cohort. The study consisted of 5 cross-sectional cohorts of all residents in any Medicare/Medicaid-certified US NH on July 15 of each of the years from 2003 to 2007. The cohort thus includes a mixture of newly admitted residents and those who have been in the NH for a long period. Each resident's health characteristics were recorded from the resident's full MDS for Nursing Home Assessment and Care Screening record that was dated most proximal to July 15 of each year. Overall, 98% of NHs in the United States have Medicare/Medicaid certification.⁹

NH data: MDS. All patients residing in Medicare- and Medicaid-certified NHs must be fully evaluated on admission, annually, and any time there is significant change in the resident's condition. A standardized assessment form (the MDS) is used. These regulations apply to all NH residents, regardless of source of payment for NH care. Nurses who have undergone specific training complete the MDS. The MDS demonstrates a reasonable level of consistency in how well MDS diagnoses correspond to hospital discharge diagnoses, and this information can be useful in research.^{10,11} Since 1997, all MDS records have been in a standardized electronic format, and a data quality protocol of range and logic checks has been in place. All data in this study are based on MDS version 2.0 <https://www.cms.gov/Research-Statistics-Data-and-Systems/Computer-Data-and-Systems/MinimumDataSets20/Downloads/MDS20Forms.pdf>. The residents' records were searched for ICD-9 codes and diagnosis check boxes of the various neurologic conditions of interest.

Diagnoses are coded with ICD-9 codes extending 2 places beyond the decimal point, which ensures the specificity of codes for chronic conditions such as epilepsy and for concomitant illnesses, including acute illnesses. A standardized protocol was developed and used to identify indications of diagnoses in the database.¹² The MDS 2.0 item I.1.aa (seizure disorder) or ICD-9 code 345.xx or 780.39 in item I.3 was included in the epi/sz category. Relevant check boxes and ICD-9 codes were used for all other diagnoses. Specific ICD-9 codes were as follows: stroke, 430.xx to 439.xx; head injury, 850.xx to 854.xx; skull fracture, 800.xx8 to 04.xx; brain tumor primary, 191.xx; brain tumor secondary, 198.3.x; Alzheimer disease, 331.0x; other dementia, 290.xx or 294.xx; hypertension, 401.xx–405.xx or 437.xx; diabetes mellitus, 250.xx, 357.2x, 362.0, or 366.41; Parkinson disease, 332.0x; multiple sclerosis (MS), 340.xx; or none of the above to evaluate persons with none of the specified neurologic conditions.

Analysis. The characteristics of each annual cross-sectional cohort were summarized separately, including demographics, clinical characteristics of function and cognition, medication and comorbidity burden, adverse outcomes related to epi/sz (falls and fractures), and prevalence of epi/sz with other comorbid conditions of interest. In addition, analysis of the prevalence of epi/sz associations with scores on the activities of daily living scale¹³ and rating of cognition (MDS Cognition Scale)¹⁴ was done. The Charlson Comorbidity Index,¹⁵ a measure of comorbidity burden in the MDS, and a medication burden scale were also included in the analysis. The medication burden scale counted the number of days of the previous 7 days that the resident received each of certain types of medications (antipsychotic, antianxiety, antidepressant, hypnotic, diuretic) and then summed the days. Because the prevalences of epi/sz and the most frequent conditions were very stable across the 5 years, further analyses used the 2007 cohort only. Selection of the MDS sets used is shown in figure 1. For this 2007 cohort, logistic regression modeling with generalized estimating equations (to account for clustering of residents within NHs) was done to model the cross-sectional prevalence of epi/sz as a function of the demographic and comorbidities of interest, adjusting for other clinical characteristics. One model was run with stroke as the comorbid focus; one model was run with dementia as the comorbid focus. Within each of these, a step-down Bonferroni procedure¹⁶ was used to carry out type I error correction across the *p* values for all tests of interest.

Standard protocol approvals, registrations, and patient consents. This study was approved by the Institutional Review Board of the University Minnesota, Twin Cities.

RESULTS The mean annual number of elderly residents in our US NH cohort from 2003 to 2007 was 1,233,695. For 2007, the distribution of sex, age, and race among elderly NH patients with and without an epi/sz indication is presented in table 1. The prevalence of epi/sz was ≈ 1.5 times higher for men than women. The prevalence was ≈ 4 times higher in the youngest (age 65–74 years) compared to the oldest (age 85+ years) age group. The highest prevalence of epi/sz by race was in black residents. Overall, those with epi/sz had on average slightly lower rates of prevalent falls or fractures in the past 180 days, slightly poorer measures of function and cognition,

Table 1 Demographics by epilepsy/seizure indication

	With epi/sz		Without epi/sz in subgroup		Prevalence of epi/sz within subgroup
Subgroup	n in subgroup	% in subgroup	n in subgroup	% in subgroup	
Sex					
Men	31,550	34.5	286,750	26.2	11.0
Women	59,821	65.5	808,372	73.8	7.4
Age at full assessment, y					
65–74	28,810	31.5	152,273	13.9	18.9
75–84	36,639	40.1	388,432	35.5	9.4
85+	25,923	28.4	554,502	50.6	4.7
Race/ethnicity					
Black, not Hispanic	16,833	18.4	117,979	10.8	14.3
White, not Hispanic	68,249	74.8	914,891	83.7	7.5
Other	6,193	6.8	60,371	5.5	10.3
American Indian/Alaskan Native	492	0.5	4,080	0.4	12.1
Asian/Pacific Islander	1,251	1.4	16,460	1.5	7.6
Hispanic	4,450	4.9	39,831	3.6	11.2
Had any fall in the past 180 d	32,894	36.0	413,988	37.8	7.4
Had any fracture in the past 180 d	7,310	8.0	117,187	10.7	5.9
Characteristic	Mean	SD	Mean	SD	
ADL (0 = independent to 6 = total dependence)	3.96	1.61	3.61	1.59	
MDS-COGS (0 = no impairment to 10 = maximum impairment)	4.92	3.04	4.19	2.95	
Charlson Comorbidity Index (range 0–30)	2.83	1.90	2.39	1.72	
Medication burden scale (range 0–35)	8.75	6.99	8.88	6.82	
Total sample	91,372		1,095,207		

Abbreviations: ADL = activities of daily living; epi/sz = epilepsy/seizure; MDS-COG = Minimum Data Set Cognition Scale. Restricted to those 65+ years of age. The full assessment closest to July 15 is presented. Demographics are based on data appearing on a majority of assessments completed for the resident. In the event of a tie, data from the admission assessment are used.

The p values were determined from the χ^2 test of whether epi/sz distribution varies by demographic subgroup or by health characteristic. All p values were <0.0001 and most likely reflected the large sample size of the cohort.

a slightly higher comorbidity burden, and a slightly lower comedication burden.

The neurologic condition having the highest association with an epi/sz indication was brain tumor, primary or secondary, with an epi/sz prevalence of 35.2% and 23.4%, respectively (table 2). The prevalence of epi/sz among those with dementias was lower (7.9% among those with any dementia, 7.0% among those with Alzheimer disease). The lowest rate of comorbidity was seen in those with none of the identified neurologic conditions, but even these persons had a rate of 6.5%.

There were large geographic differences in the prevalence of epi/sz comorbid with other conditions. The distribution of the prevalence of epi/sz indication among those who also had stroke and separately among those who also had dementia is shown in figure 2, A and B. The prevalence of epi/sz among those with

stroke was highest in the West (California and Alaska) and in the Middle Atlantic and Southeast (Mississippi, Alabama, Georgia, South Carolina, and Maryland). The prevalence of epi/sz among those with dementia was similarly distributed, with prevalences highest in the West (California, Washington, and Alaska) and in the Middle Atlantic and Southeast (Mississippi, Alabama, South Carolina, and Maryland).

The odds ratios (ORs) for epi/sz associated with the comorbid condition of stroke in combination with each of the demographic subgroups and similarly for epi/sz associated with the comorbid condition of dementia are presented in table 3. In both the stroke model and the dementia model, age has a strong decreasing association with risk of prevalent epi/sz: 65- to 74-year-olds have 3.8- to 3.9-times higher odds of epi/sz than those 85+ years, and 75- to 84-year-olds have 1.9-times higher odds than those

Table 2 Neurologic comorbidities, overall and with epilepsy/seizure disorder, in 2007

	With the condition, n	Prevalence of the condition, %	With both the condition and epi/sz, n	Prevalence of epi/sz among those with condition, %
Epi/sz	91,372	7.7	NA	NA
Stroke	271,344	22.9	37,051	13.7
Hemiplegia	113,427	9.6	20,107	17.7
Head injury	4,467	0.4	800	17.9
Skull fracture	872	0.1	81	9.3
Brain tumor primary	886	0.1	312	35.2
Brain tumor secondary	303	0	71	23.4
Alzheimer disease	247,730	20.9	17,386	7.0
Any dementia	706,925	59.6	56,180	7.9
Hypertension	841,237	70.9	63,753	7.6
Diabetes mellitus	371,068	31.3	28,942	7.8
Parkinson disease	89,451	7.5	7,422	8.3
Multiple sclerosis	7,156	0.6	766	10.7
None of the above	68,913	5.8	4,454	6.5

Abbreviation: epi/sz = epilepsy/seizure; NA = not applicable.

85+ years. This trend across age groups may be driven in part by a healthy survivor effect. Other demographic associations are weaker: men have 1.2-times higher odds of epi/sz than women, while blacks have 1.3-times higher odds than whites and non-blacks have equivalent odds compared with whites.

There is a 1.1-times higher odds of epi/sz for each 1.6-point (≈ 1 SD) worse activities of daily living score; each 3-point (≈ 1 SD) worse score is associated with 1.3-times higher odds of epi/sz for the MDS Cognition Scale, while each 6-point (≈ 1 SD) worse score is associated with equivalent odds of epi/sz for the medication burden scale (data not shown). Results for the Charlson score were inconsistent between the dementia model and the stroke model; odds of epi/sz were 3% lower per 1.8 points (≈ 1 SD) in the dementia model but 16% higher per 1.8 points in the stroke model.

In the stroke model (table 3), stroke has a strong association with epi/sz risk. Those with stroke have 2.1 times the odds of epi/sz compared to those without stroke. This increased risk of epi/sz with stroke varies subtly by demographic subgroup; for example, men have 2.0-times increased odds while women have 2.2-times higher odds of epi/sz with stroke. Here, the strong effect of age is seen again: 65- to 74-year-olds with stroke have 3.3-times higher odds of epi/sz than 85+-year-olds with stroke, while 65- to 74-year-olds without stroke have 4.3-times higher odds of epi/sz than 85+-year-olds without stroke.

In the dementia model (table 3), overall dementia has no association with epi/sz risk. Those with dementia have 1.0 times the odds of epi/sz compared to those without dementia. This is largely true by demographic subgroup as well; for example, men and women alike have an OR for epi/sz associated

Figure 2 Prevalence of epilepsy/seizure indications for those with stroke and dementia by geographic region

(A) Stroke. Six categories of distribution are represented by shading from lightest to darkest: 0%-10.5%, 10.6%-11.8%, 12.0%-13.1%, 13.2%-14.1%, 14.3%-14.8%, and 15.0%-66.7%. (B) Dementia. Six categories of distribution are represented by shading from lightest to darkest: 0%-5.7%, 5.9%-6.5%, 6.8%-7.5%, 7.6%-8.2%, 8.4%-9.1%, and 9.2%-20.0%.

Table 3 Risk of epilepsy/seizure indication associated with comorbid stroke and dementia by sex, age, and race adjusted for health characteristics

	OR for epi/sz	Lower	Upper	χ^2	p ^a
Stroke					
Main effects					
Men vs women	1.1661	1.1477	1.1849	357.35	<0.0001
Age 65–74 vs 85+ y	3.7858	3.7086	3.8646	16057	<0.0001
Age 75–84 vs 85+ y	1.9101	1.8763	1.9444	5072.5	<0.0001
Black vs white	1.3169	1.2895	1.3448	660.17	<0.0001
Other nonblack vs white	1.0012	0.9689	1.0347	0.01	0.9412
Stroke vs nonstroke	2.1248	2.0705	2.1806	3247.6	<0.0001
ADL scale (per 1 point worse)	1.04456	1.03904	1.05012	257.92	<0.0001
MDS COGS (per 1 point worse)	1.09243	1.08948	1.09549	3963.96	<0.0001
Charlson Comorbidity Index (per 1 point worse)	0.98354	0.97893	0.98807	49.14	<0.0001
Medication weeks (per 1 point worse)	1.0010	1.0000	1.0021	3.52	0.2411
Role of stroke in epi/sz risk within demographic subgroup					
Men: Stroke vs no stroke	2.0296	1.9656	2.0957	1873.6	<0.0001
Women: Stroke vs no stroke	2.2245	2.1626	2.2881	3089.3	<0.0001
Age 65–74 y: Stroke vs no stroke	1.8443	1.7848	1.9058	1338.4	<0.0001
Age 75–84 y: Stroke vs no stroke	2.2052	2.1373	2.2752	2458.8	<0.0001
Age 85+ y: Stroke vs no stroke	2.3588	2.2751	2.4454	2171.8	<0.0001
Black: Stroke vs no stroke	2.1107	2.0339	2.1903	1561.9	<0.0001
Other nonwhite: Stroke vs no stroke	2.076	1.9554	2.204	572.38	<0.0001
White: Stroke vs no stroke	2.1894	2.1466	2.2331	6053.6	<0.0001
Role of demographic in epi/sz risk by stroke subgroup					
Stroke: Men vs women	1.1139	1.087	1.1414	74.81	<0.0001
No stroke: Men vs women	1.2208	1.197	1.2451	393.23	<0.0001
Stroke: Age 65–74 vs 85+ y	3.3476	3.243	3.4556	5560.7	<0.0001
No stroke: Age 65–74 vs 85+ y	4.2813	4.1772	4.3881	13404	<0.0001
Stroke: Age 75–84 vs 85+ y	1.8468	1.7956	1.8995	1827.4	<0.0001
No stroke: Age 75–84 vs 85+ y	1.9754	1.9333	2.0185	3823.2	<0.0001
Stroke: Black vs white	1.2929	1.2545	1.3326	277.77	<0.0001
No stroke: Black vs white	1.3412	1.305	1.3784	441.56	<0.0001
Stroke: Other nonblack vs white	0.9749	0.9283	1.0239	1.03	0.6203
No stroke: Other nonblack vs white	1.0282	0.9876	1.0705	1.84	0.5249
Dementia					
Main effects					
Men vs women	1.1884	1.1697	1.2073	458.57	<0.0001
Age 65–74 vs 85+ y	3.9413	3.8612	4.0231	17115	<0.0001
Age 75–84 vs 85+ y	1.9482	1.9129	1.9842	5109	<0.0001
Black vs white	1.3179	1.2899	1.3464	637	<0.0001
Other nonblack vs white	1.008	0.9757	1.0414	0.23	0.9999
Any dementia vs not	1.0126	0.9867	1.0392	0.9	0.9999

Continued

with dementia of 1.0. However, there is an interaction of age with dementia: 65- to 74-year-olds with dementia have 4.2-times higher odds of epi/sz than 85+-year-olds with dementia, while 65- to 74-year-olds without dementia have 3.7-times higher odds of epi/sz than 85+-year-olds without dementia. There is also a subtle race/dementia interaction. Blacks with dementia have 1.5-times higher odds of epi/sz than whites with dementia, while blacks without dementia have 1.2-times higher odds of epi/sz than whites without dementia.

DISCUSSION This study is the largest evaluation of the prevalence of epi/sz in a nationwide elderly NH population estimated to include $\approx 98\%$ of all US NH residents from 2003 to 2007. The mean point prevalence of epi/sz over a 5-year period was 7.8%. This is in agreement with previous smaller studies in the United States and other countries, which ranged from $\approx 5\%$ to 10%.^{17–21} The prevalence of epi/sz in NHs is much greater than observed in community-dwelling persons ≥ 65 years of age, which is $\approx 1\%$ to 1.5%.^{4,22} The 7- to 8-fold increase in the prevalence of epi/sz in NH elderly compared to community-dwelling elderly suggests an increased incidence of epilepsy either before entering the NH or after admission. A previous nationwide study found that the prevalence of epilepsy on admission to NHs was 5.83%.¹² The total number of residents with epi/sz was $>90,000$ in our data for each year and represents a large proportion of all persons with epilepsy in the United States.

This study contributes new information on epi/sz as a comorbid condition with other neurologic disorders. Regional variation was large and followed the well-reported geographic distribution of stroke in the United States. Persons without the studied neurologic risk factors had a high prevalence of epi/sz (6.5%), although much lower than those with the neurologic conditions. This suggests that the aging process itself may lower the seizure threshold.

In one study of the epidemiology of epilepsy in community-dwelling elderly patients, a specific predisposing condition was identified in 62% to 65% of incident cases among all-age epilepsy etiology.¹² However, in our study, the vast majority of persons with an epi/sz diagnosis had one of the specified neurologic conditions (table 2). Only 4.8% of patients with epi/sz (data not shown) had none of the evaluated neurologic conditions. Thus, symptomatic epi/sz is much more common in the elderly NH population than in the community-dwelling population.

Stroke is reported to be the most common identifiable cause of epilepsy in the elderly. In a multicenter, prospective study of 1,897 community-dwelling individuals who had a stroke, seizures (single or multiple)

Table 3 Continued

	OR for epi/sz	Lower	Upper	χ^2	p^a
ADL scale (per 1 point worse)	1.05876	1.05306	1.06439	435.97	<0.0001
MDS COGS (per 1 point worse)	1.09834	1.094831	1.10197	3213.76	<0.0001
Charlson Comorbidity Index (per 1 point worse)	1.08589	1.081555	1.09024	1607.21	<0.0001
Medication weeks (per 1 point worse)	0.9982	0.997204	0.9993	10.37	0.0128
Role of dementia in epi/sz risk within demographic subgroup					
Men: Any dementia vs not	1.0323	0.9998	1.0658	3.81	0.3566
Women: Any dementia vs not	0.9933	0.9657	1.0217	0.22	0.9999
Age 65–74 y: Any dementia vs not	1.099	1.0641	1.1351	32.83	<0.0001
Age 75–84 y: Any dementia vs not	0.9569	0.9276	0.9871	7.7	0.0497
Age 85+ y: Any dementia vs not	0.9873	0.9517	1.0242	0.47	0.9999
Black: Any dementia vs not	1.1299	1.0879	1.1736	39.85	<0.0001
Other nonwhite: Any dementia vs not	1.0019	0.9446	1.0626	0	0.9999
White: Any dementia vs not	0.9172	0.8991	0.9357	71.98	<0.0001
Role of demographic in epi/sz risk by dementia subgroup					
Any dementia: Men vs women	1.2115	1.1876	1.2359	356.01	<0.0001
No dementia: Men vs women	1.1657	1.1381	1.1939	157.76	<0.0001
Any dementia: Age 65–74 vs 85+ y	4.1583	4.0539	4.2655	12056	<0.0001
No dementia: Age 65–74 vs 85+ y	3.7356	3.6213	3.8535	6911.1	<0.0001
Any dementia: Age 75–84 vs 85+ y	1.918	1.8788	1.9581	3819.3	<0.0001
No dementia: Age 75–84 vs 85+ y	1.9789	1.9209	2.0386	2025.1	<0.0001
Any dementia: Black vs white	1.4628	1.4265	1.5	879.48	<0.0001
No dementia: Black vs white	1.1874	1.149	1.227	104.99	<0.0001
Any dementia: Other nonblack vs white	1.0535	1.0129	1.0958	6.74	0.0754
No dementia: Other non-black vs white	0.9645	0.9185	1.0127	2.11	0.8780

Abbreviations: ADL = activities of daily living; epi/sz = epilepsy/seizure; MDS-COG = Minimum Data Set Cognition Scale; OR = odds ratio.

^a The p values are type I error corrected for all tests in this table with a stepdown Bonferroni method.¹⁶

occurred in 168 (8.9%).²⁴ This compares with the 13.7% stroke comorbidity in our cohort. Hemiplegia may be a marker of severity of stroke, and those with hemiplegia had a higher rate of epi/sz than stroke alone. The geographic variability of epi/sz appears to correlate with the distribution of stroke, with residents in the Stroke Belt⁵ experiencing a higher prevalence of epi/sz. The relative risk of incident epilepsy after traumatic brain injury ranges from 1.5% (mild injury) to 17.2% (severe injury), and skull fracture is predictive of later seizures.²⁵ It is not possible from the MDS to determine the severity of head injury, but it is notable

that the prevalence of epi/sz comorbid with head injury ranged from $\approx 15\%$ to 18% in this cohort. Those with a comorbidity of skull fracture had a much lower prevalence of epi/sz. The highest condition comorbid with epilepsy was primary brain tumor, with secondary brain tumor having a lower rate.

Epi/sz has been associated with Alzheimer disease and other dementias. In a study of 236 persons with mild Alzheimer disease living at home or in long-term care facilities and followed up for up to 8.95 years (median 5.99 years), the cumulative incidence of unprovoked seizures was nearly 8%.²⁶ In a population-based case-control follow-up study, the risk of seizures after the development of dementia was high (OR 8.0, 95% confidence interval 2.0–33.3).² We found a prevalence of 7.8%.

Parkinson disease affects dopaminergic systems, and its presence may block the pathways needed to produce a generalized seizure.²⁷ Our data show that the prevalence of epi/sz is higher in persons with Parkinson disease compared to those with no predisposing conditions. Our population included >6,000 persons (2003–2007) with MS, and their prevalence of epi/sz ranged from 9% to 11%, supporting a relationship between neuronal loss in MS leading to epilepsy.^{28,29} Presence of epi/sz in these patients may add to the described extra needs of these persons.³⁰

In addition to neurologic conditions, we evaluated hypertension and diabetes mellitus as potential risk factors for the association of epilepsy and seizures. In a case-control study, hypertension remained an independent predictor of unprovoked seizures even after adjustment for prior stroke.³¹ We hypothesize that hypertension may be serving as a precursor to other undetected cerebrovascular conditions, e.g., cerebral ischemia. Although diabetes mellitus is associated with microvascular disease, there are no studies linking diabetes mellitus to the development of epilepsy. Research has established that diabetes mellitus is predictive of stroke, with one team finding an OR of 2.47 (95% confidence interval 1.16–5.24).³²

An epi/sz indication may often lead to administration of antiseizure drugs (ASDs), medications known to exhibit CNS side effects that may be more of a problem in elderly NH patients. One study found that >80% of NH residents with an ICD-9 code of 345.xx or 780.39 are being treated with an ASD.³³ Common ASD-associated adverse drug reactions such as ataxia, tremor, sedation, vertigo, dyskinesias, and lethargy may impede physical function.³⁴ The presence of epilepsy itself also greatly increases the risk of fracture in all ages.³⁴ In addition, fractures are more common in community-dwelling people 64+ years of age who have epilepsy compared to those without epilepsy. This increase associated with ASD use may be due to changes in bone mineral

density associated with ASDs or to side effects such as decreased balance. Fluctuations in ASD concentrations in elderly NH residents with phenytoin, carbamazepine, and valproic acid during constant dosing can be high in elderly persons in NHs.^{35,36} This may lead to episodes of dizziness, loss of balance, and confusion, which may predispose to falls and fractures. A slightly lower rate of falls and fractures in the epi/sz cohort in this study was unexpected and may be a reflection of decreased mobility in those with stroke or more cautious nursing care for those with these diagnoses. Interactions of ASDs with other drugs may also contribute to complications.

We found that scores for activities of daily living, frailty, and cognition were worse in persons with epi/sz than in those without this diagnosis, which could also be due to the side effects of ASDs and highlights the difficult decisions needed when using ASDs in this population. For example, treating a person with Alzheimer disease after a single seizure may worsen cognition, and the probability of a second seizure is unknown.

Classic epidemiologic case ascertainment of epilepsy requires the occurrence of 2 seizures.^{22,23} There is controversy regarding treatment after a single seizure.³⁷ However, in the context of an elderly person at risk of injury during a seizure, many physicians initiate treatment after a single seizure. Thus, applying the criterion of ≥ 2 seizures in this population is impractical. A newer definition has been proposed by an International League Against Epilepsy report that allows one to be classified as having epilepsy after a single seizure in the presence of a CNS disorder known to have a high probability of additional seizures.³⁸ Because it is necessary to assign a diagnostic code to all medication prescriptions, it has been suggested that the ICD-9 code 780.39 (convulsion not otherwise specified) may be used in the presence of a single seizure when in the judgment of a physician ASD treatment is indicated.³⁹ From the MDS, it is not possible to distinguish among the different types of seizures, but it is presumed that the majority were convulsive. The prevalence of complex partial seizures or other types in the NH remains unknown.

The sensitivity of the MDS diagnosis variables was reviewed for 945 skilled nursing facilities in Ohio during 2000, and they were found to be valid for most diagnoses.⁴⁰ Previously, our group evaluated the correlation of epi/sz diagnoses as recorded in the MDS with medical records in 11 NHs in Minnesota.¹¹ The agreement between the documentation of epi/sz in NH records (discharge summaries, drug orders, physician notes) and on the MDS was 92.3% of 142 records ($\kappa = 0.83$).¹¹ However, few records mentioned the use of an EEG or neurologist involvement in the assignment of the ICD-9 codes.

The major limitation of this study is that coding of epi/sz on the MDS was probably performed by physicians generally not familiar with the definitions of epilepsy used by neurologists. While this study documents the prevalence of the epi/sz diagnostic codes on the MDS, it does not answer the question about the prevalence of epilepsy as defined by the International League Against Epilepsy definition and based on medical records. The limitations inherent in this study demonstrate the great need for prospective studies in NHs to identify the actual prevalence of epilepsy in this cohort, to identify the extent of ASD use, and to begin to obtain evidence that may lead to appropriate use of ASDs in this vulnerable population.

AUTHOR CONTRIBUTIONS

Angela K. Birnbaum and Ilo E. Leppik: reviewed data analysis, wrote and revised manuscript. Kenneth Svensden: performed statistical analysis. Lynn E. Eberly: directed statistical analysis, wrote and revised manuscript.

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